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FORWARD

The 2000 Research Progress Report of the Western Society of Weed Science (WSWS) is a compilation of contributed results of research investigations by weed scientists in the western United States. The overall objectives of the Research Progress Report is to provide an avenue for the presentation and exchange of on-going research to the weed science community. The information in this report is preliminary; therefore, it is neither intended for publication, nor for the development of endorsements or recommendations.

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WSWS appreciates the time and effort of the chair and chair-elect of each project and the authors who shared their research results with other members of WSWS.

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PROJECT 1: WEEDS OF RANGE AND FOREST

Rita Beard, Chair

Herbicide timing for the control of squarrose knapweed. Steven A. Dewey, Holli Murdock, and R. William Mace. (Department of Plants, Soils and Biometeorology, Utah State University, Logan, Utah 84322-4820). Squarrose knapweed (CENSQ) is an aggressive invader of Utah high mountain deserts, displacing many native grasses and forbs. Several herbicides including picloram, picloram+2,4-D, and clopyralid were applied at three timings to evaluate their effectiveness for controlling this weed. Individual treatments were applied to 10 by 30 foot plots with a backpack CO_2 sprayer using flatfan 8002 nozzles providing a 10 foot spray width calibrated to deliver 25 gpa at 40 psi. The soil was a clay loam with 7.6 pH and O.M. content of less than 2%. Treatments were applied on May 16, June 16, and July 15, 1998 to a randomized block design, with three replications. Squarrose knapweed ranged in size, over the three application dates, from 4 inches to 20 inches tall and budding. Visual evaluations for weed control were completed July 15, August 25, 1998 and May 27, 1999.

All but one treatment proved to be excellent for controlling squarrose knapweed by the 1999 evaluation date. The low rate of picloram was only partially effective when applied June 16, although it displayed 86 percent control when applied in July. (Utah Agricultural Experiment Station, Logan, UT. 84322-4820)

Table. Herbicide timing for the control of squarrose knapweed

Treatment				Weed control CENSQ		
	Rate	Timing	Growth stage	7/15/98	8/25/98	5/27/99
	lb ai/A		Inches			
Picloram	0.25	May	3-5	90	93	99
Picloram	0.375	"	"	88	95	95
Picloram	0.5	"	"	90	100	100
Picloram/2,4-D	1.6	"	"	97	100	100
Clopyralid	1.5	"	"	90	83	92
Picloram	0.25	June	8-15	23	58	63
Picloram	0.375	"	"	23	75	98
Picloram	0.5	"	"	23	83	100
Picloram/2,4-D	1.6	"	"	27	93	100
Clopyralid	1.5	"	"	27	97	99
Picloram	0.25	July	20-24	na	13	86
Picloram	0.375	"	"	na	18	100
Picloram	0.5	"	"	na	23	100
Picloram/2,4-D	1.6	"	"	na	38	98
Clopyralid	1.5	"	"	na	40	99
Check				0	0	0
$LSD_{(0.05)}$				9	13	6

<u>Perennial pepperweed control with metsulfuron and imazethapyr herbicides.</u> Steven A. Dewey, Holli Murdock, and R. William Mace. (Department of Plants, Soils and Biometeorology, Utah State University, Logan, Utah 84322-4820). Perennial pepperweed (LEPLA) and poverty weed (IVAAX) were treated with several herbicides including imazethapyr, metsulfuron, and 2,4-D to evaluate their effectiveness for perennial pepperweed control. Individual treatments were applied to 10 by 30 foot plots with a backpack CO_2 sprayer using flatfan 8002 nozzles providing a 10 foot spray width calibrated to deliver 25 gpa at 40 psi. The soil was a silty clay with 8 pH and O.M. content of less than 2%. Treatments were applied July 16, 1998 to a randomized block design, with three replications. Perennial pepperweed was a little past the bud stage to flowering and ranged in size from 2 to 3 feet tall. Visual evaluations for weed control were completed July 1, 1999.

Excellent control of perennial pepperweed was achieved using both metsulfuron and imazethapyr at all treatment rates; 2,4-D was less effective. Metsulfuron also provided excellent control of povertyweed but imazethapyr did poorly. The salt grasses present were not injured by either herbicide. (Utah Agricultural Experiment Station, Logan, UT. 84322-4820)

Table. Perennial pepperweed control with metsulfuron and imazethapyr herbicides

Treatment[a]	Rate	Weed control LEPLA	Weed control IVAAX
		7/1/99	
	oz ai/A	----%----	
Metsulfuron	0.5	100	95
Metsulfuron	0.75	100	98
Metsulfuron+	0.5+	99	99
2,4-D amine	12		
2,4-D amine	24	88	98
Check		0	0
Imazethapyr	1	99	31
Imazethapyr	2	100	37
Imazethapyr	3	100	61
$LSD_{(0.05)}$		4	40

[a] Nonionic surfactant applied at 0.25% v/v all treatments.

Silky crazyweed control with various herbicides. Mark A. Ferrell. This research was conducted 17 miles east of Laramie, Wyoming to evaluate silky crazyweed control with applications of various 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 10 gpa at 40 psi on June 7, 1996 (air temp. 52 F, soil temp. 0 inch 65 F, relative humidity 63%, wind north at 1 mph, 10% cloud cover). The soil was a sandy loam (64% sand, 21% silt, and 15% clay) with 3.3% organic matter and 6.5 pH. Silky crazyweed was in bud to 30% bloom and 4 to 8 inches in height. Infestations were heavy throughout the experimental area. Plant counts of the entire 10 by 27 ft plot were made June 7, 1996 prior to herbicide application. Pre-treatment counts were compared to post-treatment counts to obtain percent control for 1997 and 1999 data. Visual estimation was used for percent control in 1998.

The only treatment showing excellent control three years after application is picloram at 0.5 pounds per acre. Treatments combined with picloram continue to provide good control three years after application. Metsulfuron at 0.12 oz is also maintaining good control. (Wyoming Agric. Exp. Sta., Laramie, WY 82071. SR1734)

Table. Silky crazy weed control.

Treatment[1]	Rate	Silky crazyweed control[2]		
		June 4, 1997	June 1, 1998	June 18, 1999
	lb/A	%		
2,4-D (Hi Dep)	1.0	20	0	10
2,4-D (Hi Dep)	2.0	38	0	17
2,4-D amine	1.0	46	0	27
2,4-D amine	2.0	64	0	33
MCPA amine	2.0	5	0	8
2,4-D (Hi Dep) +picloram	1.0+0.125	96	74	85
2,4-D amine+picloram	1.0+0.125	96	99	80
2,4-D (Hi Dep)+metsulfuron[3]	1.0+0.06 oz	99	69	80
Picloram	0.125	97	92	82
Picloram	0.5	100	100	100
Metsulfuron[3]	0.12 oz	100	99	84
(LSD 0.05)		21	28	26
(CV)		22	44	35

[1]Treatments applied June 7, 1996.
[2]All plants were counted in the 10 by 27 ft plots immediately before herbicide application. Pre-treatment counts were compared to post-treatment counts to obtain percent control for 1997 and 1999 data. Visual estimation was used for percent control in 1998.
[3]X-77 added at 0.25% v/v.

Geyer larkspur control with various herbicides. Mark A. Ferrell and Thomas D. Whitson. This research was conducted north of Cheyenne, Wyoming to evaluate Geyer larkspur control with applications of various 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 30 gpa at 30 psi on June 23, 1995 (air temp. 70 F, soil temp. 0 inch 84 F, relative humidity 40%, wind north at 4 mph, sky clear). The soil was a sandy loam (57% sand, 24% silt, and 19% clay) with 4% organic matter and a 6.7 pH. Larkspur was in bud and 6 to 12 inches in height. Infestations were heavy throughout the experimental area. Plant counts of the entire 10 by 27 ft plot were made June 16, 1995 immediately before herbicide application. Pre-treatment counts were compared to post-treatment counts to obtain percent control.

The only treatments providing adequate larkspur control four years after treatment application were Tordon 22K at one quart per acre and HiDep at one quart plus Tordon 22K at ½ pint per acre. (Wyoming Agric. Exp. Sta., Laramie, WY 82071. SR1735)

Table. Geyer larkspur control.

Treatment[1]	Rate	Geyer larkspur control[2]		
		July 16, 1996	August 6, 1998	June 4, 1999
	Product/A		%	
Tordon 22K[3]	½ pint	93	85	46
Tordon 22K[3]	1 pint	94	95	38
Tordon 22K[3]	1½ pints	98	98	68
Tordon 22K[3]	1 quart	99	99	83
2,4-D (Hi Dep)[3]	1 quart	79	81	16
2,4-D ester[3]	1 quart	66	91	16
Hi Dep+Tordon 22K	1 quart+½ pint	95	99	82
2,4-D (Hi Dep)	2 quarts	82	94	51
Tordon 22K+2,4-D ester[3]	1 pint+1 pint	85	85	56
Tordon 22K+2,4-D ester[3]	1 pint+1 quart	90	97	38
Escort[3]	0.2 ounce	89	93	60
Escort[3]	0.1 ounce	73	84	41
Escort+2,4-D ester[3]	0.1 ounce+1 quart	82	97	31
Escort+Tordon 22K[3]	0.1 ounce+1½ pints	86	94	34
Hi Dep+Escort[3]	1 pint+0.1 ounce	89	98	54
Banvel[3]	1 pint	90	89	23
Banvel[3]	1 quart	80	93	32
Banvel+2,4-D ester[3]	1 pint+1 pint	54	91	24
(LSD 0.05)		22	19	32
(CV)		19	15	54

[1]Treatments applied June 23, 1995.
[2]All plants were counted in the 10 by 27 ft plots immediately before herbicide application. Pre-treatment counts were compared to post-treatment counts to obtain percent control.
[3]X-77 added at 0.25% v/v.

Imazapic activity on leafy spurge. Mark A. Ferrell. This research was conducted near Devil's Tower, Wyoming to evaluate the activity of imazapic on leafy spurge. 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 September 3, 1997 (air temp. 90 F, soil temp. 0 inch 87 F, relative humidity 32%, wind south at 5 mph, 60% cloud cover). The soil was a silt loam (27% sand, 55% silt, and 18% clay) with 2.6% organic matter and 6.2 pH. Leafy spurge was post seed and 14 to 20 inches in height. Infestations were heavy throughout the experimental area. Visual estimations of percent leafy spurge control were made June 27, 1998; 297 days after treatment and July 4, 1999; 669 days after treatment.

All treatments provided good to excellent control of leafy spurge 297 days after treatment. The addition of a methylated seed oil significantly increased leafy spurge control with imazapic at 0.125 lb/A. The addition of methylated seed oil did not increase leafy spurge control for the other rates of imazapic. No treatment gave adequate control 669 days after treatment. Grass damage was moderate to severe for all imazapic rates. The addition of methylated seed oil appeared to increase grass damage. There was no grass damage 669 days after treatment. (Wyoming Agric. Exp. Sta., Laramie, WY 82071. SR1736)

Table. Leafy spurge percent control.

		Leafy spurge control[2]		Grass damage	
Treatment[1]	Rate	June 27, 1998	July 4, 1999	June 27, 1998	July 4, 1999
	lb/A	%			
Imazapic	0.125	84	0	13	0
Imazapic[3]	0.125	95	0	35	0
Imazapic	0.1875	95	0	23	0
Imazapic[3]	0.1875	99	0	31	0
Imazapic	0.25	100	0	43	0
Imazapic[3]	0.25	100	0	53	0
Picloram	0.5	98	0	0	0
(LSD 0.05)		7	--	19	--
(CV)		5	--	44	--

[1]Treatments applied September 3, 1997.
[2]Visual estimates.
[3]methylated seed oil added at 1 qt/A.

Evaluation of diflufenzopyr with auxin herbicides for leafy spurge control. Rodney G. Lym. (Department of Plant Sciences, North Dakota State University, Fargo, ND 58105). Previous research at North Dakota State University has shown that both initial and long-term leafy spurge control is increased when diflufenzopyr was applied with auxin herbicides. Diflufenzopyr is an auxin transport inhibitor (ATI), which suppresses the transport of naturally occurring IAA and synthetic auxin-like compounds in plants. In general, diflufenzopyr interferes with the auxin balance needed for plant growth. The purpose of this research was to evaluate the effect of varying the ratio of auxin herbicide:diflufenzopyr on both short- and long-term leafy spurge control.

The first experiment was established near Valley City, ND on September 17, 1997 when leafy spurge was in the fall growth stage with 2 to 3 inch regrowth from the stem and no leaves remaining on the main stem. The herbicides were applied using a hand-boom sprayer delivering 8.5 gpa at 35 psi. The air temperature was 68 F with a dewpoint of 58 F and the sky was clear. The plots were 10 by 30 feet and replicated four times in a randomized complete block design. Leafy spurge topgrowth was visually evaluated with control based on percent stand reduction compared to the untreated check.

Leafy spurge control increased or tended to increase when diflufenzopyr was applied with an auxin herbicide, especially dicamba and picloram (Table 1). Leafy spurge control averaged 54% 12 MAT (months after treatment) when diflufenzopyr was applied with dicamba compared to only 20% when dicamba was applied alone. Control increased from 66 to 90% when diflufenzopyr was applied with picloram compared to the herbicide alone. Leafy spurge control also tended to increase when diflufenzopyr was applied with imazapic even though that herbicide is classified as an ALS inhibitor.

Long-term leafy spurge control increased when diflufenzopyr was applied with all herbicides evaluated except quinclorac (Table 1). For example, leafy spurge control averaged 68% 24 MAT when diflufenzopyr was applied with picloram at 8 oz/A or picloram plus 2,4-D at 8 + 16 oz/A but only 30 and 43%, respectively, when the herbicides were applied alone. Quinclorac averaged 50% control 24 MAT when applied at 16 oz/A alone or with diflufenzopyr.

The second experiment was established to evaluate the optimum ratio of diflufenzopyr when applied with dicamba or quinclorac. The diflufenzopyr ratio varied from the standard ratio of 2.5:1 herbicide:ATI to 5:1 and 10:1. The experiment was established near Jamestown and Valley City, North Dakota, in early June 1998 when leafy spurge was in the true-flower growth stage.

Both initial foliage injury 1 MAT and top growth control 3 MAT were higher when diflufenzopyr was applied with dicamba and quinclorac compared to the herbicide applied alone (Table 2). However, injury and control were similar regardless of diflufenzopyr rate. For instance, leafy spurge control with dicamba applied alone averaged 84% 3 MAT but increased to an average of 97% when applied with diflufenzopyr. Control with quinclorac alone averaged 78% but increased to an average of 97% when applied with diflufenzopyr. Control was also increased to 78% when diflufenzopyr was applied with glyphosate plus 2,4-D compared to 44% with the herbicides alone.

As in the previous experiment, the addition of diflufenzopyr increased long-term leafy spurge control when applied with dicamba compared to dicamba alone and averaged 57 and 25% control, respectively, 15 MAT (Table 2). The increase in control was similar regardless of the herbicide:diflufenzopyr ratio. Unlike the first experiment, long-term leafy spurge control was increased when diflufenzopyr was applied with quinclorac which averaged 80% control 15 MAT compared to only 54% when quinclorac was applied alone (Tables 1 and 2). The reason for the increase in long-term control when diflufenzopyr was applied with quinclorac in the second experiment but not the first is not known. Differences in application rate probably are not the reason since both the quinclorac and diflufenzopyr rate was less in the second than the first experiment. However, in the first experiment quinclorac was applied in the fall compared to a spring application in the second experiment

The third and fourth experiments were established to evaluate the optimum ratio of diflufenzopyr when applied with picloram or picloram plus 2,4-D for leafy spurge control. Diflufenzopyr was applied from 1.6 to 6.4 oz/A with picloram at 8 oz/A or picloram plus 2,4-D at 4 + 16 oz/A. Leafy spurge was in the true-flower growth stage, the air temperature was 63 F with a dew point of 57 F on June 9, 1998 when the third experiment was established.

In the fourth experiment, leafy spurge was in the fall regrowth stage with approximately 15% yellow foliage, the air temperature was 78 F with a dew point of 60 F.

As in the previous experiments long-term leafy spurge control was increased when diflufenzopyr was applied with picloram or picloram plus 2,4-D compared to the herbicides alone and the increase was similar regardless of the herbicide:diflufenzopyr ratio (Tables 3 and 4). Leafy spurge control averaged 88 and 83% 15 MAT when picloram or picloram plus 2,4-D was applied with diflufenzopyr compared to 62 or 38%, respectively, when the herbicides were applied alone in June (Table 3).

In general, long-term leafy spurge control was also increased when diflufenzopyr was applied with picloram or picloram plus 2,4-D in the fall, but the increase was erratic (Table 4). For instance, leafy spurge control with picloram plus 2,4-D at 4 plus 16 oz/A averaged only 1% 12 MAT compared to a range from 36 to 65% control when the same treatment was applied with diflufenzopyr. However, there was no clear trend between the amount of diflufenzopyr applied with picloram plus 2,4-D and leafy spurge control.

In summary, diflufenzopyr increased long-term leafy spurge control when applied with auxin herbicides and the increase was independent of the herbicide:diflufenzopyr ratio. The most consistent and greatest increases in long-term control came when diflufenzopyr was applied with picloram, picloram plus 2,4-D, or dicamba.

Table 1. Diflufenzopyr applied with various herbicides in the fall for leafy spurge control.

Treatment	Rate	Control/MAT[a] 9	12	15	24
	oz/A	%			
Dicamba + X-77 + 28% N	32 + 0.25% + 1.25%	65	20	3	0
Dicamba + diflufenzopyr[b] + X-77 + 28% N	32+12.8+0.25%+1.25%	78	54	11	5
Picloram	8	89	66	48	30
Picloram + diflufenzopyr	8 + 3.2	100	90	67	68
Picloram + 2,4-D	8 + 16	95	78	70	43
Picloram + 2,4-D + diflufenzopyr	8 + 16 + 3.2	99	88	85	67
Quinclorac + Scoil[c]	16 + 1 qt	99	89	74	48
Quinclorac + diflufenzopyr + Scoil[c]	16 + 6.4 + 1 qt	100	95	67	53
Imazapic + Sun-It[c] + 28% N	2 + 1 qt + 1 qt	95	84	52	20
Imazapic + diflufenzopyr + Sun-It[c] + 28% N	2 + 0.8 + 1 qt + 1 qt	99	96	66	47
LSD (0.05)		14	16	25	26

[a] Months after treatment.
[b] Commercial mixture of dicamba plus diflufenzopyr - Distinct (BAS-662).
[c] Methylated seed-oil by AGSCO.

Table 2. Diflufenzopyr applied at various ratios with herbicides for leafy spurge control averaged over two locations in North Dakota.

Treatment	Rate	Foliage injury 1 MAT[a]	Control/MAT[a] 3 MAT[a]	12	15
	oz/A	%			
Dicamba + X-77 + 28% N	32 + 0.25% + 1 qt	64	84	29	25
Dicamba + diflufenzopyr + X-77 + 28% N	32 + 3.2 + 0.25% + 1 qt	67	94	75	58
Dicamba + diflufenzopyr + X-77 + 28% N	32 + 6.4 + 0.25% + 1 qt	78	99	89	57
Dicamba + diflufenzopyr + X-77 + 28% N	32 + 12.8 + 0.25% + 1 qt	70	98	83	59
Quinclorac + Scoil[b]	12 + 1 qt	47	78	85	54
Quinclorac + diflufenzopyr + Scoil[b]	12 + 1.6 + 1 qt	61	96	96	83
Quinclorac + diflufenzopyr + Scoil[b]	12 + 3.2 + 1 qt	60	97	98	82
Quinclorac + diflufenzopyr + Scoil[b]	12 + 4.8 + 1 qt	66	98	96	75
Glyphosate + 2,4-D[c]	6 + 10	88	44	31	17
Glyphosate + 2,4-D[c] + diflufenzopyr	6 + 10 + 6.4	84	78	53	27
LSD (0.05)		8	8	14	13

[a] Months after treatment.
[b] Methylated seed-oil by AGSCO.
[c] Commercial formulation - Landmaster BW.

Table 3. Leafy spurge control with picloram or picloram plus 2,4-D applied with various ratios of diflufenzopyr in June 1998 near Valley City, North Dakota.

		Control/MAT[a]		
Treatment	Rate	3	12	15
	oz/A		%	
Picloram + diflufenzopyr	8 + 1.6	99	96	85
Picloram + diflufenzopyr	8 + 3.2	99	99	88
Picloram + diflufenzopyr	8 + 4.8	99	99	90
Picloram + diflufenzopyr	8 + 6.4	99	99	89
Picloram + 2,4-D + diflufenzopyr	4 + 16 +1.6	99	90	79
Picloram + 2,4-D + diflufenzopyr	4 + 16 + 3.2	98	93	82
Picloram + 2,4-D + diflufenzopyr	4 + 16 + 4.8	99	96	85
Picloram + 2,4-D + diflufenzopyr	4 + 16 + 6.4	99	98	85
Picloram	8	92	85	62
Picloram + 2,4-D	4 + 16	80	79	38
LSD (0.05)		5	11	13

[a] Months after treatment.

Table 4. Leafy spurge control with picloram or picloram plus 2,4-D applied with various ratios of diflufenzopyr in September 1998 near Valley City, North Dakota

		Control/MAT[a]	
Treatment	Rate	9	12
	oz/A	%	
Picloram + diflufenzopyr	8 + 1.6	99	66
Picloram + diflufenzopyr	8 + 3.2	97	44
Picloram + diflufenzopyr	8 + 4.8	99	83
Picloram + diflufenzopyr	8 + 6.4	99	74
Picloram + 2,4-D + diflufenzopyr	4 + 16 +1.6	88	36
Picloram + 2,4-D + diflufenzopyr	4 + 16 + 3.2	93	65
Picloram + 2,4-D + diflufenzopyr	4 + 16 + 4.8	95	45
Picloram + 2,4-D + diflufenzopyr	4 + 16 + 6.4	95	40
Picloram	8	88	53
Picloram + 2,4-D	4 + 16	45	1
LSD (0.05)		12	26

[a] Months after treatment.

Leafy spurge control with alternating applications of imazapic and picloram plus 2,4-D. Rodney G. Lym. (Department of Plant Sciences, North Dakota State University, Fargo, ND 58105). Imazapic is an ALS inhibiting herbicide recently labeled for leafy spurge control in non-cropland. Research at North Dakota State University has shown that occasionally imazapic will injure certain grass species. The purpose of this research was to evaluate imazapic applied alone, in rotation with picloram plus 2,4-D, or the three herbicides applied together for long-term leafy spurge control.

The experiment was established at Jamestown and Valley City, North Dakota in a dense stand of leafy spurge. Initial herbicide treatments were applied in early June during the true-flower growth stage or in mid-September when leafy spurge was in the fall regrowth growth stage. Initial treatments of imazapic were followed by picloram plus 2,4-D. Likewise, initial treatments of picloram plus 2,4-D were followed by imazapic. Imazapic was applied at 1 or 2 oz/A in the spring or fall, respectively. Picloram plus 2,4-D was applied at the general use rate of 4 + 16 oz/A in the spring or 8 + 16 oz/A in the fall. The three-way mixture of picloram plus 2,4-D plus imazapic was applied once in the spring or fall with no follow-up treatment.

Treatments were applied with a hand-held sprayer delivering 8.5 gpa at 35 psi. The experiment was a randomized complete block design with four replications at both locations and plots were 10 by 30 feet. Control was based on percent stand reduction as compared to the untreated check.

Table. Leafy spurge control with imazapic combined or alternated with picloram and 2,4-D applied in the spring of fall at two locations.

				August 1998			June 1999			Sept. 1999		
Treatment	Rate	Treatment	Rate	JMS[a]	VC[a]	Mean	JMS[a]	VC[a]	Mean	JMS[a]	VC[a]	Mean
	— oz/A —		- oz/A -	% control								
Spring 1998		Fall 1998										
Picloram+2,4-D	4+16	Imazapic+Scoil+28% N	2+1qt+1qt	85	88	86	99	99	99	70	95	82
Imazapic+Scoil+28% N	1+1qt+1qt	Picloram+2,4-D	8+16	28	58	43	99	99	99	53	82	67
Picloram+2,4-D+imazapic +Scoil+28% N	4+16+1+ 1qt+1qt	None		99	95	97	95	99	99	97	99	98
LSD (0.05)				11	16	7[b]						
Fall 1998		Spring 1999										
Picloram+2,4-D	8+16	Imazapic+Scoil+28% N	1+1qt+1qt				98	94	96	82	91	87
Imazapic+Scoil+28% N	2+1qt+1qt	Picloram + 2,4-D	8+16				99	99	99	96	98	97
Picloram+2,4-D+ imazapic +Scoil+28% N	8+16+2+ 1qt+1qt	None					99	99	99	59	64	61
LSD (0.05)							NS	2	NS	11	16	9[c]

[a] JMS = Jamestown, VC = Valley City

[b] Significant interaction between locations. Control with imazapic at Valley City was higher than at Jamestown.

[c] Control at Valley City is higher than at Jamestown.

The three herbicide mixture of picloram plus 2,4-D plus imazapic applied once in the spring provided the best long-term leafy spurge control (Table). Control averaged across locations was 98% in September 1999, 15 months after treatment. This high level of control was unexpected and is similar to picloram applied alone at 32 oz/A. The same three-herbicide treatment applied in the fall only averaged 61% control 12 months after treatment. The best split treatments were picloram plus 2,4-D applied in the spring followed by imazapic in the fall and imazapic fall-applied followed by picloram plus 2,4-D in the spring.

Leafy spurge control with *Aphthona nigriscutis* alone or combined with herbicides. Rodney G. Lym, Don A. Mundal, and Robert B. Carlson. An experiment to evaluate the effect of herbicide application timing on biocontrol insect population and leafy spurge control was established on a private farm near Cuba, North Dakota. Approximately 500 *Aphthona nigriscutis* were released in July 1989 in a moderately dense patch of leafy spurge. The insects established and began to spread to other patches of leafy spurge within the pasture prior to the beginning of this experiment.

The experiment was established in two patches of leafy spurge approximately 5000 square feet each and about 100 yards apart. The treatments included picloram plus 2,4-D at 0.5 + 1 lb/A fall applied, picloram plus 2,4-D at 0.25 + 1 lb/A spring applied, and an untreated control. Herbicides were applied annually beginning with the initial spring treatment on June 5, 1992, and the first fall treatment on September 10, 1992. Herbicides were reapplied at similar dates from 1993 to 1995. The plots were 15 by 50 feet, and treatments were replicated four times (two per patch). *A. nigriscutis* population was evaluated by sweep counts with a standard insect collection net and are reported as a mean of three square meters (five sweeps equals 1 m^2).

Leafy spurge stem density declined rapidly when herbicides were fall applied to plants infested with *A. nigriscutis* (Table 1). The leafy spurge stand declined from 164 stems/m^2 in 1992, to 10 stems/m^2 the following year. Leafy spurge gradually declined with the insect alone treatment from 187 stems/m^2 in June 1992 to 5 stems/m^2 by May 1995. Both the insect alone and fall-applied herbicide plus insect treatments provided more rapid leafy spurge stem reduction than the spring-applied herbicides plus insects treatment. Herbicides applied in June prevent the adult flea beetles from feeding on those plants, and thus probably reduce egg laying and subsequent larvae feeding.

Leafy spurge stem density continued to decline over time and averaged 11 stems/m^2 in 1999. Since herbicide application was stopped after 1995, the decline is due to control by *Aphthona* flea beetles alone (Table 1). Control tended to be better with the picloram plus 2,4-D applied in the fall with insects and the insects alone treatment compared to the same herbicides applied in the spring. It is likely that the *A. nigriscutis* will maintain long-term leafy spurge control without further chemical treatments.

The *A. nigriscutis* population gradually increased over time from 1993 to 1996 and averaged 90 adults/m^2 in 1997 and 1998 regardless of treatment (Table 2). Flea beetle population began to decline in 1997 as the leafy spurge density decreased. There was an average of only 23 beetles/m^2 in 1998 regardless of the initial treatment. Thus, 9 yr after the initial release of flea beetles, the population appeared to be in equilibrium with the leafy spurge population. It took 4 yr less for this equilibrium to be reached when herbicides were used in conjunction with the biocontrol agents compared to the insects alone.

In summary, the fall herbicide treatment combined with the biological control agent *Aphthona nigriscutis* provided more rapid leafy spurge control than the insects alone. The leafy spurge density gradually declined when only insects were present and took 3 yr longer to reduce the infestation to the same level achieved in 1 yr by the herbicide-plus-insect combination treatment and 4 yr longer than herbicides alone (based on long-term averages). Leafy spurge density and *A. nigriscutis* population had reached an equilibrium by 6 yr after the first herbicide treatment and are expected to maintain acceptable long-term leafy spurge control.

Table 1. Leafy spurge stem density after treatment with *Aphthona nigriscutis* alone or combined with herbicide treatments near Cuba, ND.

		Stem density/evaluation date							
Treatment[a]	Rate	June 1992	May 1993	May 1994	May 1995	June 1996	June 1997	June 1998	June 1999
	lb/A	No./m²							
Picloram + 2,4-D (Spring)	0.25+1	220	208	134	16	22	13	15	17
Picloram + 2,4-D (Fall)	0.5+1	164	10	11	0.5	0.5	12	11	9
Insect only	..	187	150	99	5	13	17	17	7
LSD (0.05)		30	27	20	10	10	NS	NS	5

[a] Herbicides annually applied in June or September from 1992 to 1995.

Table 2. Effect of herbicide application on *Aphthona nigriscutis* population 3 yr after the biocontrol insect had established.

		A. nigriscutis counts[b]/year							
Treatment[a]	Rate	1992	1993	1994	1995	1996	1997	1998	1999
	lb/A	No./m²							
Picloram + 2,4-D (Spring)	0.25+1	1	0	19	76	25	12	17	19
Picloram + 2,4-D (Fall)	0.5+1	21	52	40	30	18	8	26	20
Insects only	..	12	28	132	70	96	23	27	24
LSD (0.05)		5	16	63	26	29	6	NS	NS

[a] Herbicides annually applied in June or September from 1992 through 1995.
[b] Highest number collected during sampling from June through September.

Response of smooth hawkweed to several herbicides. Timothy W. Miller and Laurel Baldwin. (Washington State University, Mount Vernon, WA 98273 and Whatcom County Noxious Weed Control, Bellingham, WA 98226) Smooth hawkweed is a recently-introduced European weed that is currently known to infest portions of Whatcom, Skagit, and Snohomish counties in northwestern Washington. In 1998, this hawkweed species was listed as a Class B noxious weed in Washington. Due to the newness of the weed in the state, it was desirable to test several herbicides with potential to aid in the control of smooth hawkweed on roadsides, non-cropland sites, and pastures.

The experiment was established April 6, 1999 on a roadside near Bellingham, Washington heavily infested with smooth hawkweed. Treatments were applied May 10, when the hawkweed was 4 to 8 inches tall and actively growing. Rain had fallen most of the previous week, but the weeds were dry at the time of application (Table 1). Herbicides were applied using a CO_2-pressurized backpack sprayer spraying the equivalent of 31.3 gpa at 37 psi. Smooth hawkweed control was visually estimated June 7 (28 days after treatment, DAT). A 0.09 m^2 quadrat was placed within each plot June 18, and vegetation within the quadrat clipped at the soil line. Grasses were then separated from hawkweed, and both components were air-dried inside a greenhouse for 7 days and dry weights recorded. The experimental design was a randomized complete block with four replicates. Means were separated using Fisher's Protected LSD. Data are presented in Table 2.

Table 1. Application data.

10:00 a.m., May 10, 1999
Broadcast, postemergence
Weeds 4 to 8 in. tall
40% cloud cover
Winds 2 to 4 mph from W
Air temp. = 55 F
Soil temp (6") = 41 F
Relative humidity = 48%
No dew; soil surface moist

Initial control of smooth hawkweed ranged from 34 to 89% at 28 DAT. Treatments with clopyralid, dicamba, triclopyr, BAS 662, and 2,4-D generally provided fair control of the weed (80% control or greater). All herbicide treatments except metsulfuron applied alone reduced hawkweed dry weight at 39 DAT compared to the untreated control. Hawkweed biomass weights ranged from 1.2 to 5.9 g/0.09 m^2 (119 to 585 lbs/ac). Grass dry weight at 39 DAT was not statistically affected by these herbicides and ranged from 2.4 to 7.1 g/0.09 m^2 (238 to 703 lbs/ac). Hawkweed flowering in 1999 was suppressed by all treatments except 2,4-D amine (data not shown). Hawkweed density will be rated in the spring of 2000 to more fully evaluate the effect of the 1999 herbicide application.

Table 2. Control of smooth hawkweed at 28 days after treatment (DAT) by various herbicides, and dry weight of hawkweed and grass at 39 DAT.

Treatment	Rate	Weed Control	Dry weight: Hawkweed	Dry weight: Grass
	lbs/A	%	g/0.09 m^2	g/0.09 m^2
BAS 662 01 H	0.69	81	1.2	5.3
2,4-D amine	3.0	55	5.7	5.5
dicamba	1.0	68	5.9	6.4
dicamba + 2,4-D	0.5 + 1.4	80	4.0	7.1
clopyralid + 2,4-D	0.19 + 1.0	89	3.8	5.3
triclopyr + 2,4-D	0.75 + 1.5	80	2.6	4.7
clopyralid	0.38	84	3.5	4.5
metsulfuron[a]	0.6 oz	34	12.6	2.7
metsulfuron[a] + dicamba + 2,4-D	0.6 oz + 0.5 + 0.95	74	3.1	2.5
Untreated control	—	0	12.9	4.7
$LSD_{0.05}$	—	15	5.2	ns

[a]Metsulfuron treaments applied with silicon surfactant (Sylgard) at 0.2 % v/v.

Giant hogweed injury by several herbicides. Timothy W. Miller and Cathy Lucero. (Washington State University, Mount Vernon, WA 98273 and Clallam County Noxious Weed Control, Port Angeles, WA 98362) Giant hogweed is a recently-introduced European weed that is currently known to infest portions of western Washington. This species is a Class A noxious weed in Washington. A trial was designed to determine the susceptibility of giant hogweed to several herbicides. The site was a creekside heavily infested with giant hogweed near Port Angeles, Washington. Individual plants were marked with wire flags and herbicides applied April 23, when the hogweed had 4 to 5 leaves and was actively growing, ranging from 1 to 3 feet in height. Rain had fallen most of the previous week, but the weeds were dry at the time of application (Table 1). Herbicides were applied using a CO_2-pressurized backpack sprayer spraying the equivalent of 41 gpa at 37 psi. Giant hogweed injury (0 = no injury and the plant flowered; 100 = dead plant) was visually estimated July 1. The experimental design was a randomized complete block with four replicates. Means were separated using Fisher's Protected LSD.

Based on these results, glyphosate and imazapic were the herbicides of choice, both causing greater than 90% injury of treated giant hogweed by July 1 (Table 2). Triclopyr + 2,4-D was slightly less effective, but still gave good control (80% injury).

Table 1. Application data.

11:00 a.m., April 23, 1999
Broadcast, postemergence
Weeds 1 to 3 ft. tall
0% cloud cover
Winds 1 to 4 mph from NE
Air temp. = 25 C
Soil temp (6") = 4 C
Relative humidity = 34%
No dew; soil surface moist

Table 2. Control of giant hogweed by various herbicides.

Treatment[a]	Trade name	Rate[b]	Weed Control
		lbs/A	%
2,4-D amine	Weedar	2.0	8
2,4-D amine	Weedar	3.0	45
dicamba	Banvel	1.0	66
glyphosate	Roundup	1.5	100
dicamba + 2,4-D + MCPP	Weed B Gon	4 pt	34
imazapic + mso	Plateau + SunIt II	0.188 + 0.6% v/v	97
dicamba + 2,4-D	Weedmaster	0.5 + 1.44	50
clopyralid + 2,4-D	Curtail	0.19 + 1.0	48
triclopyr + 2,4-D	Crossbow	0.75 + 2.67	80
clopyralid	Transline	0.38	37
untreated check	—	—	30
$LSD_{0.05}$	—	—	25

[a]mso = methylated seed oil.
[b]Weed B Gon is listed in pints of formulated product per acre.

The influence of picloram, 2,4-D, or picloram + 2,4-D on prickly pear cover and control on Colorado rangeland. James R. Sebastian and K.G. Beck. (Department of Bioagriculture Sciences and Pest Management, Colorado State University, Fort Collins, CO 80538) An experiment was established near Kersey, CO to evaluate prickly pear (OPUPO) control with 2,4-D, picloram, picloram + 2,4-D, or pre-mixed picloram + 2,4-D. The experiment was designed as a randomized complete block with four replications.

Herbicides were applied to OPUPO at the vegetative growth stage on August 2, 1996. All treatments were applied with a CO_2-pressurized backpack sprayer using 11003LP flat fan nozzles at 21 gal/A, 14 psi. Other application information is presented in Table 1. Main plot size was 10 by 30 feet.

Visual evaluations for control and cover compared to non-treated control plots were collected in June 1997 and August 1998, approximately 1 and 2 years after treatment (YAT). A point frame was used in 1997, but this method missed low growing vegetation. A Daubenmire frame was used in 1998 to remedy the problem. Cover data are means from 10 point frames or 0.1 m^2 quadrats per plot (40 total quadrats per treatment).

OPUPO died slowly after treatments were applied. All treatments controlled less than 63% of OPUPO 1 YAT (Table 2). When treatments were evaluated 2 YAT, control ranged from 34 to 94%. More than 85% of OPUPO was controlled 2 YAT with 0.25 lb of picloram or more. It required 0.38 lb of picloram to decrease OPUPO cover to zero 2 YAT, whereas 0.3 lb of picloram plus 1 lb of 2,4-D decreased OPUPO cover to zero. OPUPO was controlled poorly by 2, 4-D alone. (Weed Research Laboratory, Colorado State University, Fort Collins, CO 80523).

Table 1. Application data for prickly pear control on Colorado rangeland.

Environmental data	
Application date	August 2, 1996
Application time	10:30 AM
Air temperature, F	83
Relative humidity, %	50
Wind speed, mph	2 to 4

Application date	species	growth stage	height (in.)
August 3, 1996	OPUPO	vegetative	3 to 6
	ARTFI	flower	18 to 36
	CARSP	vegetative	8 to 9
	ORYHY	late boot	14 to 23
	SPOCR	late boot	9 to 12
	STICO	late boot	24 to 36

Table 2. The influence of picloram, 2,4-D, or picloram + 2,4-D on prickly pear cover and control on Colorado rangeland.

Herbicide[a]	Rate	Prickly Pear Control		Prickly Pear Cover	
	(lb ai/A)	1997	1998	1997	1998
		%			
Picloram	0.06	29	55	6	14
	0.13	19	70	9	9
	0.2	13	55	4	10
	0.3	35	87	5	2
	0.4	29	91	5	0
Picloram[b] + 2,4-D	0.13 + 0.5	30	70	6	4
2,4-D	2.0	21	6	12	43
Picloram[c] + 2,4-D	0.07 + 0.25	18	34	9	17
	0.13 + 0.5	35	75	5	3
	0.2 + 0.71	24	70	7	5
	0.3 + 1.0	48	88	3	0
	0.4 + 1.5	63	94	2	0
Control		0	0	7	40
LSD (0.05)		26	21	6	8

[a] X-77 surfactant added to all treatments at 0.25% v/v.
[b] Picloram plus the amine formulation of 2,4-D.
[c] Premixed formulation of picloram + amine formulation of 2,4-D (Grazon P&D).

Common mullein control on Colorado rangeland. James R. Sebastian and K.G. Beck. (Department of Bioagriculture Sciences and Pest Management, Colorado State University, Fort Collins, CO 80538) An experiment was established at Cherry Creek Reservoir State Park, CO to evaluate common mullein (VESTH) control with picloram, 2,4-D, picloram + 2,4-D, pre-mixed picloram + 2,4-D, or picloram + fluroxypyr. The experiment was designed as a randomized complete block with four replications.

Herbicides were applied on May 19, 1999 when VESTH was in the rosette growth stage. All treatments were applied with a CO_2-pressurized backpack sprayer using 11003LP flat fan nozzles at 21 gal/A, 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 in July, August, and October 1999, 41, 76, and 106 days after treatment (DAT). All treatments controlled less than 68% of VESTH 30 DAT. Fluroxypyr or 2,4-D controlled VESTH poorly (0 to 15%) 41, 76, and 106 DAT. Bolted and rosette VESTH plants were evaluated separately at the October 5 evaluation due to a flush of fall rosettes. The only treatments with residual VESTH rosette control on October 5 was picloram + 2,4-D (78 to 86%). Bolted VESTH control at the August 6 and October 5 evaluations were very similar. Increased rates of picloram plus fluroxypyr or picloram plus 2,4-D provided fair to good VESTH control (50 to 84%) on October 5.

Table 1. Application data for common mullein control on Colorado rangeland.

Environmental data	
Application date	May 19, 1999
Application time	12:00 AM
Air temperature, F	75
Relative humidity, %	65
Wind speed, mph	2 to 5

Application date	species	growth stage	height (in.)
August 3, 1996	VESTH	rosette	4 to 12 diameter
	CRUNU	rosette	3 to 14 diameter
	CIRAR	rosette	3 to 5 diameter
	BROTE	early flower	3 to 6
	ARKSP	dormant	
	SPOCR	dormant	

Table 2. Common mullein control on Colorado rangeland.

Herbicide[a]	Rate	Common Mullein Control			
				Bolted	Fall Rosettes
	(lb ai/A)	(%)			
		July 1	August 6	October 5	
Fluroxypyr	0.13	0	10	10	0
	0.19	6	13	13	0
	0.25	11	14	14	0
	0.5	3	14	14	0
Picloram + Fluroxypyr[d]	0.1 +0.15	58	50	50	8
	0.15 + 0.23	60	69	69	31
	0.21 +.29	65	84	84	15
2,4-D	0.13 + 0.5	10	15	15	0
Picloram[c] + 2,4-D	0.13 + 0.5	61	53	48	86
	0.19 + 0.75	59	65	65	80
	0.25 + 1.0	68	81	81	78
Picloram	.013	1	0	0	0
	0.25	60	73	73	33
Control		0	0	0	0
LSD (0.05)		9	13	12	13

[a] X-77 surfactant added to all treatments at 0.25% v/v.
[b] Picloram plus the amine formulation of 2,4-D.
[c] Premixed formulation of picloram + amine formulation of 2,4-D (Grazon P&D).
[d] Premixed formulation of picloram + fluroxypyr (Plenum)

Scotch thistle control on Colorado rangeland. James R. Sebastian and K.G. Beck. (Department of Bioagriculture Sciences and Pest Management, Colorado State University, Fort Collins, CO 80538) An experiment was established at Sedalia, CO to evaluate Scotch thistle (ONRAC) control. The experiment was designed as a randomized complete block with four replications.

Herbicides were applied on May 18, 1999 when ONRAC was in the rosette to bolting growth stage. All treatments were applied with a CO_2-pressurized backpack sprayer using 11003LP flat fan nozzles at 21 gal/A, 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 in July and August 1999, approximately 40 and 75 days after treatment (DAT). Herbicide treatments that contained dicamba controlled ONRAC faster than others. For example, ONRAC control from metsulfuron 40 DAT was 58% whereas metsulfuron plus dicamba controlled 78% of ORNAC. Both treatments controlled 100% of ONRAC 75 DAT. All treatments except Exceed applied alone (2.0 oz A/A) controlled 98 to 100% of ONRAC. Exceed applied alone controlled 55% of ONRAC control 75 DAT.

Table 1. Application data for common mullein control on Colorado rangeland.

Environmental data	
Application date	May 18, 1999
Application time	10:30 AM
Air temperature, F	65
Relative humidity, %	62
Wind speed, mph	0 to 2

Application date	species	growth stage	height (in.)
August 3, 1996	ONRAC	Bolting	8 to 30

Table 2. Scotch thistle control on Colorado rangeland.

Herbicide[a]	Rate	Scotch Thistle Control	
	(OZ A/A)	June 29, 1999	August 6, 1999
Trisulfuron	0.6	45	98
Trisulfuron + Dicamba	0.6 + 8.0	61	100
Trisulfuron + Imazapic + Dicamba	0.6 + 4.0 + 8.0	75	100
Prosulfuron[b] + Primsulfuron	1.0 + 1.0	46	55
Prosulfuron[b] + Primsulfuron + Dicamba	1.0 + 1.0 + 8.0	73	100
Prosulfuron[b] + Primsulfuron + Imazapic + Dicamba	1.0 + 1.0 + 4.0 + 5.3	66	100
Trisulfuron[c] + Dicamba +Metsulfuron	0.6 + 2.4 + 1.0	56	100
Metsulfuron	1.0	58	100
Metsulfuron + Dicamba	1.0 + 8.0	78	100
Metsulfuron + Imazapic + Dicamba	1.0 + 4.0 + 5.3	73	100
Prosulfuron[b] + Primsulfuron + Trisulfuron	1.0 + 1.0 + 0.6	48	98
Control		0	0
LSD (0.05).		8	6

[a] Non-ionic surfactant added to all treatments at 0.25% v/v.
[b] Pre-mixed formulation of prosulfuron + primsulfuron (Exceed)
[c] Pre-mixed formulation of trisulfuron + dicamba + metsulfuron (Rave)

Yellow toadflax control on Colorado rangeland. James R. Sebastian and K.G. Beck. (Department of Bioagriculture Sciences and Pest Management, Colorado State University, Fort Collins, CO 80538) An experiment was established near Camp Hale, CO to evaluate yellow toadflax (LINVU) control with picloram, picloram + 2,4-D, chlorflurenol, fluroxypyr, and their combinations. The experiment was designed as a randomized complete block with four replications.

Herbicides were applied on July 20, 1998 when LINVU was at vegetative to flower growth stage. All treatments were applied with a CO_2-pressurized backpack sprayer using 11003LP flat fan nozzles at 21 gal/A, 14 psi. Other application information is presented in Table 1. Plot size was 10 by 30 feet.

Visual evaluations for control were collected on July 29, 1999, approximately 1 year after treatment (YAT). It took at least 1.0 lb ai/A of picloram to achieve greater than 74% LINVU control approximately 1 YAT. The addition of 2,4-D or chlorflurenol to picloram did not increase LINVU control when compared to picloram applied at the same rates alone. Picloram at 2.0 lb ai/A almost eliminated LINVU (99%) 1 YAT. Grass injury increased as the rate of picloram increased in picloram (from 9 to 35%). LINVU was controlled poorly by chlorflurenol or fluroxypyr alone or in combination (0 to 8%). (Weed Research Laboratory, Colorado State University, Fort Collins, CO 80523).

Table 1. Yellow toadflax control on Colorado rangeland.

Environmental data	
Application date	July 20, 1998
Application time	12:00 AM
Air temperature, F	65
Relative humidity, %	52
Wind speed, mph	0

Application date	species	growth stage	height (in.)
August 3, 1996	LINVU	vegetative	4 to 7
	LINVU	flower	7 to 17
	AGRSM	vegetative	8 to 12
	BROMA	veg to late flwr	7 to 16
	POASP	veg to late flwr	3 to 7
	CHRNA	vegetative	12 to 18

Table 2. Yellow toadflax control on Colorado rangeland.

Herbicide	Rate	Yellow toadflax Control	Grass Injury
	(lb ai/A)	July 29, 1999	
		(%)	
Picloram	0.5	68	16
	1.0	89	29
	2.0	99	35
Picloram + chlorflurenol	0.5 + 0.13	54	9
	0.5 + 0.25	39	13
	1.0 + 0.25	74	19
	1.0 + 0.5	88	25
Picloram[a] + 2,4-D	0.5 + 2.0	64	20
Picloram[a] + 2,4-D + Chlorflurenol	0.5 +2.0 +0.25	61	16
Fluroxypyr	0.25	8	0
	0.5	8	0
Fluroxypyr + Chlorflurenol	0.25 + 0.07	0	0
Fluroxypyr + Chlorflurenol	0.25 + 0.13	0	0
Chlorflurenol	0.07	9	0
	0.13	0	0
	0.25	0	0
	0.5	0	0
Control		0	0
LSD (0.05)		14	7

[a] Premixed formulation of the triisopropanolamine salt of picloram + triisopropanolamine salt of 2,4-D (Grazon P&D).

The influence of picloram, 2,4-D, or picloram + 2,4-D on broom snakeweed and wild taragon on Colorado rangeland. James R. Sebastian and K.G. Beck. (Department of Bioagricultural Sciences and Pest Management, Colorado State University, Fort Collins, CO 80538) An experiment was established near Laporte, CO to evaluate broom snakeweed (GUESA) and wild tarragon (ARTDR) control with 2,4-D, picloram, picloram + 2,4-D, or premixed picloram + 2,4-D. The experiment was designed as a randomized complete block with four replications.

Herbicides were applied to GUESA and ARTDR at late bud growth stage on August 7, 1996. All treatments were applied with a CO_2-pressurized backpack sprayer using 11003LP flat fan nozzles at 21 gal/A, 14 psi. Other application information is presented in Table 1. Plot size was 20 by 30 feet.

Visual evaluations for control were made in treated plots and compared to non-treated control plots in July 1997, August 1998 and 1999, approximately 1, 2, and 3 years after treatment (YAT). All treatments controlled GUESA 5 to 100% (Table 2). It required 0.3 lb/A of picloram to control more than 80% of GUESA or 0.2 lb/A + 0.7 lb/A picloram plus 2,4-D to achieve 71% or greater GUESA control 1 to 3 YAT. Similar rates of picloram plus 2,4-D premixed or field mixed provided the same GUESA and ARTDR control. GUESA and ARTDR were controlled poorly by 2,4-D alone. More than 75% of ARTDR was controlled with 0.4 lb picloram or 0.3 + 1.0 lb/A of picloram plus 2,4-D 1 to 3 YAT.

Table 1. Application data for the influence of picloram, 2,4-D, or picloram + 2,4-D on broom snakeweed and wild tarragon on Colorado rangeland.

Environmental data	
Application date	August 7, 1996
Application time	7:30 AM
Air temperature, F	68
Relative humidity, %	70
Wind speed, mph	0 to 4

Application date	species	growth stage	height (in)
August 7, 1996	GUESA	Late bud	7 to 12
	TARSP	Bud	9 to 14
	AGRSM	Vegetative	9 to 14
	BOUGR	Flower	2 to 3
	HORJU	Late flower	5 to 6

Table 2. The influence of picloram, 2,4-D, or picloram + 2,4-D on broom snakeweed and wild tarragon on Colorado rangeland.

Herbicide[a]	Rate	Broom Snakeweed			Wild Taragon		
		Control (%)					
	(lb ai/A)	1997	1998	1999	1997	1998	1999
Picloram	0.06	5	8	8	5	0	0
	0.13	45	33	31	54	34	15
	0.2	56	39	38	59	30	25
	0.3	86	86	80	79	64	55
	0.4	93	96	93	90	84	80
Picloram[b] + 2,4-D	0.13 0.5	66	59	53	63	48	39
2,4-D	2.0	34	33	30	28	26	20
Picloram[c] + 2,4-D	0.07 + 0.25	21	20	19	29		13
	0.13 + 0.5	59	48	44	60	35	29
	0.2 + 0.71	81	76	71	80	69	59
	0.3 + 1.0	90	94	93	91	81	75
	0.4 + 1.5	99	100	100	96	94	93
Control		0	0	0	0	0	0
LSD (0.05)		18	21	19	19	19	21

[a] X-77 surfactant added to all treatments at 0.25% v/v.
[b] Picloram plus the amine formulation of 2,4-D.
[c] Premixed formulation of the triisopropanolamine salt of picloram + triisopropanolamine salt of 2,4-D.

Meadow hawkweed control with imazapic. Sandra L. Shinn and Donald C. Thill. (Plant Science Division, University of Idaho, Moscow, ID 83844-2339) A study was established on unimproved pasture land near St. Maries, Idaho to evaluate meadow hawkweed control with imazapic and picloram. Soil type at St. Maries was a silt loam (36% sand, 6% clay, 58% silt, pH 6.3, and 5.1% organic matter). Herbicide treatments were arranged as a 2 (fertilizer) by 12 (herbicide) factorial, randomized complete split-block design with four replications and individual plots were 2.4 by 12.2 m. Herbicides were applied with a CO_2 pressurized backpack sprayer calibrated to deliver 94 L/ha at 250 kPa (Table 1). Fertilizer [112 kg N/ha as ammonium sulfate (21-0-0-24)] was applied only during the first spring in each experiment to one half of each block, while no fertilizer was applied to the other half. Meadow hawkweed control was evaluated visually, and plants counted and biomass collected on June 25, 1998, and June 29, 1999, respectively, (1997-1999 study) and on June 30, 1999 (1998-2000 study) at the flowering stage. Plants were counted and cut from a 0.25 m^2 area, dried for 72 hours and weighed. The 1998 data (1997-1999 study) are reported in 1999 WSWS Research Progress Report, ISSN-0090-8142, page 5.

Table 1. Application data.

	1997-1999 experiment		1998-2000 experiment	
Application timing	October 7, 1997	April 21, 1998	October 15, 1998	April 29, 1999
Meadow hawkweed stage	5 to 6 leaves	10 to 12 leaves	5 to 6 leaves	10 to 12 leaves
Air temperature (C)	11	22	9	12
Relative humidity (%)	61	45	73	45
Wind (km/h)	1	4	1	2
Cloud cover (%)	95	10	70	50
Soil temperature (C at 5 cm)	5	11	5	13

The fertilizer by treatment interaction and fertilizer main effect were not significant in either experiments. Picloram applied in the fall or spring in both studies controlled meadow hawkweed 88 to 100%, and reduced plant density 80 to 100% and biomass 93 to 100%, compared to the untreated control (Table 2). Imazapic applied sequentially (fall and spring) visually suppressed meadow hawkweed 31 to 68% and reduced biomass 10 to 36% in the 1998-2000 study. Imazapic applied alone in the spring at 0.14 and 0.21 kg/ha controlled the meadow hawkweed 70 to 88% (1998-2000). Fall applied imazapic did not control meadow hawkweed.

Table 2. Meadow hawkweed percent control, plant density and biomass during June 1999.

			1997-1999 experiment			1998-2000 experiment		
Treatment	Rate	Application timing[a]	Control	Density	Biomass	Control	Density	Biomass
	kg/ha		%	plants/m^2	g/m^2	%	plants/m^2	g/m^2
Imazapic[b]	0.07	F	0	293	88	0	299	118
Imazapic	0.14	F	0	343	142	0	467	163
Imazapic	0.21	F	0	337	111	0	480	176
Picloram	0.42	F	94	14	3	100	75	9
Imazapic + imazapic	0.07 + 0.14	F + S	0	439	156	68	407	80
Imazapic + imazapic	0.07 + 0.07	F + S	0	468	166	31	405	83
Imazapic + imazapic	0.14 + 0.07	F + S	0	565	175	40	375	112
Imazapic	0.07	S	0	521	154	33	433	121
Imazapic	0.14	S	0	636	163	70	474	113
Imazapic	0.21	S	0	455	138	83	306	52
Picloram	0.42	S	99	0	0	88	0	0
Untreated check	--	--	--	359	143	0	361	125
LSD (0.05)			3	211	73	22	168	67

[a] F = fall application, S = spring application

[b] All imazapic treatments were applied with a methylated seed oil plus surfactant at 1.25% v/v.

Perennial grass tolerance to imazapic. Sandra L. Shinn and Donald C. Thill. (Plant Science Division, University of Idaho, Moscow, ID 83844-2339) A study was established near Moscow, Idaho to evaluate tolerance of seven forage grasses to five different rates of imazapic. Soil type at Moscow was a silt loam (20% sand, 18% clay, 62% silt, pH 5.6, and 2.6% organic matter). Grasses were seeded on May 12, 1998. Herbicide and grass treatments were arranged as a randomized complete split-block design with four replications. Herbicides were applied with a CO_2 pressurized backpack sprayer calibrated to deliver 93 L/ha at 228 kPa on April 23, 1999 (Table 1). Grass injury was evaluated visually, and plant height and biomass were taken 60 days after the herbicide application on June 23, 1999. Plants were cut from 1.0 m of row, dried for 72 hours, and weighed.

Table 1. Application data.

Application timing	April 23, 1999
Grass species (cm)	5 to 25
Air temperature (C)	25
Relative humidity (%)	38
Wind (km/h)	1
Cloud cover (%)	0
Soil temperature (C at 5 cm)	16

All species of forage grass were injured (stunted) 8 to 28% when imazapic was applied at 0.016 kg/ha (Table 2). Imazapic at 0.25 kg/ha injured orchardgrass and the bromes 84 to 88% and all wheatgrass species 27 to 61%. Imazapic applied at 0.016 and 0.25 kg/ha reduced the height of all seven grass species 21 to 44% and 55 to 93%, respectively, compared to their individual controls. Biomass of all grass species was reduced 43 to 62% by imazapic at 0.016 kg/ha, except orchardgrass, which was reduced only 9%. Imazapic at 0.250 kg/ha reduced biomass of all grass species 81 to 98% compared to their individual controls. Contrasts comparing grass injury, height, and biomass of all wheatgrass varieties versus brome varieties, were significant ($P>0.0001$) (data not shown). Brome species were more sensitive than the wheatgrasses to all imazapic rates. Overall, as imazapic rate increased from 0.016 to 0.250, grass injury increased, and height and biomass decreased compared to their untreated controls.

Table 2. Visual injury, plant density and above ground biomass of forage grasses treated with five rates of imazapic.

Grass species	Grass injury					Height						Biomass					
	Imazapic rate (kg/ha)					Imazapic rate (kg/ha)						Imazapic rate (kg/ha)					
	0.016	0.032	0.064	0.125	0.25	0.016	0.032	0.064	0.125	0.25	Untreated	0.016	0.032	0.064	0.125	0.25	Untreated
	%[a]					cm						g/m^2					
Bluebunch Wheatgrass	8	14	15	16	27	84	76	61	56	48	106	192	144	142	137	69	369
Crested Wheatgrass	19	34	44	39	48	56	43	43	33	33	91	227	143	151	93	57	400
Intermediate Wheatgrass	16	18	41	46	61	76	69	53	38	28	119	240	217	174	103	89	522
Western Wheatgrass	11	19	29	41	54	71	53	48	36	36	97	175	119	145	76	62	393
Meadow Brome	23	53	56	75	84	61	41	36	28	18	112	134	70	71	35	27	363
Smooth Brome	24	56	58	65	88	69	38	30	23	8	114	135	55	36	12	6	356
Orchardgrass	28	44	56	45	84	64	33	20	25	13	86	136	27	19	16	5	150
$LSD_{0.05}$			13.5						5.8						72.2		

[a] There is a significant interaction between forage grass species and treatments, so only one LSD is reported for each factor (injury, height, biomass).

Spotted knapweed control with imazapic. Sandra L. Shinn and Donald C. Thill. (Plant Science Division, University of Idaho, Moscow, ID 83844-2339) A study was established on unimproved pasture land near St. Maries, Idaho, and at Farragut State Park near Athol, Idaho during fall 1997 to evaluate spotted knapweed control with imazapic and picloram. Soil type at St. Maries was a silt loam (39.6% sand, 4.4% clay, 56% silt, pH 6.3, and 5.5% organic matter). Soil type at Farragut State Park was a sandy loam (60% sand, 6% clay, 34% silt, pH 7.3 and 5.7% organic matter). Herbicide treatments were arranged as a 2 (fertilizer) by 12 (herbicide) factorial randomized complete split-block design with four replications and individual plots were 2.4 by 12.2 m. Herbicides were applied with a CO_2 pressurized backpack sprayer calibrated to deliver 94 L/ha at 234 kPa (Table 1). Fertilizer [112 kg N/ha as ammonium sulfate (21-0-0-24)] was applied during spring 1998 to one half of each block, while no fertilizer was applied to the other half. Spotted knapweed control was evaluated visually, and plant counts and biomass were taken at the flowering stage on June 25, 1998 and June 28, 1999 at St. Maries and June 29, 1998 and June 28, 1999 at Farragut State Park. Plants were counted and cut from a 0.25 m^2 area of each plot, dried for 72 hours, and weighed. The 1998 data are reported in 1999 WSWS Research Progress Report ISSN-0090-8142, page 9.

Table 1. Application data.

	St. Maries		Farragut State Park	
Application timing	October 7, 1997	April 21, 1998	October 6, 1997	May 5, 1998
Spotted knapweed stage	5 to 6 leaves	8 to 10 leaves	5 to 6 leaves	8 to 10 leaves
Air temperature (C)	11	22	11	30
Relative humidity (%)	61	40	65	39
Wind (km/h)	1	3	2	2
Cloud cover (%)	95	20	100	0
Soil temperature at 5 cm (C)	5	11	9	11

The fertilizer by treatment by location interaction was not significant, thus data were combined across locations. Plant density, biomass and percent control were not affected by fertilizer (data not shown). Picloram applied in the fall or spring controlled spotted knapweed 77 to 87%, reduced plant density 68 to 96%, and reduced biomass 50 to 96% compared to the untreated control (Table 2). Imazapic did not control spotted knapweed.

Table 2. Spotted knapweed percent control, plant density and biomass. Herbicide treatments were applied during fall 1997, and spring 1998. Data are for the 1999 growing season.

Treatment	Rate	Application timing[a]	Control	Density	Biomass
	kg/ha		%	plants/m²	g/m²
Imazapic[b]	0.07	F	0	122	108
Imazapic	0.14	F	0	78	63
Imazapic	0.21	F	0	83	67
Picloram	0.42	F	77	30	34
Imazapic + imazapic	0.07 + 0.14	F + S	0	153	157
Imazapic + imazapic	0.07 + 0.07	F + S	0	106	116
Imazapic + imazapic	0.14 + 0.07	F + S	0	121	137
Imazapic	0.07	S	0	82	122
Imazapic	0.14	S	0	102	136
Imazapic	0.21	S	0	113	111
Picloram	0.42	S	87	4	3
Untreated check	–	–	–	104	67
LSD (0.05)			1	24	79

[a] F = fall application, S = spring application

[b] All imazapic treatments were applied with a methylated seed oil plus surfactant at 1.25% v/v.

The effect of imazapic on yellow starthislte control and pasture grass production. Sandra L. Shinn and Donald C. Thill. (Plant Science Division, University of Idaho, Moscow, ID 83844-2339) A study was established on unimproved pasture land near Genesee, Idaho to determine the affect of imazapic and picloram on yellow starthistle control and annual and perennial grass production. Soil type at Genesee was a silt loam (38% sand, 8% clay, 54% silt, pH 6.7 and 4.2% organic matter). Herbicide treatments were arranged as a randomized complete block design with four replications and plots were 2.4 by 9.1 m. Herbicides were applied with a CO_2 pressurized backpack sprayer calibrated to deliver 93 L/ha at 221 kPa (Table 1). Yellow starthistle control and grass injury were evaluated visually, and plant counts and biomass were taken on June 10, 1999, when yellow starthistle was in the flowering stage. Plants were counted and cut at the soil surface from a 0.25 m^2 area, dried for 72 hours and weighed.

Table 1. Application data.

Application timing	April 12, 1999
Yellow starthistle stage	4 to 8 leaves
Annual grass stage	4 to 6 leaves
Perennial grass stage	4 to 6 leaves
Air temperature (C)	15
Relative humidity (%)	56
Wind (km/h)	3
Cloud cover (%)	60
Soil temperature (C at 5 cm)	5

Imazapic alone controlled the yellow starthistle 75 to 96%, but injured the annual and perennial grasses 95 to 100% and 50 to 83%, respectively. Imazapic alone reduced perennial grass density 32 to 80% and biomass 57 to 94% compared to the untreated control (Table 2). Picloram controlled yellow starthistle 100% and did not injury the perennial or annual grasses. Picloram applied in combination with imazapic controlled yellow starthistle 100%, but injured annual grasses 90 to 95% and perennial grasses 43 to 65%. The biomass of perennial grasses in picloram alone treated plots was almost five times greater than in the untreated control.

Table 2. Yellow starthistle percent control, plant density and biomass.

		Yellow starthistle			Annual grasses[a]			Perennial grasses[b]		
Treatment	Rate	Control	Density	Biomass	Injury	Density	Biomass	Injury	Density	Biomass
	kg/ha	%	plants/m^2	g/m^2	%	plants/m^2	g/m^2	%	plants/m^2	g/m^2
Imazapic[c]	0.07	75	24	50	95	0	0	50	67	15
Imazapic	0.14	96	3	1	100	0	0	83	20	2
Picloram	0.28	100	0	0	0	40	9	0	124	161
Picloram	0.42	100	0	0	0	5	2	0	135	172
Imazapic + picloram	0.07 + 0.28	100	0	0	90	3	1	43	178	31
Imazapic + picloram	0.07 + 0.42	100	0	0	90	0	0	43	217	34
Imazapic + picloram	0.14 + 0.28	100	1	1	95	0	0	55	75	7
Imazapic + picloram	0.14 + 0.42	100	0	0	95	12	1	65	55	8
Untreated check	--	--	198	84	0	9	2	0	99	35
LSD (0.05)		14	146	58	9	22	4	24	96	27

[a] Annual grass species consisted of 75% brome species and 25% medusahead rye.
[b] Perennial grass species consisted of 50% bulbous bluegrass and 50% bluebunch wheatgrass.
[c] All imazapic treatments were applied with a methylated seed oil plus surfactant at 1.25% v/v.

Yellow starthistle control with imazapic. Sandra L. Shinn and Donald C. Thill. (Plant Science Division, University of Idaho, Moscow, ID 83844-2339) A study was established during fall 1997, at two locations on unimproved pasture land near Lewiston, Idaho (upper and lower Tammany) to evaluate yellow starthistle control with imazapic and picloram. Soil type at lower Tammany was a silt loam (38% sand, 8% clay, 54% silt, pH 7.5, and 4.3% organic matter), and at upper Tammany soil was a silt loam (38% sand, 10% clay, 52% silt, pH 7.3, and 5.4% organic matter). Herbicide treatments were arranged as a 2 (fertilizer) by 15 (herbicide) factorial randomized complete split-block design with four replications and individual plots were 2.4 by 12.2 m. Herbicides were applied with a CO_2 pressurized backpack sprayer calibrated to deliver 93 L/ha at 230 kPa (Table 1). Fertilizer [112 kg N/A as ammonium sulfate (21-0-0-24)] was applied during spring 1998 to one half of each block, while no fertilizer was applied to the other half. Yellow starthistle control was evaluated visually, and plant counts and biomass data were collected when yellow starthistle plants had firm buds on June 4, at lower Tammany and June 9, 1999, at upper Tammany. Yellow starthistle plants were counted and cut from a 0.25 m^2 area, dried for 72 hours and weighed. The 1998 data are reported in 1999 WSWS Research Progress Report ISSN-0090-8142, page 31.

Table 1. Application data.

	Upper Tammany			Lower Tammany		
Application date	9-27-97	11-11-97	3-18-98	9-27-97	11-6-97	2-24-98
Application timing	PRE	POST	POST	PRE	POST	POST
Yellow starthistle stage	—	2 to 4 leaves	5 to 8 leaves	—	2 to 4 leaves	5 to 8 leaves
Air temperature (C)	14	12	16	16	15	4
Relative humidity (%)	48	68	38	48	60	64
Wind (km/h)	8	4	4	3	5	7
Cloud cover (%)	60	60	10	60	40	40
Soil temperature at 5 cm (C)	13	9	10	13	12	5

The fertilizer by treatment by location interaction was not significant, thus data were combined across locations. Also the fertilizer by treatment and fertilizer main affect were not significant for plant density, biomass, and percent control. Picloram applied in the fall or spring controlled yellow starthistle 86 to 94%, reduced plant density 82 to 99%, and reduced biomass 18 to 96% compared to the untreated control (Table 2). Imazapic applied PRE reduced the yellow starthistle density 7 to 27%, and applied in the spring at 0.07 kg/ha and sequentially at 0.07 + 0.07 kg/ha reduced plant density 25 to 32%. However, surviving plants were large and produced biomass similar to or greater than the untreated control.

Table 2. Yellow starthistle percent control, plant density, and biomass. Herbicide treatments were applied during fall 1997, and spring 1998. Data are for the 1999 growing season.

Treatment	Rate	Application timing[a]	Control	Density	Biomass
	kg/ha		%	plants/m^2	g/m^2
Imazapic[b]	0.07	F - PRE	0	224	133
Imazapic	0.14	F - PRE	0	281	227
Imazapic	0.21	F - PRE	0	286	229
Imazapic	0.07	F - POST	0	284	206
Imazapic	0.14	F - POST	0	306	173
Imazapic	0.21	F - POST	0	236	203
Picloram	0.42	F - POST	86	55	140
Imazapic + imazapic	0.07 + 0.14	F + S - POST	0	351	212
Imazapic + imazapic	0.07 + 0.07	F + S - POST	0	209	311
Imazapic + imazapic	0.14 + 0.07	F + S - POST	0	324	342
Imazapic	0.07	S - POST	0	228	393
Imazapic	0.14	S - POST	0	367	343
Imazapic	0.21	S - POST	0	320	421
Picloram	0.42	S - POST	94	2	7
Untreated check	—	—	—	306	170
LSD (0.05)			4	108	105

[a] F = fall application, S = spring application

[b] All imazapic treatments were applied with a methylated seed oil plus surfactant at 1.25% v/v.

Yellow starthistle control with imazapic, picloram, clopyralid, 2,4-D, and dicamba. Sandra L. Shinn and Donald C. Thill. (Plant Science Division, University of Idaho, Moscow, ID 83844-2339) A study was established near Lewiston, Idaho (upper and lower Tammany) to evaluate yellow starthistle control with imazapic, picloram, clopyralid, dicamba, and 2,4-D. Soil type at lower Tammany was a silt loam (38% sand, 8% clay, 54% silt, pH 7.5, and 4.3% organic matter), and at upper Tammany the soil was a silt loam (38% sand, 10% clay, 52% silt, pH 7.3, and 5.4% organic matter). The experimental design was a randomized complete block with four replications and individual plots were 2.4 by 9.1 m. Herbicide treatments were applied postemergence on February 24, 1998 at lower Tammany and on March 18, 1998 at upper Tammany with a CO_2 pressurized backpack sprayer calibrated to deliver 94 L/ha at 206 kPa (Table 1). On June 7, 1999, yellow starthistle control was evaluated visually at both sites, and plants were counted and cut from a 0.25 m^2 area, dried for 72 hours, and weighed. The 1998 data are reported in 1999 WSWS Research Progress Report ISSN-0090-8142, page 29-30.

Table 1. Application data.

	Lower Tammany	Upper Tammany
Yellow starthistle stage	5 to 8 leaves	5 to 8 leaves
Air temperature (C)	4	16
Relative humidity (%)	38	64
Wind (km/h)	5	3
Cloud cover (%)	40	10
Soil temperature (C at 5 cm)	5	10

At upper Tammany, imazapic at 0.14 kg/ha plus dicamba or 2,4-D reduced yellow starthistle plant density 78 to 90% compared to the untreated control, which had an average of 260 plants/m^2 (Table 2). At upper Tammany, clopyralid reduced yellow starthistle density 78% and biomass 98% compared to the untreated control. Imazapic and dicamba applied alone and in combination at 0.21 + 1.12 kg/ha, respectively, at lower Tammany reduced the plant density 33 to 60%. Imazapic alone or in combination with dicamba or 2, 4-D did not visually control yellow starthistle at either site. At upper and lower Tammany, picloram controlled yellow starthistle 93 to 100% and reduced yellow starthistle density 99%, and biomass 96 to 99%.

Table 2. Yellow starthistle control, density and biomass. Treatments were applied in late winter 1998. Data are for the 1999 growing season.

		Lower Tammany			Upper Tammany		
Treatment	Rate	control	density	biomass	control	density	biomass
	kg/ha	%	plants/m^2	g/m^2	%	plants/m^2	g/m^2
Imazapic[a]	0.14	0	406	932	0	417	211
Imazapic	0.21	0	325	1240	0	203	263
2,4-D	2.24	0	975	528	0	207	66
Clopyralid	0.42	0	853	497	0	57	8
Dicamba	1.12	0	348	1169	0	227	108
Picloram	0.42	100	4	35	93	3	1
Imazapic + dicamba	0.14 + 1.12	0	814	925	0	57	375
Imazapic + 2,4-D	0.14 + 2.24	0	573	805	0	27	140
Imazapic + dicamba	0.21 + 1.12	0	240	865	0	212	719
Imazapic + 2,4-D	0.21 + 2.24	0	520	824	0	242	271
Untreated check	–	–	605	908	–	260	452
LSD (0.05)		–	478	757	–	403	485

[a] All imazapic treatments were applied with a methylated seed oil plus surfactant at 1.25% v/v.

The competitive effects of five cool-season perennial grasses on foxtail barley. Tom D. Whitson and Jerry M. Langbehn (Dept. Of Plant Sciences, University of Wyoming, Laramie, WY 82071). Foxtail barley (*Hordeum jubatum* L.) is a short-lived perennial that reproduces from seed. It is increasing in density in many hay meadows of the west and is causing economic losses in hay. Chemical control has not proven to be consistent because of uncertain fall moisture to activate products such as pronamide. This experiment was conducted near Thermopolis, WY to determine the competitive ability of five perennial cool-season grasses that are well adapted to high pH soil conditions. Soils had a 7.8, 1.6% organic matter, 38% sand, 23% silt and 39% clay. Plots were 12' by 50' arranged in a randomized complete block design with three replications. Seedbed preparation was done with a rototiller in two directions on June 18, 1997. A single application of glyphosate at 1.0 lb ae/Acre was applied to control volunteer foxtail barley and annual weeds on August 1, 1997. Seeding was done with a Brillion seeder August 12, 1997 at 15 lb PLS/Acre. Species seeded included: hybrid wheatgrass (experimental line RS1; quackgrass x bluebunch wheatgrass [*Elytrigia repens* L. Nevski x *Pseudoroegneria spicata* (Pursh) A. Löve], Pryor slender wheatgrass (*Elymus trachycaulus* spp. *trachy*). Jose tall wheatgrass (*Thinopyrum ponticum*), Shoshone beardless wildrye (*Leymus multicaulus*), Prairieland altai wildrye (*Leymus angustus*). Evaluations were made September 1, 1998 and clipping by species on July 8, 1999. Tall wheatgrass was well-adapted to this high pH site and became established well one year after seeding. The second year tall wheatgrass displaced 90% of the foxtail barley and produced 4,485 lbs. of dry forage/Acre, while the production of foxtail barley was only 356 lb/Acre. The protein and relative feed value of tall wheatgrass was at the level of the average of the five species (Wyoming Agric. Exp. Sta., Laramie, WY 82071, SR 1739).

Table . Competitive effects of five cool-season grasses with foxtail barley.

	1998	1999				
	Foxtail barley	Dry wt. lbs/A		Perennial grass		Foxtail barley
Grass species	Control	Perennial grass	Foxtail barley	Crude protein	Relative feed value	Control
	(%)			(%)		(%)
Hybrid wheatgrass (Newhy)	47	1371	795	9.6	81.7	56
Slender wheatgrass (Prior)	3	2598	1005	4.4	70.6	59
Tall wheatgrass (Jose)	57	4485	356	8.2	80.5	90
Beardless wheatgrass (Shoshone)	0	721	2014	10.5	83.1	19
Altai wheatgrass (Prairieland)	2	1086	2462	8.5	91.1	27
(Average)	21.8	2052	1326	8.2	81.4	50

1.) Seeded with a Brillion Seeder, Aug. 12, 1997 at 15 lbs (PLS)/Acre.

2.) All species were clipped by species (four) M^2 quadrats/rep., oven dried then weighed.

The effects of various herbicides on musk thistle. Tom D. Whitson, (Dept. of Plant Sciences, Laramie, WY 82071). Musk thistle (*Carduus nutans* L.) forms dense competitive stands, excluding other vegetation. These studies were conducted near Riverside, Wyoming to compare various herbicides for control of musk thistle. Soils had a 7.1 pH, 1.1% organic matter, 90% sand, 3% silt and 7% clay. Plots were 10 x 27 feet arranged in a randomized complete block design with four replications. Herbicide applications were made on May 3, 1998 to thistle in the pre-bloom and seedling growth stage. Air temperature was 85°F with clear skies, a relative humidity of 10%, 2-3 mph wind, soil temperature: surface 118°F, 4 in. 102°F. Evaluations were made Aug. 18, 1998 and June 20, 1999. Metsulfuron applied at rates above 1.0 oz/A provided 100% control of musk thistle. Applications of metsulfuron at 0.5 oz provided 35% control in 1998, but one year later control increased to 76%. (Wyoming Agric. Exp. Sta., Laramie, WY 82071, SR 1737).

Table . Control of musk thistle with various herbicides.

		% control	
Treatment	Rate (oz/A)	1998	1999
Metsulfuron[a]	0.5	35	76
Metsulfuron[a]	1.0	58	100
Metsulfuron[a]	1.5	73	100
Metsulfuron[a]	2.0	84	100
Imazapic[a]	6.0	00	00
Imazapic[a]	8.0	00	00
Imazapic[a]	10.0	00	00
Triasulfuron[a]	0.28	00	08
Triasulfuron[a]	0.56	04	26
Triasulfuron + dicamba	4.0	03	18
Untreated	-	00	00

[a] All herbicides were applied with 0.25% v/v activator 90 surfactant.

Control of perennial pepperweed at two growth stages with various herbicides. Tom D. Whitson, (Dept. of Plant Sciences, Laramie, WY 82071). Perennial pepperweed (*Lapidium latifolium* L.) is rapidly spreading throughout western U.S. waterways. This invasive species has an ability to spread throughout creeping root systems and by seed. Perennial pepperweed is of great concern to game and land managers because of the monocultures that result with infestations. Various herbicide applications were compared in these studies to determine their efficacy on perennial pepperweed. Studies were conducted near Farson, WY. Plots were 10 by 27 ft arranged in a randomized complete block design with four replications. Soils were a clay loam with 25% sand, 30% silt, 45% clay and 2.8% organic matter having a pH of 7.7. Herbicides were applied at 30 gal/A at 40 psi pressure to perennial pepperweed in the vegetative and bloom stages. Metsulfuron treatments above 1.0 oz/A and imazapic 8 fl oz or above provided greater than 87% control at both growth stages. Triasulfuron applications at 0.28 and 0.56 provided less than 70% control. (Wyoming Agric. Exp. Sta., Laramie, WY 82071, SR 1738).

Table . Control of perennial pepperweed at two growth stages with various herbicides.

		Growth stage	
Treatment	Rate (oz/A)	Vegetative	Bloom
		% control	
Metsulfuron	0.5	80	77
Metsulfuron	1.0	87	92
Metsulfuron	1.5	99	98
Metsulfuron	2.0	99	99
Imazapic	6.0	91	75
Imazapic	8.0	91	87
Imazapic	10.0	98	98
Triasulfuron	0.28	53	48
Triasulfuron	0.56	68	68
Triasulfuron + dicamba	4.0	62	65
Check		0	0

1. Herbicides were applied June 11, 1998 to plants in the vegetative stage and July 28, 1998 to plants in the bloom stage. All treatments were applied with 0.25% v/v Activator 90 surfactant.

PROJECT 2: WEEDS OF HORTICULTURAL CROPS

Henry Wu, Chair

Control of *Horkelia fusca* in established peppermint. Daniel B. Marcum and W. Thomas Lanini. (University of California Cooperative Extension, McArthur, CA 96056, and Department of Vegetable Crops, University of California, Davis 95616) Weeds not only reduce peppermint yield, but also quality, which can make peppermint oil unmarketable. *Horkelia fusca* has been observed to be tolerant in bentazon treatments and increasing in abundance in northeastern California peppermint fields. This field trial was initiated to examine *Horkelia fusca* control and peppermint tolerance with oxyfluorfen alone or in combination with bentazon. Treatments were applied in September. Control of *Horkelia fusca* was good (>80%) with 0.75 lb/A of oxyfluorfen, however crop injury was 50% with this treatment. Reducing the rate of oxyfluorfen, reduced the injury to peppermint, but also reduced *Horkelia fusca* control. Bentazon alone was much safer on the peppermint, but failed to provide adequate control of *Horkelia fusca*. The combination of oxyfluorfen plus bentazon did not increase *Horkelia fusca* control versus oxyfluorfen alone. Treating in December or January, when peppermint is dormant may reduce peppermint injury while still allowing *Horkelia fusca* control.

Table. Control of *Horkelia fusca* in peppermint.

Treatment	Rate	*Horkelia fusca* Control	Peppermint injury
	lb/A	%	%
Oxyfluorfen	0.25	50	30
Oxyfluorfen	0.75	83	50
Oxy + bent[a]	0.25 + 1.34	30	5
Bentazon	1.34	53	30
Untreated		0	0

[a] Oxy = oxyfluorfen, bent = bentazon.

Evaluation of carfentrazone-ethyl and pelargonic acid for primocane suppression in red raspberry and Marion blackberry. Diane Kaufman, Gina Koskela, and Ray William. (Department of Horticulture, Oregon State University, Corvallis, OR 97331) The removal of early primocane growth and lower foliage from fruiting canes enhances production of machine harvested red raspberries and Marion blackberries. Oxyfluorfen has provided inadequate suppression of primocanes in Marion blackberry, and there is concern among growers that repeated use has reduced plant vigor in red raspberry. Unlike oxyfluorfen, which can remain active in the soil for several weeks, carfentrazone-ethyl and pelargonic acid are contact herbicides with little soil residual. This research was conducted in two commercial fields in the Portland area and at the North Willamette Research and Extension Center to evaluate the effectiveness of carfentrazone-ethyl and pelargonic acid for primocane suppression in two varieties of red raspberry ('Meeker' and 'Willamette') and Marion blackberry, and establish optimal use rates. This report summarizes 3 years of evaluation with carfentrazone and 2 years of evaluation with pelargonic acid.

With the exception of the 1998 observations of pelargonic acid on Marion blackberry and boysenberry, each experiment was randomized in a complete block design with four replications. Treatments were applied with a CO2 pressurized backpack sprayer, mounted with a single 8002 nozzle set at 40 psi. Rates were applied at the equivalent of 50 gals of water per acre with carfentrazone and 75 gals of water with pelargonic acid and each included the addition of 0.25% surfactant on a volume basis. Red raspberries were treated one time in late April/early May. Marion blackberries were treated multiple times between mid-April and early June.

The surfactant applied in 1997, 1998, and 1999 was WA-100, R-11, and Freeway, respectively. Because choice of surfactant appeared to have an effect on the quality of burn in 1998, an observational trial (2 replications) comparing the effectiveness of carfentrazone with 5 different surfactants, (C-17; LI-700; Freeway; Silwet; R-11; no surfactant) was established in 'Meeker' red raspberry.

Marion Blackberry: Carfentrazone-ethyl applied 2 or 3 times at rates of 0.05, 0.1, or 0.2 lb active ingredient/A was compared to oxyfluorfen applied twice at a rate of 0.4 lb ai/A. At all rates and timings , carfentrazone consistently provided more uniform and thorough suppression of primocanes than oxyfluorfen, with no apparent damage to fruiting canes or plant vigor. There were no differences among treatments in yield, primocane number or primocane diameter in 1997, 1998, or 1999. Fruit size tended to be smallest in the untreated control. There were significantly fewer kinked and damaged primocanes at the end of the season in 1997 and 1998 in all carfentrazone treatments compared to oxyfluorfen plots. Although carfentrazone gave an acceptable burn each year, the quality of burn was better with WA-100 or Freeway as the surfactant than with R-11, despite similar weather conditions at the time of the first application each year.

Table 1. Burn ratings, Marion blackberry, conducted in mid-May, after1-2 applications.

Treatment	1997 Primocane	1997 Lower laterals	1998 Primocane	1998 Lower laterals	1999 Primocane	1999 Lower laterals
Carfen 0.05	8.6	9.3	6.8	9.3	8.6	8.8
Carfen 0.1	9.0	9.4	7.9	9.3	9.3	9.4
Carfen 0.2	9.6	9.9	8.1	9.3	9.9	9.7
Oxyfluorfen	4.6	6.0	3.6	7.0	5.8	6.8
Surfactant	WA-100		R-11		Freeway	
First spray date	4/25/97		4/14/98		4/26/99	
Weather	sunny, 55 degrees F		partly cloudy, 55 F		cloudy, 50 F	

*Rating scale 0-10; 0= no burn, 10=100%

Because pelargonic acid, applied twice at a concentration of 5.33% to unreplicated plots of Marion blackberry and boysenberry, did not adequately burn back primocanes of either variety in 1998, it was not evaluated on Marion blackberry in 1999.

Red Raspberry: Carfentrazone applied at rates of 0.025, 0.05, 0.1, and 0.2 lb active ingredient/A was compared to oxyfluorfen applied at 0.1 (Meeker) and 0.067 (Willamette) lb ai/A, pelargonic acid applied at a concentration of 5.33%, hand removal of primocanes, and an untreated control. Carfentrazone provided more uniform and thorough suppression of primocanes than oxyfluorfen with no apparent damage to fruiting canes or plant vigor. The burn with pelargonic acid was similar to that with oxyfluorfen in 1998, but not as effective as oxyfluorfen when applied under cloudy conditions in 1999. The quality of burn from all herbicides was better in 1997 and 1999 with WA-100 and Freeway than with R-11 in 1998.

Table 2. Burn ratings, Meeker red raspberry.

Treatment	1997 Primocane	1997 Lower laterals	1998 Primocane	1998 Lower laterals	1999 Primocane	1999 Lower laterals
Carfen 0.025	–	–	7.9	9.1	9.4	9.8
Carfen 0.05	9.9	10	7.8	9.2	9.8	9.9
Carfen 0.1	10	9.9	8.0	8.6	9.9	10
Carfen 0.2	9.9	9.9	8.9	9.7	9.9	10
Oxyfluorfen	6.3	9.4	5.2	7	9.3	9.8
Pelargonic acid	–	–	5.8	7.6	7.2	8.5
Surfactant	WA-100		R-11		Freeway	
Spray date	5/1/97		4/27/98		4/28/99	
Weather	partly cloudy, 55 F		partly cloudy, 60 F		cloudy, 50 F	

*Rating scale 0-10; 0= no burn, 10=100%

There were no differences among treatments in yield, cane number, cane diameter, percent bud break, or number of laterals in 'Meeker' red raspberry in 1997, 1998, or 1999. Fruit size tended to be smallest in the untreated control and largest in carfentrazone at the 0.1 rate. There were no differences among treatments in fruit size, cane number, cane diameter, percent bud break, or number of laterals in 'Willamette' red raspberry in 1997, 1998, or 1999. However, yield tended to be higher in the hand removal and carfentrazone 0.1 rate plots in 1998 and 1999.

In the surfactant observation trial conducted in 'Meeker' red raspberry in 1999, carfentrazone at the 0.05 lb rate was applied with 5 different surfactants. The fastest burn (1-2 days) was with C-17 crop oil. The LI-700, Freeway, and Silwet resulted in similar burns, with excellent burn back achieved within 2-5 days. The R-11 resulted in the slowest burn, with canes and foliage not completely burned back for almost 2 weeks. Burn back was slowest and least uniform in the two plots sprayed with no surfactant.

Evaluation of the effects of dimethenamid on plant populations and yields in radish, rutabaga, and turnip. Robert McReynolds, Chris Cornwell, and Karen Cornwell. (North Willamette Research and Extension Center, Oregon State University, Aurora OR 97002). As is true for many minor crops, there are few broadleaf herbicides registered for use in root crops. Phytotoxicity screens conducted in previous years demonstrated good crop safety with dimethenamid in turnip, rutabaga and radish. Trials were conducted in 1999 in each crop in order to evaluate the impact of preemergence applications of dimethenamid on stand establishment and plant biomass or yield.

Each trial was conducted in a commercial field. The same treatments were applied in all three trials, except in the radish trial, that did not include the postemergence application. All the trials were kept relatively weed free in order to better evaluate the effects of the treatments on emergence and yields. Trial designs were randomized complete block with 4 replications. Replicate dimensions in the turnip and rutabaga trials were 1.8 by 6 meters. Dimensions of the radish replicates were two by six meters. The treatments were applied with a CO_2 backpack sprayer calibrated to deliver 38 to 40 gpa at 38 psi. The carrier solution used for each treatment was 1000 ml.

The treatments were applied to the turnip trial on June 30 in a field of Latourell loam soil type (air temp 71F, relative humidity 68%, soil temp 68F, wind from the north gusty from 6 to 8 mph, cloud cover 90%, soil surface dry). The field was sprinkler irrigated with approximately 0.75 inches of water the following day. The postemergence treatment was applied on July 13 and irrigated the following day with approximately 0.5 inches of water (air temp 84F, relative humidity 36%, soil temp 85F, no wind, cloud cover 0, soil surface dry). The plant populations were counted on July 13 and the trial was harvested 84 days after planting on September 23.

The rutabaga trial treatments were applied on June 10 in a field of Aloha silt loam soil type (air temp 68F, relative humidity 62%, soil temp 65F, wind from the SW gusty to 3 mph, cloud cover 0, soil surface dry). The rutabaga variety Laurentian had been seeded the previous day. The field was sprinkler irrigated three hours after the treatments were applied. The postemergence treatment was applied on June 25 to seedlings in the early second true leaf stage of growth (air temp 64F, relative humidity 73%, soil temp 64F, wind from the SW gusty up to 8 mph, cloud cover 50%, soil surface wet). The field received approximately 0.16 inches of rain the following day. Plant populations were counted on June 24 and the trial was harvested 125 days after planting on October 15.

The treatments were applied to the radish trial on June 4 (air temp 56F, relative humidity 94%, soil temp 58F, wind from the SW less than 3 mph, cloud cover 100%, soil surface moist). The variety Cabernet had been seeded earlier that day in a field of Willamette silt loam soil type. During the four-day period following the applications, the area received approximately 0.47 inches of rainfall. Plant populations were counted on June 14 and the trial was harvested 27 days later on July 1.

Rutabaga appeared to have the greatest tolerance to all the preemergence rates applied. There were no reductions in the plant populations, the number of roots, the ratio of tops to roots or the total plant biomass. Turnip stands were reduced by both the lowest and the highest preemergence rates. However, the yield of medium sized roots was significantly reduced by only highest rate. The reduction in plant populations probably resulted in the increase observed in the weight of the large sized roots (not statistically significant). Radish exhibited the least degree of tolerance to dimethenamid applications. All the rates applied significantly reduced root yields in comparison to the untreated control and resulted in a higher ratio of tops to roots. However, plant populations were not significantly reduced. Future trials are planned in order to verify these results.

Table 1. The effect of various rates of dimethenamid on turnip plant populations and root yields.

Rate	Plant population	Small[a]	Medium[a]	Large[a]	Yield-all sizes[b]
lb/a	plants/m	kg			
Untreated	18.6	15.2	3.2	10.7	29.1
0.25 PREE	15.9	15.3	2.9	11.5	29.7
0.5 PREE	17	15.7	2.6	11.6	29.9
0.75 PREE	14.2	14.2	1.7	11.6	27.5
0.5 POST	19.4	14.8	3.3	9.5	27.6
LSD 0.05	2.6	NSD	1.1	NSD	NSD

[a]Sizes of roots, small < 2.5 inches, medium >2.5 and <3.5, large >3.5
[b]Yield from 3.2 m^2 /replicate.

Table 2. The effect of various rates of dimethenamid on rutabaga plant populations, the number of roots, and plant biomass.

Rate	Plant population	Ratio-tops/roots[a]	Number of roots[b]	Plant biomass[b]
lb/a	plants/m			kg
Untreated	15.6	0.12	84.3	21.2
0.25 PREE	15.9	0.13	87.5	21.4
0.5 PREE	14.8	0.12	87.8	21.6
0.75 PREE	15.3	0.11	88.8	21.9
0.5 POST	15.3	0.11	92.5	25.9
LSD 0.05	NSD	NSD	NSD	NSD

[a]Ratio based upon the weights of 25 plants selected at random from each replicate.
[b]Yield from 3.2 m^2 /replicate.

Table 3. The effect of various rates of dimethenamid applied preemergence on radish stands, root yields and plant biomass.

Rate	Plant population	Ratio-tops/roots	Tops	Roots	Plant biomass[b]
lb/a	plants/m		kg		
Untreated	21.2	0.41	2.2	5.3	7.5
0.25	22.4	0.6	2.6	4.5	7.2
0.5	28	0.62	2.6	4.2	6.8
0.75	25.7	0.58	2.5	3.8	6.3
LSD 0.05	5.5	0.18	NSD	0.6	1.1

[b]Yield from 5.6m^2/replicate

Evaluation of new herbicides for use in strawberries. Diane Kaufman, Joe DeFrancesco, Gina Koskela, Ed Peachey. Two field trials were established at the North Willamette Research and Extension Center (NWREC) in the North Willamette Valley of Oregon on a Quatama silt loam soil with 4% organic matter. Herbicides were applied using a CO_2 backpack sprayer equipped with a 4-nozzle boom (TeeJet 8002, flat fan) at 40 psi, at a rate of 20 gallons of water per acre.

1. Establishment Trial. 'Totem' strawberries were planted in raised beds on May 13, 1999. Plots four rows wide and 30 feet long were arranged in a completely randomized block design with four replications. Soil was lightly raked over the strawberry crowns immediately after planting (to ensure that no green growth was visible) and then lightly irrigated. Herbicide treatments were made on May 15, 1999 and followed immediately with approximately one inch of irrigation. The herbicides applied at planting will again be applied during winter dormancy (similar to the program developed for the use of oxyfluorfen). Because most herbicides began to lose effectiveness by late summer, all plots received a maintenance herbicide application of simazine (1lb. ai/A) and napropamide (2 lb. ai/A) on September 29, 1999, after the plots had been hoed free of weeds.

Weed control was evaluated approximately every 30 days, beginning about a month after application of treatments. If needed, plots were hand-weeded after each evaluation. Phytotoxicity was evaluated beginning two days after herbicide applications and, then, periodically throughout the growing season. Plant vigor was evaluated July 14, 1999. Yield data will be collected in summer 2000.

Table 1. Treatments in Establishment Trial.

Treatments	Rate at planting	Winter Rate
	lb/A	lb/A
Azafenidin	0.2	0.3
Dimethenamid	1	1.25
Fluamide	0.25	Fluamide + Sulfentrazone (0.25) (0.25)
Oxyfluorfen	0.2	0.2
Rimsulfuron	0.0117	0.0117
Sulfentrazone	0.062	0.25
Thiazopyr	0.5	0.5
Hand-weeded control [a]	----	----
Weedy control [a]	----	----

[a] Included in trial to provide a basis for comparison when evaluating plant vigor and yield.

Table 2. Dominant weeds present during growing season, 1999.

Date	Primary Weeds	Other Weeds
June 28	Nightshade	Shepherd's purse, henbit, pineappleweed, chickweed, pigweed, annual bluegrass, barnyard grass.
July 21	Pigweed Crabgrass	Shepherd's purse, sowthistle, pineappleweed, chickweed, nightshade, annual bluegrass, barnyard grass.
August 18	Pigweed	Shepherd's purse, pineappleweed, sowthistle, groundsel, annual bluegrass, crabgrass, barnyard grass. (Heavy grass pressure)
September 20	Annual bluegrass	Shepherd's purse, pineappleweed, sowthistle, groundsel.

Azafenidin provided the longest lasting control of all weeds (Table 3). Thiazopyr provided excellent control of grasses through September and excellent control of broadleaves through August; by September, broadleaf control in the Thiazopyr plots had become marginal, with pressure from pineappleweed and groundsel. Sulfentrazone provided good control of broadleaves through August and virtually no control of grasses. Oxyfluorfen, the chemical standard in this experiment, provided excellent control of broadleaves and grasses through August. Dimethenamid provided excellent control of broadleaves through July and excellent control of grasses through August. Fluamide provided excellent control of grasses all season and virtually no control of broadleaves. Rimsulfuron provided only fair-good control of broadleaves through July and virtually no control of grasses.

Table 3. Weed control in establishment trial (expressed as percent control compared to the weedy check plots) on four dates.

Treatment	Broadleaf Weed Control 6/28	7/21	8/18	9/20	Grass Weed Control 6/28	7/21	8/18	9/20
	%				%			
Azafenidin	99.7	96.5	97.0	96.2	97.2	96.2	92.5	97.5
Dimethenamid	97.0	93.7	71.8	60.6	100.0	98.3	93.8	75.0
Fluamide	66.5	62.0	54.5	56.9	100.0	100.0	97.0	100.0
Oxyfluorfen	93.7	95.0	85.5	66.9	96.0	91.4	93.3	80.0
Rimsulfuron	74.0	86.2	51.0	61.9	56.2	64.2	41.8	62.5
Sulfentrazone	90.8	90.2	89.5	70.0	29.2	50.0	57.9	50.0
Thiazopyr	99.3	98.9	92.2	75.0	100.0	100.0	100.0	97.5
Significance	*	***	***	**	**	***	***	***
LSD (≤ 0.05)	19.7	9.4	14.6	14.3	29.5	15.0	15.3	18.0

*, **, *** = Significance at P ≤ 0.05, ≤ 0.01, ≤ 0.001, respectively

There were no statistically significant differences among treatments in number of leaves, number of runners, or overall plant size (Table 4). However, there was a trend for more runners in the azafenidin, dimethenamid, fluamide, and hand weeded plots when compared to the weedy check plots or other herbicide-treated plots.

Table 4. Strawberry plant vigor evaluated 7/14/99 (plants established 5/13/99, treated with herbicides 5/15/99).

Treatment	# Leaves per plant	# Runners per plant	Plant Size (cm^2)
Azafenidin	7.95	1.85	498.5
Dimethenamid	7.05	1.85	517.6
Fluamide	7.45	1.85	613.6
Oxyfluorfen	6.75	1.30	483.1
Rimsulfuron	6.10	1.20	423.8
Sulfentrazone	7.05	1.55	534.8
Thiazopyr	6.70	1.00	464.4
Hand-weeded control	6.55	1.95	541.6
Weedy control	5.95	1.05	507.7
Significance (P ≤ 0.05)	ns	ns	ns

Most of the herbicide treatments did not cause significant phytotoxicity. The oxyfluorfen-treated plants exhibited many red spots on the first flush of leaves after treatment application and well into early June. By late June, however, plants treated with oxyfluorfen showed no signs of phytotoxicity. Azafenidin-treated plants had a few red spots on newly emerged leaves. Rimsulfuron-treated plants had some yellowish coloration in the newly emerged leaves and the plants remained a greenish-yellow color throughout the growing season.

2. Fall Timing Trial. This planting was also established on raised beds at NWREC on May 13, 1999 and will be used to evaluate herbicide treatments made in the fall to strawberries planted in May. Plots, four rows wide and 30 feet long,-were arranged in a completely randomized block design with four replications. To achieve weed control throughout the summer in this planting, napropamide, at a rate of 4 lb ai/A, was applied to all plots immediately after planting; one inch of irrigation followed the napropamide application. Herbicide treatments were made on September 29, 1999 and were followed by one inch of irrigation. As of early November, weed control was good and there were no signs of phytotoxicity in any of the plots. Weed control and strawberry plant vigor will be further evaluated in the winter and early spring.

Table 5. Treatments in Fall Timing Trial.

Treatment	Rate
	Lb/A
Azafenidin	0.3
Dimethenamid	1.25
Fluamide + Isoxaben	0.25 + 0.75
Fluamide + Sulfentrazone	0.25 + 0.125
Isoxaben	0.75
Sulfentrazone	0.167
Thiazopyr	0.5
Simazine + Napropamide	1 + 2
Hand-weeded control	—
Weedy control	—

Screening of low-rate preemergence herbicides in vegetable crops. Steven A. Fennimore, Milton J. Haar and Stefan J. Richard. (Department of Vegetable Crops and Weed Science, University of California-Davis, Salinas, CA 93905). All indications are that pesticide use cancellations, as the result of the Food Quality Protection Act, will have major impacts on weed management programs in vegetables. The objective of this study was to identify new potential herbicides for vegetable crops. Broccoli 'Marathon', carrot 'Neptune', cantaloupe 'Topnet', iceberg lettuce 'Pacific Pride', redleaf lettuce 'Redtide', onion 'Staccato', spinach 'Nordic', and processing tomato 'Halley 3155' were screened in the field for tolerance to low-rate herbicides at the University of California/USDA Vegetable Research Station, Salinas, California. Preemergence herbicides and rates tested in lb/A were: carfentrazone at 0.05, 0.1, 0.15 and 0.2, sulfentrazone at 0.15 and 0.25, SAN 582 at 0.94 and 1.2, halosulfuron at 0.032 and 0.047, rimsulfuron at 0.016 and 0.031, flumioxazin at 0.063, 0.125 and 0.25, isoxaben at 0.25 and 0.5, fluamide at 0.525, 0.6 and 0.675, and corn gluten meal at 435.6 and 871.2. The planting date was June 16, 1999, and spray date was June 17, 1999. Stand counts were taken at 45 days after treatment (DAT). Phytotoxicity assessments were taken 14 and 28 DAT, and crop biomasses (dry weight) were taken at 45 DAT. Mean separation was performed using Fisher's protected LSD (α=0.05).

Broccoli and carrot were not tolerant to any of the herbicides tested (Table 1). Herbicide treatments that were found acceptable by crop were: cantaloupe treated with halosulfuron at 0.032 and corn gluten meal at 435.6, iceberg lettuce treated with carfentrazone at 0.1 (Table 2), redleaf lettuce treated with carfentrazone at 0.05 and 0.1, onion treated with carfentrazone at 0.05 (Table 3), spinach treated with carfentrazone at 0.05, SAN 582 at 0.94, and tomato treated with carfentrazone at 0.15, SAN 582 at 0.94, halosulfuron at 0.032 and 0.047, and rimsulfuron at 0.016 and 0.031 (Table 4). All combinations not previously mentioned resulted in unacceptable crop injury.

Table 1. Stand count, crop phytotoxicity, and biomass for broccoli and carrot.

Herbicide	Rate	Broccoli				Carrot			
	lb/A	Stand m^{-1}	Phytotoxicity[a]		Biomass[b] $g\ m^{-1}$	Stand m^{-1}	Phytotoxicity[a]		Biomass[b] $g\ m^{-1}$
Carfentrazone	0.050	11.5	1.5	1.5	51.3	106.8	0.3	0	34.3
Carfentrazone	0.100	3.8	2.0	6.7	20.6	62.5	4.5	2.5	42.3
Carfentrazone	0.150	4.5	5.0	7.5	11.8	36.5	7.0	2.4	21.0
Carfentrazone	0.200	0	9.5	10.0	0	4.3	8.8	5.8	2.4
Sulfentrazone	0.150	15.0	0	4.5	92.8	88.3	4.3	4.1	62.4
Sulfentrazone	0.250	8.5	5.5	7.5	23.5	45.3	7.5	5.8	27.0
SAN 582	0.940	13.3	1.0	4.8	64.0	35.8	5.3	7.0	17.1
SAN 582	1.200	8.5	1.0	3.8	61.0	11.5	5.8	8.5	2.0
Halosulfuron	0.032	0	4.5	9.5	0	49.3	7.0	8.8	1.2
Halosulfuron	0.047	0	4.8	9.8	0	8.3	7.3	8.8	0.2
Rimsulfuron	0.016	0	4.5	9.8	0	61.5	6.8	6.5	11.5
Rimsulfuron	0.031	0	4.3	9.8	0	20.0	8.0	9.0	1.9
Flumioxazin	0.063	0	10.0	10.0	0	21.5	6.5	3.1	19.0
Flumioxazin	0.125	1.0	3.3	9.4	2.0	14.3	6.5	2.6	11.8
Flumioxazin	0.250	0	10.0	10.0	0	1.8	9.3	6.9	0.9
Isoxaben	0.250	0	10.0	10.0	0	48.5	2.0	1.9	36.8
Isoxaben	0.500	0	10.0	10.0	0	22.5	2.3	2.9	20.3
Fluamide	0.525	6.0	3.5	6.9	32.0	119.5	1.5	2.6	54.8
Fluamide	0.600	7.3	4.0	7.5	29.5	84.5	2.3	3.1	52.5
Fluamide	0.675	7.3	2.0	6.3	34.8	58.3	2.5	2.5	43.8
Corn gluten meal	435.600	11.3	0	0.5	39.3	66.3	0	0.5	17.3
Corn gluten meal	871.200	11.3	0	0.3	45.8	74.3	0	0	16.0
Hand weeded	--	15.5	0	0.8	143.3	108.5	0.3	0.3	80.3
Untreated	--	14.8	0	0.5	59.8	105.5	0	0	34.7
LSD		4.1	2.0	1.9	30.1	48.7	2.7	2.6	27.4
Days after treatment		45	14	28	45	45	14	28	45

[a]Crop phytotoxicity 0=no injury, 10=dead
[b]Crop biomass, dry weight

Table 2. Stand count, crop phytotoxicity, and biomass for cantaloupe and iceberg lettuce.

Herbicide	Rate	Cantaloupe				Iceberg lettuce			
	lb/A	Stand m^{-1}	Phytotoxicity[a]		Biomass[b] $g\ m^{-1}$	Stand m^{-1}	Phytotoxicity[a]		Biomass[b] $g\ m^{-1}$
Carfentrazone	0.050	4.5	0.8	2.8	4.3	3.0	0	0	23.8
Carfentrazone	0.100	3.5	1.8	5.1	7.3	8.0	2.3	1.0	58.0
Carfentrazone	0.150	4.3	2.5	6.0	8.0	9.8	3.8	3.0	28.2
Carfentrazone	0.200	3.3	2.3	5.9	3.1	9.3	4.8	2.5	42.3
Sulfentrazone	0.150	12.8	2.8	4.8	13.3	6.4	7.0	8.3	10.8
Sulfentrazone	0.250	6.0	4.5	7.3	2.2	0.3	9.5	10.0	0.1
SAN 582	0.940	3.8	6.4	4.6	1.9	0.8	9.5	9.5	1.3
SAN 582	1.200	2.3	6.3	6.3	2.0	0	8.8	10.0	0
Halosulfuron	0.032	13.8	0.3	1.3	24.3	0	8.0	9.5	0
Halosulfuron	0.047	4.8	3.0	5.8	10.3	0	8.5	9.8	0
Rimsulfuron	0.016	5.0	2.8	7.8	1.1	0	7.8	10.0	0
Rimsulfuron	0.031	3.8	4.5	9.3	0.3	0	8.0	10.0	0
Flumioxazin	0.063	0.3	8.0	10.0	0.1	0	10.0	10.0	0
Flumioxazin	0.125	0.3	8.9	8.5	0.5	0	10.0	10.0	0
Flumioxazin	0.250	0	9.8	10.0	0	0	10.0	10.0	0
Isoxaben	0.250	1.0	7.0	6.3	4.1	0.3	7.5	8.0	5.3
Isoxaben	0.500	0	10.0	10.0	0	2.3	8.5	9.3	0.3
Fluamide	0.525	7.8	2.5	4.8	10.8	3.8	8.6	8.0	7.0
Fluamide	0.600	6.5	3.9	4.0	11.8	0	9.3	10.0	0
Fluamide	0.675	6.3	1.3	5.0	11.3	0.3	9.1	9.8	2.3
Corn gluten meal	435.600	15.0	0	0.3	14.5	9.0	0	0.5	10.3
Corn gluten meal	871.200	3.3	2.5	0	4.1	6.3	0	0.8	4.3
Hand weeded	--	7.0	0	0.8	12.3	10.8	0	0	48.3
Untreated	--	7.3	0.3	0	6.7	11.8	0	0	24.3
LSD		7.2	3.8	3.9	11.8	5.3	2.5	2.4	22.0
Days after treatment		45	14	28	45	45	14	28	45

[a]Crop phytotoxicity 0=no injury, 10=dead
[b]Crop biomass, dry weight

Table 3. Stand count, crop phytotoxicity, and biomass for red leaf lettuce and onion.

Herbicide	Rate	Red leaf lettuce				Onion			
	lb/A	Stand m^{-1}	Phytotoxicity[a]		Biomass[b] $g\ m^{-1}$	Stand m^{-1}	Phytotoxicity[a]		Biomass[b] $g\ m^{-1}$
Carfentrazone	0.050	19.5	0	0	39.3	6.0	0.3	0	4.9
Carfentrazone	0.100	11.3	2.5	1.0	37.5	3.5	3.8	3.3	1.3
Carfentrazone	0.150	12.0	4.3	1.3	32.8	2.5	6.0	5.0	0.7
Carfentrazone	0.200	7.0	5.8	3.1	26.8	0.8	7.5	6.5	0.5
Sulfentrazone	0.150	7.8	7.0	8.3	4.3	4.5	7.5	5.0	0.4
Sulfentrazone	0.250	0.3	10.0	10.0	0	1.0	8.5	9.0	0
SAN 582	0.940	1.0	9.5	9.5	1.0	3.5	1.8	6.5	1.0
SAN 582	1.200	0	9.0	10.0	0	4.8	1.3	6.8	1.2
Halosulfuron	0.032	0	9.0	10.0	0	0	3.8	8.4	0
Halosulfuron	0.047	0	9.4	10.0	0	1.3	6.3	8.8	0
Rimsulfuron	0.016	0	8.5	10.0	0	0.5	4.0	6.5	0
Rimsulfuron	0.031	0	9.1	10.0	0	0	6.8	10.0	0
Flumioxazin	0.063	0	10.0	10.0	0	1.0	3.3	3.5	0.3
Flumioxazin	0.125	0	10.0	10.0	0	0.8	5.8	7.3	0.3
Flumioxazin	0.250	0	10.0	10.0	0	0.5	10.0	20.0	0
Isoxaben	0.250	0.8	7.5	7.8	5.5	2.5	2.0	4.5	0.9
Isoxaben	0.500	0	10.0	10.0	0	1.8	3.0	5.3	0.5
Fluamide	0.525	1.0	9.1	8.0	2.0	1.0	2.5	6.3	0.1
Fluamide	0.600	0.8	9.5	9.3	2.9	2.3	3.5	7.0	0.5
Fluamide	0.675	0.8	9.4	10.0	1.3	0.8	1.8	6.4	0.2
Corn gluten meal	435.600	13.3	0	0	28.8	1.8	0	0	0.2
Corn gluten meal	871.200	13.8	0	0.3	18.0	3.0	0	0	0.3
Hand weeded	--	12.3	0	0	58.8	3.8	0	0.3	1.8
Untreated	--	14.8	0	0	40.5	2.5	0	0	0.2
LSD		4.7	2.5	2.2	23.4	3.0	3.6	6.3	2.5
Days after treatment		45	14	28	45	45	14	28	45

[a]Crop phytotoxicity 0=no injury, 10=dead
[b]Crop biomass, dry weight

Table 4. Stand count, crop phytotoxicity, and biomass for spinach and processing tomato.

Herbicide	Rate lb/A	Spinach Stand m^-1	Spinach Phytotoxicity[a]		Spinach Biomass[b] g m^-1	Processing tomato Stand m^-1	Processing tomato Phytotoxicity[a]		Processing tomato Biomass[b] g m^-1
Carfentrazone	0.050	21.3	0.5	1.0	119.5	27.8	0	0.3	28.0
Carfentrazone	0.100	4.8	7.8	8.5	36.8	5.8	4.8	3.3	38.8
Carfentrazone	0.150	7.8	6.8	6.3	90.8	13.8	1.0	1.5	62.0
Carfentrazone	0.200	1.0	9.3	10.0	2.0	2.3	6.3	8.0	7.2
Sulfentrazone	0.150	1.8	9.1	9.8	2.5	21.0	3.3	0.8	71.0
Sulfentrazone	0.250	0	10.0	10.0	0	11.5	7.0	5.8	27.0
SAN 582	0.940	18.3	2.0	2.6	129.5	14.8	0.8	0.9	60.8
SAN 582	1.200	14.5	6.3	4.8	82.3	14.8	0.8	2.5	40.2
Halosulfuron	0.032	0	6.8	9.4	0	14.5	0.3	1.1	66.3
Halosulfuron	0.047	0	7.5	9.3	0	20.5	1.3	0.9	65.5
Rimsulfuron	0.016	14.5	6.8	9.0	0.8	18.5	0.5	0	107.5
Rimsulfuron	0.031	2.8	6.5	9.0	0.1	22.5	1.3	0	105.3
Flumioxazin	0.063	0.5	10.0	10.0	0.3	0	10.0	10.0	0
Flumioxazin	0.125	0	10.0	10.0	0	0	10.0	10.0	0
Flumioxazin	0.250	0	10.0	10.0	0	0	10.0	10.0	0
Isoxaben	0.250	0	7.5	10.0	0	1.0	5.0	6.3	7.3
Isoxaben	0.500	0	10.0	10.0	0	0	10.0	10.0	0
Fluamide	0.525	14.8	2.8	3.5	125.8	4.5	5.5	6.8	7.0
Fluamide	0.600	18.8	2.0	4.0	173.8	3.0	4.3	7.3	14.9
Fluamide	0.675	18.5	2.6	3.0	162.8	4.0	5.3	7.0	5.6
Corn gluten meal	435.600	12.5	0	1.1	60.8	12.3	0.3	0	8.8
Corn gluten meal	871.200	11.0	0	1.1	42.8	12.8	2.0	0.5	8.8
Hand weeded	--	17.8	0	0.5	146.0	17.0	0.5	0	69.8
Untreated	--	16.8	0	0.3	67.3	13.3	0	0.3	25.0
LSD		7.8	2.7	1.8	51.0	8.8	2.9	2.8	25.5
Days after treatment		45	14	28	45	45	14	28	45

[a]Crop phytotoxicity 0=no injury, 10=dead
[b]Crop biomass, dry weight

Screening of low rate postemergence herbicides in vegetable crops. Steven A. Fennimore, Milton J. Haar and Stefan J. Richard. (Department of Vegetable Crops, University of California-Davis, Salinas, CA 93905). All indications are that pesticide use cancellations, as the result of the Food Quality Protection Act, will have major impacts on weed management programs in vegetables. The objective of this study was to identify new potential herbicides for vegetable crops. Broccoli 'Marathon', carrot 'Neptune', cantaloupe 'Topnet', iceberg lettuce 'Pacific Pride', redleaf lettuce 'Redtide', onion 'Staccato', spinach 'Nordic', and processing tomato 'Halley 3155' were screened in the field for tolerance to low-rate herbicides at the University of California/USDA Vegetable Research Station, Salinas, California. Postemergence herbicides and rates tested in lb/A were: carfentrazone at 0.01 and 0.03, cloransulam at 0.008 and 0.016, halosulfuron at 0.032 and 0.047, imazamox at 0.032 and 0.4, imazethpyr at 0.094, rimsulfuron at 0.031, SAN 582 at 1.5, sulfentrazone at 0.15 and 0.25, and triflusulfuron at 0.016 and 0.031. The planting date was May 26, 1999, and the spray date was June 18, 1999. At the time of application the crop growth stages, in numbers of true leaves, were as follows: broccoli; 2, carrot; 1 to 2, iceberg and redleaf lettuce; 3 to 4, onion; 1 to 3, spinach; 2 to 4, and tomato, 2. Stand counts were taken 35 days after treatment (DAT), phytotoxicity assessments were taken at 7, 14 and 28 DAT, and crop biomasses (dry weight) were taken at 35 DAT. Mean separation was performed using Fisher's protected LSD (α=0.05).

Broccoli, carrot and onion were not tolerant to any of the herbicides tested (Tables 1 and 3). Crop/herbicide combinations with acceptable tolerance were: cantaloupe treated with halosulfuron at 0.047 (Table 2), both iceberg lettuce and red leaf lettuce treated with imazamox at 0.032 and 0.04 and imazethapyr at 0.094 (Tables 2&3), spinach treated with cloransulam at 0.008 and 0.016, and SAN 582 at 1.5, and processing tomato treated with halosulfuron at 0.032 and rimsulfuron at 0.031 lb/A (Table 4). All combinations not previously mentioned resulted in unacceptable crop injury.

Table 1. Stand count, crop phytotoxicity, and biomass for broccoli and carrot.

Herbicide	Rate	Broccoli					Carrot				
	lb/A	Stand	Phytotoxicity [a]			Biomass [b]	Stand	Phytotoxicity [a]			Biomass [b]
		m^{-1}				$g\ m^{-1}$	m^{-1}				$g\ m^{-1}$
Carfentrazone	0.010	0.3	9.1	9.7	3.3	0.5	41.5	9.1	6.7	3.3	16.7
Carfentrazone	0.030	0	10.0	10.0	5.0	0	21.5	9.6	9.0	5.0	6.7
Sulfentrazone	0.150	13.8	7.0	6.7	0.7	75.5	87.8	7.3	4.0	0.7	47.3
Sulfentrazone	0.250	16.0	7.3	6.3	2.3	134.5	69.3	7.3	4.5	2.3	55.5
Cloransulam	0.008	1.0	7.5	9.7	1.5	0	73.5	3.9	4.3	1.5	14.3
Cloransulam	0.016	0.8	7.0	9.4	2.5	0.3	67.3	4.3	4.5	2.5	24.5
SAN 582	1.500	14.0	1.3	1.3	3.1	107.3	73.5	0.5	0.7	3.1	22.3
Imazamox	0.032	0.3	7.3	9.7	6.3	0	22.5	5.7	8.9	6.3	3.7
Imazamox	0.040	0	8.0	9.7	4.0	0	38.5	4.6	8.1	4.0	11.3
Halosulfuron	0.032	0	6.5	9.7	10.0	0	4.8	6.3	9.3	10.0	3.3
Halosulfuron	0.047	0	7.0	9.7	8.0	0	14.5	6.7	7.6	8.0	0.9
Rimsulfuron	0.031	0	7.9	10.0	10.0	0	2.0	7.7	10.0	10.0	3.3
Triflusulfuron	0.016	12.0	5.7	7.0	6.0	54.3	27.3	4.0	4.7	6.0	5.3
Triflusulfuron	0.031	11.5	6.5	7.3	5.0	38.3	56.3	4.7	5.5	5.0	9.6
Imazethpyr	0.094	0	7.3	9.9	9.5	0	8.8	5.3	9.1	9.5	0.5
Hand weeded	–	15.8	0.3	0.7	0	190.7	101.5	0	0.0	0	183.0
Untreated	–	14.3	0	0.0	0	88.7	101.5	0	0.0	0	29.0
LSD		1.9	1.1	0.9	2.8	33.7	29.0	1.2	1.7	2.7	21.2
Days after treatment		35	7	14	28	35	35	7	14	28	35

[a] Crop phytotoxicity 0=no injury, 10=dead

[b] Crop biomass, dry weight

Table 2. Stand count, crop phytotoxicity, and biomass for cantaloupe and iceberg lettuce.

Herbicide	Rate	Cantaloupe					Iceberg lettuce				
	lb/A	Stand	Phytotoxicity[a]			Biomass[b]	Stand	Phytotoxicity[a]			Biomass[b]
		m^{-1}				$g\ m^{-1}$	m^{-1}				$g\ m^{-1}$
Carfentrazone	0.010	1.5	9.8	9.9	6.3	0.9	2.0	9.7	9.5	5.7	4.3
Carfentrazone	0.030	1.0	10.0	10.0	8.3	0.7	0.5	10.0	9.7	8.0	3.7
Sulfentrazone	0.150	1.3	9.9	10.0	7.7	0.5	9.8	8.1	7.3	1.3	28.3
Sulfentrazone	0.250	1.0	10.0	10.0	10.0	0.3	5.3	8.9	9.1	7.5	6.0
Cloransulam	0.008	6.0	6.5	6.5	2.5	18.5	9.8	3.7	1.7	0.5	50.7
Cloransulam	0.016	2.3	8.7	9.0	8.1	1.4	11.5	6.5	3.7	1.7	45.0
SAN 582	1.500	5.3	2.0	7.0	7.7	1.9	14.8	0	0	1.3	39.7
Imazamox	0.032	2.3	8.6	8.9	9.5	0.4	13.8	2.3	1.4	0.3	100.0
Imazamox	0.040	0.5	7.9	8.9	7.5	0	15.3	1.8	1.0	0	81.0
Halosulfuron	0.032	15.3	0.7	0.4	0.5	40.3	5.5	7.4	9.1	7.0	9.8
Halosulfuron	0.047	23.5	1.3	0	0	84.0	5.5	7.5	8.5	4.3	3.2
Rimsulfuron	0.031	22.5	3.6	0.7	0	82.7	0.3	8.9	9.9	10.0	0.1
Triflusulfuron	0.016	18.5	4.0	1.0	0	36.0	14.0	5.3	4.5	1.3	31.0
Triflusulfuron	0.031	19.5	5.0	2.4	0.5	39.0	13.5	6.0	6.7	0.6	20.5
Imazethpyr	0.094	4.0	8.9	9.5	9.7	2.1	14.0	2.0	1.1	0.1	83.0
Hand weeded	—	24.0	0	0	0	71.0	11.0	0	0	0	79.7
Untreated	—	7.3	0	0	0	4.9	9.5	0	0	0	10.2
LSD		9.2	1.8	1.1	3.7	30.3	5.1	1.7	1.8	3.0	27.2
Days after treatment		35	7	14	28	35	35	7	14	28	35

[a] Crop phytotoxicity 0=no injury, 10=dead
[b] Crop biomass, dry weight

Table 3. Stand count, crop phytotoxicity, and biomass for redleaf lettuce and onion.

Herbicide	Rate	Red lettuce					Onion				
	lb/A	Stand	Phytotoxicity[a]			Biomass[b]	Stand	Phytotoxicity[a]			Biomass[b]
		m^{-1}				$g\ m^{-1}$	m^{-1}				$g\ m^{-1}$
Carfentrazone	0.010	1.8	9.5	9.0	6.5	6.0	4.8	2.7	2.0	0.9	2.1
Carfentrazone	0.030	2.3	9.9	9.4	6.7	6.0	2.0	8.7	5.3	4.7	0.1
Sulfentrazone	0.150	12.8	8.5	7.3	1.7	23.5	3.5	6.5	4.5	3.3	0.4
Sulfentrazone	0.250	20.3	8.5	8.5	6.3	23.0	3.3	5.7	6.0	8.0	1.0
Cloransulam	0.008	23.8	5.0	2.0	1.0	77.8	2.0	1.3	5.7	7.5	0.3
Cloransulam	0.016	20.3	7.3	3.7	2.5	58.0	0.3	0.3	7.5	10.0	0
SAN 582	1.500	18.8	0	0	1.3	87.5	6.8	0	0.4	4.7	1.2
Imazamox	0.032	21.0	2.5	1.7	0.6	113.5	4.3	0.5	5.5	7.3	0.4
Imazamox	0.040	28.5	1.7	1.5	0.3	114.0	5.3	0.3	5.0	5.7	0.5
Halosulfuron	0.032	17.3	7.3	8.5	3.0	21.3	0	1.5	8.7	10.0	0
Halosulfuron	0.047	12.8	7.5	8.5	4.5	9.0	0	2.3	8.0	10.0	0
Rimsulfuron	0.031	4.8	8.1	9.3	9.7	1.5	0	1.1	9.0	10.0	0
Triflusulfuron	0.016	23.0	5.5	3.4	0.5	51.0	4.3	0.3	3.7	0	0.9
Triflusulfuron	0.031	20.0	6.5	6.5	0.9	44.5	4.0	1.4	4.0	2.3	0.4
Imazethpyr	0.094	20.0	2.0	0.7	0.3	114.0	0	1.0	8.0	10.0	0
Hand weeded	—	27.0	0	0	0	166.0	8.0	0	0.3	0	12.5
Untreated	—	22.0	0	0	0	60.3	6.3	0	0	0	0.5
LSD		11.6	1.5	2.0	2.8	32.1	4.0	2.1	2.7	3.7	2.5
Days after treatment		35	7	14	28	35	35	7	14	28	35

[a] Crop phytotoxicity 0=no injury, 10=dead
[b] Crop biomass, dry weight

Table 4. Stand counts, crop phytotoxicity, and biomass for spinach, and processing tomato.

Herbicide	Rate lb/A	Spinach Stand m[-1]	Spinach Phytotoxicity[a]			Spinach Biomass[b] g m[-1]	Processing tomato Stand m[-1]	Processing tomato Phytotoxicity[a]			Processing tomato Biomass[b] g m[-1]
Carfentrazone	0.010	6.3	9.5	9.5	5.0	34.8	0	10.0	10.0	10.0	0
Carfentrazone	0.030	0.8	10.0	9.9	8.8	13.3	0	10.0	10.0	10.0	0
Sulfentrazone	0.150	1.3	9.6	9.6	8.0	11.5	0	10.0	10.0	10.0	0
Sulfentrazone	0.250	0.5	9.9	10.0	9.3	2.8	1.0	10.0	10.0	9.3	0.5
Cloransulam	0.008	54.5	2.5	2.7	0.3	222.3	1.8	7.5	8.9	8.3	2.3
Cloransulam	0.016	49.0	1.9	3.5	0.3	251.8	1.3	6.6	9.5	9.8	0.8
SAN 582	1.500	52.5	2.3	0	3.5	194.3	11.3	2.5	0.3	1.3	15.3
Imazamox	0.032	10.0	4.5	8.3	8.0	23.5	0	8.5	10.0	10.0	0
Imazamox	0.040	7.8	4.7	8.3	6.8	13.0	0	9.3	10.0	7.5	0
Halosulfuron	0.032	2.3	4.5	9.0	9.8	1.0	17.5	1.3	0.6	0.3	131.8
Halosulfuron	0.047	0	5.5	9.0	10.0	0	17.5	0.7	1.0	0.3	79.8
Rimsulfuron	0.031	5.3	6.5	8.7	9.5	6.0	20.3	0.5	0	0	165.5
Triflusulfuron	0.016	14.5	3.3	6.5	4.5	36.3	12.0	3.8	5.0	2.8	41.3
Triflusulfuron	0.031	8.5	5.3	7.5	7.8	8.0	14.5	4.5	6.0	3.3	28.3
Imazethpyr	0.094	5.3	4.7	8.3	10.0	1.8	0	8.9	10.0	10.0	0
Hand weeded	--	50.3	0	0	0	228.8	17.8	0.3	0	0	111.7
Untreated	--	47.0	0	0	0	140.8	11.3	0.3	0	0	12.3
LSD		9.8	1.4	1.0	3.0	65.6	6.3	1.5	1.7	3.3	31.9
Days after treatment		35	7	14	28	35	35	7	14	28	35

[a] Crop phytotoxicity 0=no injury, 10=dead
[b] Crop biomass, dry weight

Pendimethalin and bensulide for onion weed control. K. Umeda, D. MacNeil, N. Lund, and D. Roberts. (University of Arizona Cooperative Extension Maricopa County, 4341 E. Broadway, Phoenix, AZ 85040) Three small plot field tests were conducted in Central Arizona: 1) University of Arizona Maricopa Agricultural Center (MAC), Maricopa, AZ, under furrow irrigation, 2) Tolleson, AZ, under sprinkler irrigation, and 3) Waddell, AZ, under furrow irrigation. Each of the experiments was set up as randomized complete block design with three or four replicates. Onions were planted on conventional 40-inch beds with 2 seedlines of cv. Desex per bed at MAC, nine seedlines of cv. Granex 33 at Tolleson, and eight seedlines of cv. Rafiki at Waddell. All treatment plots consisted of two beds and measured 25 or 40 ft in length. Herbicide treatments were applied using a hand-held boom with four flat fan 8002 nozzle tips spaced 20 in apart. The sprays were applied in 20 or 25 gpa water pressurized with a CO_2 backpack sprayer at 35 psi. At MAC, the preplant incorporated (PPI) herbicide treatments were applied on 29 October 1998 and mechanically incorporated with a "sidewinder" power mulcher-bed shaper immediately after applications. The sky was clear and air temperature at 60°F during applications. Onions were planted on 30 Oct and preemergence (PREE) applications were made immediately after and then furrow irrigated within 24 hr. The air temperature was 80°F with few scattered clouds and the soil temperature was 72°F. At Tolleson, PPI treatments were applied on 02 Nov when it was clear and 66°F with soil temperature at 62°F and then treatments were immediately mechanically incorporated with a power mulcher for the first time. Subsequently, three more passes with the power mulcher were made to loosen and dry the soil after prior rains. Onions were planted on 06 Nov and PREE treatments were applied after planting when it was clear and 80°F. Solid set sprinklers were use to germinate and establish the crop stand followed by furrow irrigation for the remainder of the growing season. At Waddell, onions were planted on 28 Oct and PREE herbicide treatments were applied immediately after planting and then furrow irrigated within 48 hr. The weather was clear and 78°F with the soil slightly moist at 76°F. Onion injury was visually estimated and crop stand establishment and height were measured at intervals during the growing season. Visual weed control evaluations were also made at Waddell. Onions were harvested at Tolleson and MAC to determine effect of herbicide treatments on onion yield.

Pendimethalin applied PPI at rates ranging from 0.25 to 0.75 lb AI/A did not significantly injure onions or cause a significant yield reduction (Tables 1 and 2). Pendimethalin PREE at 0.25 to 0.50 lb AI/A caused no observable injury and did not affect yields of onions that were furrow irrigated (Table 1 and 3). Pendimethalin applied PREE at 0.50 lb AI/A caused significant crop stand and yield reduction compared to lower rates or the untreated check under sprinkler irrigation (Table 2). Combination treatments of pendimethalin plus bensulide applied PREE did not cause any measurable crop height or stand reduction compared to the standard treatment or untreated check (Table 3). Pendimethalin at 0.25 lb AI/A plus bensulide at 4.0 lb AI/A adequately controlled cheeseweed, yellow sweetclover, sowthistle, and London rocket (Table 4).

Table 1. Pendimethalin herbicide injury on onions, MAC.

Treatment	Rate (lb AI/A)	Timing	Onion Injury Height (in.) 19 Jan	15 Mar	Yield lb/plot
Untreated check			2.8	12.7	18.9
Pendimethalin	0.25	PPI	2.8	13.1	25.5
Pendimethalin	0.38	PPI	2.7	12.6	25.3
Pendimethalin	0.50	PPI	2.7	11.7	25.2
Pendimethalin	0.75	PPI	2.6	11.8	27.3
Pendimethalin	0.25	PREE	2.8	12.4	21.7
Pendimethalin	0.38	PREE	2.8	13.9	28.6
Pendimethalin	0.50	PREE	2.7	12.3	31.7
LSD (p=0.05)			0.5	1.8	5.3

Onions planted 29 October 1998, harvested 20 May 1999.
PPI applied on 29 Oct, PREE applied on 30 Oct.
Height = average of 10 or 20 plants/plot, yields = harvested 5 ft row of 2 rows/plot

Table 2. Pendimethalin herbicide injury on onions under sprinkler irrigation, Tolleson.

Treatment	Rate (lb AI/A)	Timing	Onion Injury 28 Jan CSI (%)	Ht. (in.)	CSR (%)	No./ft	25 Mar Ht. (in.)	Yield 10 May lb/plot
Untreated check			0	6.4	0	46.3	25.3	103
Pendimethalin	0.25	PPI	0	6.6	0	41.0	25.3	106
Pendimethalin	0.50	PPI	5	6.3	0	46.3	25.4	107
Pendimethalin	0.75	PPI	7	6.2	0	36.3	25.2	98
Pendimethalin	0.25	PREE	13	6.4	0	39.0	26.1	102
Pendimethalin	0.50	PREE	47	5.3	38	25.3	24.2	83
LSD (p=0.05)			16.7	0.9	23.6	13.3	1.6	13.5

PPI applied on 02 Nov 1998, PREE applied on 06 Nov.
CSI = crop stand injury, CSR = crop stand reduction
Ht.= average of 10 or 20 plants/plot; No. = plants per seedline; Harvested 5 ft row of 2 rows/plot for yield.

Table 3. Pendimethalin and bensulide herbicide injury on onions, Waddell.

Treatment	Rate (lb AI/A)	Onion Injury 20 Nov	06 Jan	28 Jan No./ft	28 Jan Ht.(in.)	10 Apr Ht (in.)
		%	%			
Untreated check		0	0	35.0	9.2	22.5
DCPA	9.0	0	0	37.0	10.2	21.6
Bensulide	4.0	0	0	37.0	9.4	21.8
Bensulide	6.0	0	0	36.0	10.0	22.6
Pendimethalin	0.25	0	0	35.8	10.6	21.4
Pendimethalin	0.50	0	0	36.8	9.8	22.6
Pendimethalin	0.75	0	2	35.5	10.7	22.0
Pendimethalin + bensulide	0.25 + 4.0	0	2	37.0	9.9	22.2
Pendimethalin + bensulide	0.25 + 6.0	0	9	35.3	10.5	22.8
Pendimethalin + bensulide	0.50 + 6.0	0	9	39.0	10.7	23.4
LSD (p=0.05)		0	2.4	7.7	2.2	2.3

Herbicides applied PREE on 28 October 1998.
Onions furrow irrigated all season.
No./ft = number of plants/1 ft of row on 8 lines per bed
Ht. = onion plant height, average of 5 plants/plot

Table 4. Pendimethalin and bensulide herbicide weed control in onions, Waddell.

Treatment	Rate (lb AI/A)	Weed Control (%) MALPA 20 Nov	MALPA 06 Jan	MEUOF 20 Nov	MEUOF 06 Jan	SONOL 20 Nov	SONOL 06 Jan	SSYIR 20 Nov	SSYIR 06 Jan
Untreated check		0	0	0	0	0	0	0	0
DCPA	9.0	91	13	55	13	99	85	99	85
Bensulide	4.0	94	0	55	0	94	79	97	73
Bensulide	6.0	89	0	63	0	95	78	99	75
Pendimethalin	0.25	96	84	74	83	96	86	98	89
Pendimethalin	0.50	94	90	78	88	98	95	99	94
Pendimethalin	0.75	95	96	84	93	99	97	99	98
Pendimethalin + bensulide	0.25 + 4.0	95	90	84	88	99	96	98	94
Pendimethalin + bensulide	0.25 + 6.0	96	95	90	94	97	97	99	97
Pendimethalin + bensulide	0.50 + 6.0	98	96	90	93	99	97	99	98
LSD (p=0.05)		7.2	13.5	10.8	13.3	3.4	9.4	1.6	10.3

Onions planted and treated PREE on 28 October 1998.
Onions furrow irrigated all season.

Garbanzo bean herbicide weed control study. K. Umeda and D. MacNeil. (University of Arizona Cooperative Extension Maricopa County, 4341 E. Broadway, Phoenix, AZ 85040.) A small plot field test was conducted at the University of Arizona Maricopa Agricultural Center, Maricopa, AZ. Garbanzo beans cv. UC-27 were planted on 40-inch beds on 09 December 1998. Herbicide treatment plots were arranged in a randomized complete block design with three replicates. Each plot consisted of two beds and measured 13 ft in length. Herbicide treatments were applied using a hand-held boom equipped with four flat fan 8002 nozzle tips and spaced 20-inches apart. The sprays were applied with a backpack CO_2 sprayer pressurized to 35 psi and delivering 17 gpa water for the PREE treatments and 18 gpa water for the POST treatments. All POST treatments included 0.25% v/v non-ionic surfactant, Latron CS-7. PREE herbicide treatments were applied on 15 December when the air temperature was 72°F, nearly clear with few scattered cloud, a slight wind at 5 mph, and the soil was slightly moist from a trace rainfall prior to the applications. The beans were furrow irrigated after applications to germinate and establish the crop. POST herbicide treatments were applied on 03 February 1999 when the air temperature was 54°F, clear, and no winds. The beans had three runners with the first runner stem measuring 2-3 inches in length. Weeds present were narrowleaf lambsquarters at 1-inch height, knotweed at 1-2 inch height, yellow sweetclover at 2 trifoliolate leaf stage, sowthistle at 2-3 leaf stage, and London rocket at 10-12 leaf stage or 1-inch diameter. Weed control and crop injury were visually rated after herbicide applications.

Pendimethalin and oxyfluorfen applied PREE caused minimal injury and gave very good weed control of better than 90% (Table 1). Oxyfluorfen and sulfentrazone alone applied POST gave very good weed control at 6 WAT (Table 2). The combination of pendimethalin followed by oxyfluorfen or sulfentrazone gave complete control of all weeds. Oxyfluorfen and sulfentrazone applied POST following PREE treatments gave nearly complete weed control with good crop safety. Clomazone caused significant crop injury and stand reduction when applied PREE. Metribuzin applied POST completely reduced the crop stand and gave complete control of all weeds. Metolachlor, dimethenamid, metribuzin, flumetsulam, and imazamox generally did not provide acceptable control of narrowleaf lambsquarters and sowthistle. Bentazon, acifluorfen, and fomesafen were not effective against narrlowleaf lambsquarters but gave adequate control of the other weeds. Combinations of PREE applied herbicides followed by POST herbicides demonstrated more effective weed control than when herbicides were applied alone.

Table 1. Garbanzo bean preemergence herbicide weed control.

Treatment	Rate (lb AI/A)	Timing	Crop Injury	Weed Control CHEAL	SONOL	MEUOF
			%	%		
Untreated check			0	0	0	0
Pendimethalin	1.0	PREE	3	97	97	98
Metolachlor	1.0	PREE	10	40	67	90
Dimethenamid	0.75	PREE	13	48	70	90
Metribuzin	1.0	PREE	12	48	80	86
Oxyfluorfen	0.25	PREE	3	93	95	99
Clomazone '	1.0	PREE	95	99	99	99
Sulfentrazone	0.375	PREE	15	83	85	83
Flumetsulam	0.05	PREE	3	63	63	85
Imazamox	0.05	PREE	5	53	74	78
LSD (p=0.05)			6.8	35.2	13.5	13.6

PREE herbicides applied 15 December 1998, early rating on 03 February 1999.

Table 2. Garbanzo bean preemergence and postemergence herbicide weed control.

Treatment	Rate (lb AI/A)	Timing	Crop Injury	Weed Control CHEAL	SSYIR	POLAV	MEOUF
			%	---- % ----			
Untreated check			0	0	0	0	0
Pendimethalin	1.0	PREE	0	92	99	99	99
Metolachlor	1.0	PREE	0	0	93	96	77
Dimethenamid	0.75	PREE	0	17	96	93	90
Metribuzin	1.0	PREE	0	57	99	96	87
Oxyfluorfen	0.25	PREE	2	77	99	99	96
Clomazone	1.0	PREE	96	98	99	99	99
Sulfentrazone	0.375	PREE	3	73	99	83	72
Flumetsulam	0.05	PREE	0	17	99	80	47
Imazamox	0.05	PREE	2	23	99	93	73
Bentazon	1.0	POST	8	57	94	76	83
Acifluorfen	0.375	POST	5	63	99	90	99
Fomesafen	0.375	POST	5	23	99	94	99
Lactofen	0.2	POST	10	88	99	88	98
Oxyfluorfen	0.25	POST	10	95	98	95	93
Metribuzin	1.0	POST	99	99	99	99	99
Sulfentrazone	0.375	POST	7	99	99	99	98
Oxyfluorfen + Bentazon	0.25 + 1.0	PREE + POST	7	88	99	93	99
Oxyfluorfen + Acifluorfen	0.25 + 0.375	PREE + POST	8	93	99	99	99
Oxyfluorfen + Fomesafen	0.25 + 0.375	PREE + POST	7	92	99	96	99
Oxyfluorfen + Lactofen	0.25 + 0.2	PREE + POST	12	98	99	96	99
Oxyfluorfen + Oxyfluorfen	0.25 + 0.25	PREE + POST	10	99	99	99	99
Oxyfluorfen + Metribuzin	0.25 + 1.0	PREE + POST	99	99	99	95	93
Oxyfluorfen + Sulfentrazone	0.25 + 0.375	PREE + POST	7	99	99	90	92
Metribuzin + Bentazon	1.0 + 1.0	PREE + POST	8	75	99	73	88
Metribuzin + Acifluorfen	1.0 + 0.375	PREE + POST	8	63	99	75	98
Metribuzin + Fomesafen	1.0 + 0.375	PREE + POST	5	78	99	86	98
Metribuzin + Lactofen	1.0 + 0.2	PREE + POST	10	88	99	85	96
Metribuzin + Oxyfluorfen	1.0 + 0.2	PREE + POST	10	92	99	95	93
Metribuzin + Metribuzin	1.0 + 1.0	PREE + POST	99	99	99	99	99
Metribuzin + Sulfentrazone	1.0 + 0.375	PREE + POST	7	99	99	99	99
Sulfentrazone + Bentazon	0.375 + 1.0	PREE + POST	10	77	99	81	87
Sulfentrazone + Acifluorfen	0.375 + 0.375	PREE + POST	10	78	99	88	99
Sulfentrazone + Fomesafen	0.375 + 0.375	PREE + POST	8	93	99	93	99
Sulfentrazone + Lactofen	0.375 + 0.2	PREE + POST	13	95	99	85	96
Sulfentrazone + Oxyfluorfen	0.375 + 0.25	PREE + POST	10	98	98	90	92
Sulfentrazone + Metribuzin	0.375 + 1.0	PREE + POST	99	99	99	99	99
Sulfentrazone + Sulfentrazone	0.375 + 0.375	PREE + POST	7	99	99	98	96
LSD (p=0.05)			3.8	22.9	3.3	14.7	13.9

PREE herbicides applied 15 December 1998, POST herbicides applied 03 February 1999. Rated on 15 March 1999.

Table 2. Garbanzo bean preemergence and postemergence herbicide weed control, cont'd.

Treatment	Rate (lb AI/A)	Timing	Crop Injury	Weed Control CHEAL	SSYIR	POLAV	MEUOF
			%	%			
Pendimethalin + Bentazon	1.0 + 1.0	PREE + POST	7	95	99	99	98
Pendimethalin + Acifluorfen	1.0 + 0.375	PREE + POST	8	93	99	99	99
Pendimethalin + Fomesafen	1.0 + 0.375	PREE + POST	5	95	99	99	99
Pendimethalin + Lactofen	1.0 + 0.2	PREE + POST	10	96	99	99	99
Pendimethalin + Oxyfluorfen	1.0 + 0.2	PREE + POST	12	99	99	99	99
Pendimethalin + Metribuzin	1.0 + 1.0	PREE + POST	99	99	99	99	99
Pendimethalin + Sulfentrazone	1.0 + 0.375	PREE + POST	7	99	99	99	99
Metolachlor + Bentazon	1.0 + 1.0	PREE + POST	10	42	98	80	75
Metolachlor + Acifluorfen	1.0 + 0.375	PREE + POST	8	47	99	85	99
Metolachlor + Fomesafen	1.0 + 0.375	PREE + POST	7	40	99	91	99
Metolachlor + Lactofen	1.0 + 0.2	PREE + POST	12	82	99	90	99
Metolachlor + Oxyfluorfen	1.0 + 0.2	PREE + POST	10	92	99	92	93
Metolachlor + Metribuzin	1.0 + 1.0	PREE + POST	99	99	99	99	99
Metolachlor + Sulfentrazone	1.0 + 0.375	PREE + POST	8	99	94	99	93
Dimethenamid + Bentazon	0.75 + 1.0	PREE + POST	3	57	99	75	78
Dimethenamid + Acifluorfen	0.75+ 0.375	PREE + POST	8	47	99	83	96
Dimethenamid + Fomesafen	0.75 + 0.375	PREE + POST	5	48	99	80	99
Dimethenamid + Lactofen	0.75 + 0.2	PREE + POST	10	87	99	88	93
Dimethenamid + Oxyfluorfen	0.75 + 0.25	PREE + POST	12	92	99	92	93
Dimethenamid + Metribuzin	0.75 + 1.0	PREE + POST	99	99	99	99	99
Dimethenamid + Sulfentrazone	0.75 + 0.375	PREE + POST	8	99	99	99	96
Clomazone + Bentazon	1.0 + 1.0	PREE + POST	98	94	99	96	93
Clomazone + Acifluorfen	1.0 + 0.375	PREE + POST	96	98	99	98	99
Clomazone + Fomesafen	1.0 + 0.375	PREE + POST	98	99	99	99	99
Clomazone + Lactofen	1.0 + 0.2	PREE + POST	98	99	99	98	99
Clomazone + Oxyfluorfen	1.0 + 0.2	PREE + POST	96	99	99	99	99
Clomazone + Metribuzin	1.0 + 1.0	PREE + POST	99	99	99	99	99
Clomazone + Sulfentrazone	1.0 + 0.375	PREE + POST	96	99	99	99	99
Flumetsulam + Bentazon	0.05 + 1.0	PREE + POST	5	40	99	75	70
Flumetsulam + Acifluorfen	0.05 + 0.375	PREE + POST	7	40	99	86	93
Flumetsulam + Fomesafen	0.05 + 0.375	PREE + POST	5	65	99	91	99
Flumetsulam + Lactofen	0.05 + 0.2	PREE + POST	10	78	99	90	99
Flumetsulam + Oxyfluorfen	0.05 + 0.25	PREE + POST	8	95	96	95	92
Flumetsulam + Metribuzin	0.05 + 1.0	PREE + POST	99	99	99	99	99
Flumetsulam + Sulfentrazone	0.05 + 0.375	PREE + POST	7	99	99	99	88
Imazamox + Bentazon	0.05 + 1.0	PREE + POST	8	77	99	80	83
Imazamox + Acifluorfen	0.05 + 0.375	PREE + POST	5	63	99	83	98
Imazamox + Fomesafen	0.05 + 0.375	PREE + POST	7	80	99	89	99
Imazamox + Lactofen	0.05 + 0.2	PREE + POST	10	77	99	83	96
Imazamox + Oxyfluorfen	0.05 + 0.25	PREE + POST	8	95	99	92	93
Imazamox + Metribuzin	0.05 + 1.0	PREE + POST	99	99	99	99	99
Imazamox + Sulfentrazone	0.05 + 0.375	PREE + POST	7	99	99	99	91
LSD (p=0.05)			3.8	22.9	3.3	14.7	13.9

PREE herbicides applied 15 December 1998, POST herbicides applied 03 February 1999. Rated on 15 March 1999.

Screening new herbicides for cantaloupe and watermelon. K. Umeda, D. MacNeil, N. Lund, and D. Roberts. (University of Arizona Cooperative Extension Maricopa County, 4341 E. Broadway, Phoenix, AZ 85040) Two small plot field tests were conducted at the University of Arizona, Maricopa Agricultural Center, Maricopa, AZ. Cantaloupe cv. Cruiser and watermelon cv. Calsweet were each planted in single rows on raised 40-inch beds that were furrow irrigated. Herbicide treatments were applied as a single replicate on two beds measuring 180 ft in length. Immediately after planting on 06 July 1999, PREE herbicide treatments were applied on the soil surface of two adjacent beds (1 cantaloupe and 1 watermelon). Herbicides were applied using a hand-held boom equipped with four flat fan 8002 nozzle tips spaced 20 inches apart. The treatments were sprayed using a CO_2 backpack sprayer set up to deliver a constant dilution of the spray solution from a 0.5 L plastic bottle supplied with 2L of water from a separate tank. The sprays were applied in 24 gpa water pressurized to 30 psi. At the time of PREE applications, the weather was partly cloudy with air temperature at 110°F and a very slight breeze. The soil was dry and 104°F. The field was irrigated soon after herbicide applications on the same day. POST herbicide applications were made cn 19 July with the same equipment and delivery system and an adjuvant, Latron CS-7 at 0.25% v/v was added to all treatments. The cantaloupe and watermelon were at the 2-leaf stage of growth, Palmer amaranth was the predominant weed at the 3-4 leaf stage and few purple nutsedge were present. The air temperature was 88°F, clear, and there was no wind during applications. Crop safety and weed control were evaluated visually at 4 weeks after treatment (WAT) for the PREE treatments and at 2 WAT for the POST treatments. Acceptable weed control was observed and measured as better than 80% control and acceptable crop safety was observed and measured as less than 30% injury.

Seventeen herbicides that recently gained registrations in corn, soybeans, or other major crops were evaluated in screening tests for potential use in melons. In the PREE herbicide screening test, flumioxazin, dimethenamid, halosulfuron, and s-metolachlor demonstrated melon crop safety at rates higher than rates for effective weed control. In the postemergence screening test, halosulfuron and rimsulfuron gave acceptable weed control with adequate crop safety. Flumetsulam and thifensulfuron appeared to offer some acceptable weed control with a very narrow margin of crop safety. Herbicides that did not offer adequate melon crop safety or acceptable weed control in the screening tests were carfentrazone, sulfentrazone, cloransulam, flumiclorac, fluthiamide/metribuzin, imazamox, isoxaflutole, triflusulfuron, primisulfuron/prosulfuron, and clomazone. The field screening tests were made possible in part by funding provided by the USDA Interregional Research Project No. 4.

Table 1. Preemergence herbicide screening test for cantaloupe and watermelon.

Herbicide	Formulation	Initial Rate (lb AI/A)	Safe Rate* (<30% injury) cantaloupe	watermelon	Weed Control* (>80%)
carfentrazone	40 DF	0.032	0.0062	0.007	>0.032
sulfentrazone	4F	0.375	0.15	0.125	>0.15
cloransulam	0.84	0.039	< 0.006	<0.006	>0.039
flumetsulam	0.8	0.05	0.008	<0.008	>0.05
flumiclorac	0.86 EC	0.05	0.05	0.013	>0.05
flumioxazin	50 WDG	0.094	0.035	<0.045	0.015
fluthiamide/metribuzin	0.68	0.94	<0.16	<0.16	0.16
dimethenamid	7.5 /gal	1.5	0.54	0.54	0.5
halosulfuron	75 WDG	0.1	0.037	0.044	0.018
imazamox	1 EC	0.04	0.009	0.009	0.011
isoxaflutole	75 WDG	0.14	<0.018	<0.018	0.06
s-metolachlor	7.62 /gal	2.0	0.94	0.94	0.5
rimsulfuron	25 DF	0.031	<0.015	<0.013	0.015
thifensulfuron	25 DF	0.004	0.002	0.001	>0.004
triflusulfuron	50 DF	0.016	0.008	0.009	>0.016
primisulfuron/prosulfuron	0.57	0.036	0.006	<0.004	0.013
clomazone	3 ME	1.0	0.47	0.222	0.47

*Safe rate and weed control rates in lb AI/A

Table 2. Postemergence herbicide screening test for cantaloupe and watermelon.

Herbicide	Formulation	Rate (lb AI/A)	Safe Rate* (<30% injury) cantaloupe	watermelon	Weed Control* (>80%)
carfentrazone	40 DF	0.032	<0.008	<0.008	0.01
sulfentrazone	4F	0.375	<0.094	<0.094	0.067
cloransulam	0.84 lb	0.039	0.014	0.009	0.027
flumetsulam	0.8 lb	0.05	0.015	<0.013	0.012
flumiclorac	0.86 EC	0.05	0.024	0.024	0.024
flumioxazin	50 WDG	0.094	0.017	0.017	0.02
fluthiamide/metribuzin	0.68 lb	0.94	0.12	<0.24	0.16
dimethenamid	7.5 lb/gal	1.5	>1.5	>1.5	>1.5
halosulfuron	75 WDG	0.1	0.06	0.043	0.016
imazamox	1 EC	0.04	0.009	0.01	0.012
isoxaflutole	75 WDG	0.14	<0.024	<0.024	0.02
s-metolachlor	7.62 lb/gal	2.0	0.97	0.97	0.97
rimsulfuron	25 DF	0.031	0.014	0.008	0.003
thifensulfuron	25 DF	0.004	0.0009	0.0005	0.0003
triflusulfuron	50 DF	0.016	0.003	0.002	>0.016
primisulfuron/prosulfuron	0.57	0.036	<0.004	<0.004	0.005
clomazone	3 ME	1.0	1.0	1.0	>1.0

*Safe rate and weed control rates in lb AI/A.

Early postemergence herbicide weed control in onions. K. Umeda and D. MacNeil. (University of Arizona Cooperative Extension Maricopa County, 4341E. Broadway, Phoenix, AZ 85040) Two small plot field tests were conducted at the University of Arizona Maricopa Agricultural Center (MAC), Maricopa, AZ and near Waddell, AZ. The tests were set up in a randomized complete block design with three replicates at MAC and four replicates in Waddell. Onions were planted on conventional 40-inch beds at both locations. Onion cv. Desex was planted in two seedlines at MAC on 30 October 1998 and cv. Rafiki was planted in eight seedlines in Waddell on 28 October. All treatment plots consisted of two beds measuring 25 ft in length. All POST herbicide treatments were applied using a hand-held boom equipped with four flat fan 8002 nozzle tips spaced 20-inches apart. The herbicides were applied with a backpack CO_2 sprayer pressurized to 35 psi and delivering 20 gpa water. Applications were made at Waddell on 20 November when the onions exhibited a flag leaf and the first true leaf beginning to emerge. Weeds present were yellow sweetclover at the cotyledon to 1-leaf stage and few small cheeseweed, London rocket, and sowthistle. The weather was clear and sunny with the air temperature at 76°F and a slight breeze. Applications at MAC were made on 18 December when the weather was clear and the air temperature was 56°F. The second true leaf of the onions were emerging at MAC at the application time. Weeds present at MAC were knotweed at the 4-6 leaf stage, sowthistle at the 4-6 leaf stage, cheeseweed at the 4-leaf stage, lambsquarters at the 4-6 leaf stage, and yellow sweetclover at the 2-3 trifoliolate stage. Weed control and crop injury were visually estimated and crop height, stand establishment, and yield measurements were collected at appropriate intervals.

Onions treated with bromoxynil or oxyfluorfen at the time when the first true leaf was emerging were not injured at Waddell (Table 1). No significant onion crop stand reduction occurred from any of the POST treatments. Onion height was not affected by any of the POST treatments through the season. A single application of oxyfluorfen or bromoxynil offered up to 7 weeks of very good weed control (Table 2) with excellent crop safety. Onions treated at the 2-leaf stage of growth with bromoxynil or oxyfluorfen exhibited no significant crop injury at rates less than 0.25 lb AI/A (Table 3). Delayed and reduced control of knotweed could have contributed to the decreased onion yield in the herbicide treated onions compared to the handweeded check. Onion yield in the untreated check was significantly reduced compared to oxyfluorfen treated onions or the handweeded check (Table 3).

Table 1. Early postemergence herbicide onion crop injury.

Treatment	Rate	Onion Injury		Onion Stand	Onion Height	
	(lb AI/A)	01 Dec	06 Jan	28 Jan	28 Jan	07 Apr
		%		No./ft	inch	
Untreated check		0	0	41	11.3	24.0
Bromoxynil	0.063	0	0	38	11.1	24.1
Bromoxynil	0.094	0	0	39	10.3	24.4
Bromoxynil	0.125	0	0	39	10.5	24.5
Oxyfluorfen	0.063	0	0	37	10.5	23.9
Oxyfluorfen	0.125	0	0	39	11.3	25.4
LSD (p=0.05)		0	0	6.9	1.44	1.76

Herbicides applied on 20 November 1998 at Waddell, AZ

Onion stand = no. of plants / ft in 8 seedlines / bed, Onion height = avg. ht. of 5 plants / plot

Table 2. Early postemergence herbicide weed control in onions

Treatment	Rate	Weed Control (%)				
	(lb AI/A)	MALPA		MEUOF		SSYIR
		01 Dec	06 Jan	01 Dec	06 Jan	06 Jan
Untreated check		0	0	0	0	0
Bromoxynil	0.063	69	74	68	50	91
Bromoxynil	0.094	70	81	80	69	97
Bromoxynil	0.125	83	83	88	80	99
Oxyfluorfen	0.063	-	-	89	80	99
Oxyfluorfen	0.125	99	99	93	81	98
LSD (p=0.05)		12.4	6.7	9.6	11.7	5.6

Herbicides applied on 20 November 1998 at Waddell, AZ

Table 3. Postemergence herbicide weed control and crop safety in onions

Treatment	Rate	Onion	Onion	Weed Control				
	(lb AI/A)	Injury	Yield	POLAV	CHEAL	MALPA	MEUOF	SONOL
		%	lb.			%		
Untreated check		0	10.3	0	0	0	0	0
Handweeded check		0	27.7	99	99	99	99	99
Bromoxynil	0.125	0	13.4	57	96	95	83	95
Bromoxynil	0.25	0	13.5	78	96	91	90	98
Bromoxynil	0.375	10	14.7	80	96	96	93	99
Oxyfluorfen	0.125	0	17.1	85	98	98	90	98
Oxyfluorfen	0.25	0	19.6	83	98	95	90	99
LSD (p=0.05)		0	6.5	11	3	8.4	8.9	3.2

Herbicides applied on 18 December 1998 at MAC, rated 03 February 1999, harvested 20 May 1999.

Onion yield = weight / 5 ft of 2 rows harvested

Tolerance of winter processing squash (*Cucurbita maxima*) to sulfentrazone and azafenidin. R. Ed Peachey and R. D. William (Horticulture Department, Oregon State University, Corvallis, OR 97331) The objective of this research was to determine tolerance of *Cucurbita maxima* (var. Golden Delicious) winter squash to sulfentrazone applied PPI or PES and azafenidin PES. Four 30-inch rows of Golden Delicious squash were planted on May 20, 1999 in 38 by 20 ft plots. The soil type was a silty clay loam with a pH of 6.4, OM of 5.18 %, and CEC of 25.2 meq/100g. PPI herbicides were incorporated with a vertical-tine tiller just before planting. PES herbicides were applied after planting and incorporated with 0.5 inches of irrigation water. On June 23 (6 WAP), 33 ft. of one of the four rows in each plot was cut and biomass weighed. Then each plot was reduced to two rows wide by 33 ft. in length and thinned to equal stands. Plots were hoed and cultivated to minimize weed competition, particularly in the untreated check plots. Golden Delicious squash were harvested from the remaining 2 rows on October 22.

A slight reduction in growth was noted when sulfentrazone was applied PPI at 0.375 lb/A (Table 1). Squash biomass harvest at 6 WAP indicated no differences between treatments. Sulfentrazone applied PPI at 0.375 may have decreased biomass, but not compared to the check plot. The biomass yield of the check and azafenidin treatments was probably low because of early season weed competition and hoeing disturbance. Yield was not reduced by either rate of sulfentrazone when applied PPI or PES compared to the check plot (Table 2). There was a slight indication that average fruit weight was greater in the sulfentrazone treatments than the check plots and that fruit weight was less in PES treatments than PPI treatments.

Table 1. Squash tolerance to herbicides.

	Herbicide	Timing	Rate	No. obs.	Crop emergence (3 WAP)	Crop injury (5 WAP)	Biomass harvest (6 WAP)	Avg. plant wt.
			lb/A		no/plot	%	lbs	lbs
1	Sulfentrazone	PPI	0.188	4	77	5	3.7	0.24
2	Sulfentrazone	PPI	0.375	4	72	13	3.2	0.24
3	Sulfentrazone	PES	0.188	4	74	5	3.8	0.27
4	Sulfentrazone	PES	0.375	4	80	0	4.1	0.25
5	Azafenidin	PES	0.025	4	79	0	3.3	0.21
6	Check	-	-	4	79	0	3.2	0.22
	FPLSD $_{0.1}$				NS	15	NS	NS
	CV (%)				8	145	24	18

Table 2. Squash yield response to herbicides.

	Herbicide	Timing	Rate	No. obs.	No. fruit harvested	Fruit yield	Average fruit wt
			lb/A		no/ac	t/ac	lbs
1	Sulfentrazone	PPI	0.188	4	3400	28.0	16.5
2	Sulfentrazone	PPI	0.375	4	3280	26.4	16.1
3	Sulfentrazone	PES	0.188	4	3220	25.6	15.9
4	Sulfentrazone	PES	0.375	4	3550	27.2	15.2
5	Azafenidin	PES	0.025	4	3370	23.5	14.0
6	Check	-	-	4	3200	22.5	14.1
FPLSD $_{0.1}$					ns	4.4	1.6
CV					11	13	9

Herbicide and ethoprop insecticide effects on early season snap bean emergence, growth and root health. R. Edward Peachey (Horticulture Department, Oregon State University, Corvallis, OR 97331). Herbicide injury to snap beans is frequent in early season plantings in cold, wet soils. The objective of this research was to evaluate potential for injury to snap beans when two or more pesticides are used in combination in typical early season plantings. A seedbed was prepared on April 29 by disking and rototilling. The experimental design was randomized complete block factorial with 3 replications. Ethoprop was applied to plots and incorporated with a field cultivator on April 30 followed by application of metolachlor, EPTC and trifluralin and incorporation within one hour with a vertical tine tiller. Snap beans were planted on April 30 at 159,000 seeds/A. Lactofen was applied on May 1 followed by 1.4 inches of rain and average max. temperatures of 58 F in the two weeks following planting. Plots were cultivated to minimize weed competition. Bean emergence rate was determined by counting emerged plants with two true unfolded leaves on May 15. Bean growth was estimated visually on June 3 (6 WAP) along with root health.

Unseasonably cold weather kept snap beans from emerging until 18 days after planting. Severe crop injury was noted with many of the treatments (Table 1). Injury was particularly high in the first block and data are not included in the analysis. Trifluralin had the most negative impact on emergence and growth in these conditions. Ethoprop generally improved emergence. Analysis of variance found significant negative interactions among several herbicide combinations but not the insecticide ethoprop (Table 2).

Table 1. Herbicide and insecticide effects on emergence and root formation in snap beans.

	Herbicide/insecticide timing and rate (lb/A)					Emergence and growth				Root health ratings				
	PPI				PES	N	Two leaf stage	Total emergence (6 WAP)	Crop growth	N	Root biomass	Adven-titious roots	Nodu-lation	Lesion rating
	2.0	4.0	0.75	3.0	0.22									
							---no/2.5 m---		% red.		--- 1= few or none; 10= many ---			
1	Metolachlor	EPTC	Trifluralin	Ethoprop	Lactofen	4	16	64	15	2	7.0	2.5	1.0	2.5
2	Metolachlor	EPTC	Trifluralin		Lactofen	6	7	61	18	3	7.0	4.7	2.7	2.3
3	Metolachlor	EPTC	Trifluralin	Ethoprop		4	30	71	0	2	7.0	7.0	0.5	1.5
4	Metolachlor	EPTC	Trifluralin			2	20	83	5	1	5.0	2.0	1.0	2.0
5	Metolachlor	EPTC		Ethoprop	Lactofen	4	33	75	0	2	8.5	2.0	7.0	2.5
6	Metolachlor	EPTC			Lactofen	4	23	75	5	2	9.0	3.0	0.5	1.5
7	Metolachlor	EPTC		Ethoprop		4	42	73	0	2	7.0	1.5	1.5	0.5
8	Metolachlor	EPTC				4	26	70	0	2	8.5	2.5	0.0	2.0
9	Metolachlor		Trifluralin	Ethoprop	Lactofen	4	23	74	0	2	6.5	4.0	4.0	3.5
10	Metolachlor		Trifluralin		Lactofen	4	19	75	5	2	8.0	3.0	0.0	3.0
11	Metolachlor		Trifluralin	Ethoprop		4	21	71	3	2	7.0	3.0	1.0	0.5
12	Metolachlor		Trifluralin			4	23	74	13	2	5.0	5.0	0.5	2.0
13	Metolachlor			Ethoprop	Lactofen	4	25	72	0	2	7.5	2.0	3.0	2.0
14	Metolachlor				Lactofen	4	39	74	0	2	7.0	4.5	0.5	4.0
15	Metolachlor			Ethoprop		4	37	79	3	2	8.5	1.0	0.5	2.5
16	Metolachlor					4	31	74	0	2	5.5	2.0	2.5	3.0
17		EPTC	Trifluralin	Ethoprop	Lactofen	4	12	72	25	2	7.0	6.5	0.0	2.5
18		EPTC	Trifluralin		Lactofen	4	5	72	33	2	4.5	5.5	0.0	3.5
19		EPTC	Trifluralin	Ethoprop		4	12	72	23	2	5.0	5.5	2.5	2.0
20		EPTC	Trifluralin			4	6	74	23	2	5.5	5.5	0.0	4.0
21		EPTC		Ethoprop	Lactofen	4	32	72	0	2	8.0	1.5	0.0	2.0
22		EPTC			Lactofen	4	37	75	0	2	5.0	2.5	1.0	2.0
23		EPTC		Ethoprop		4	36	73	0	2	6.5	2.5	2.0	4.0
24		EPTC				4	41	77	0	2	8.5	1.5	0.5	0.5
25			Trifluralin	Ethoprop	Lactofen	4	14	76	3	2	6.0	4.0	0.5	3.0
26			Trifluralin		Lactofen	4	14	76	5	2	5.5	6.5	0.0	2.5
27			Trifluralin	Ethoprop		4	12	67	18	2	5.5	4.0	2.5	4.0
28			Trifluralin			4	16	75	8	2	6.0	4.5	0.5	4.0
29				Ethoprop	Lactofen	4	27	72	0	2	6.5	2.5	3.0	2.0
30					Lactofen	4	29	75	0	2	5.0	3.0	1.5	1.5
31				Ethoprop		4	32	71	0	2	6.5	1.5	0.5	3.0
32	None					4	32	67	0	2	7.5	3.5	0.5	1.0
LSD(0.05)							15	ns	10		3.0	3.6	ns	ns

Table 2. ANOVA results of pesticide effects on snap bean shoot and root growth. Values represent probability of effect on measured variable. Main effect and two way interactions are presented. Values greater than 0.15 are not presented.

Herbicide	Two leaf stage	Total emergence	Growth reduction	Root biomass rating	Adventitious root development	Lesions	Nodulation
Main effects							
Metolachlor	0.03[a]	-	0.01	0.01	-	-	-
EPTC	-	-	0.001(-)	-	-	-	-
Trifluralin	0.001(-)	-	0.001(-)	0.01(-)	0.001(-)	-	-
Lactofen	0.02 (-)	-	-	-	-	-	-
Ethoprop	0.11	-	-	-	-	-	0.07
Two-way interactions							
Metolachlor x EPTC	-	-	0.05 (-)	-	-	-	-
Metolachlor x trifluralin	0.01 (-)	-	0.001(-)	-	-	0.08 (-)	-
Metolachlor x lactofen	-	-	-	0.10	-	0.07 (-)	-
Metolachlor x ethoprop	0.07	-	-	-	-	-	-
EPTC x trifluralin	0.03 (-)	-	0.001(-)	-	-	-	-
EPTC x lactofen	-	-	0.001(-)	-	-	-	-
EPTC x ethoprop	0.01	-	-	-	0.14 (-)	-	-
Trifluralin x lactofen	-	-	-	-	-	-	-
Trifluralin x ethoprop	-	-	-	-	-	-	-
Lactofen x ethoprop	-	-	-	-	-	-	-

[a] (-) negative effect of this pesticide or pesticide combination on snap bean growth variables; unmarked values indicate positive effect on bean growth.

Response of cauliflower to several herbicides. Timothy W. Miller. (Washington State University, Mount Vernon, WA 98273) Weeds are of considerable importance to cauliflower producers. Trifluralin is used on nearly all commercial cauliflower fields in Washington state, but control of several common weed species by that product is nearly always incomplete, forcing producers to use expensive hand labor to achieve adequate weed control. Of particular concern is shepherd's-purse, which, in addition to competing with the crop, releases seeds that frequently stick to the surface of the curd, detracting from cauliflower appearance and reducing its market value.

Several herbicides were tested for efficacy and selectivity in cauliflower during 1999 in a commercial production cauliflower field near Mount Vernon, WA. Plots were established June 18 in 'Rivella' cauliflower. Plots were 10 feet long, with one cauliflower row per plot. Preemergence treatments were applied June 22 and postemergence treatments July 15; a CO_2-pressurized backpack sprayer delivering 41 gpa at 37 psi was used for both application timings (Table 1). The two dominant weed species in the plots were henbit and shepherd's-purse. Cauliflower injury and general weed control were visually estimated July 21 and August 12. The experimental design was a randomized complete block with three replicates. A general linear models procedure was used to analyze the data. Means were separated using Fisher's Protected LSD.

Cauliflower injury July 21 was unacceptably high for thiazopyr, azafenidin, and preemergence sulfentrazone (100%), pendimethalin (98%), and dimethenamid (68%)(Table 2). By August 21, weed control from the remaining treatments was > 90% with *S*-metolachlor and the high rates of pyridate and postemergence sulfentrazone (Table 2). Cauliflower treated either with the high rate of postemergence sulfentrazone or the low rate of pyridate produced significantly heavier yields than did the untreated check, but no treatments significantly increased cauliflower head number (Table 2).

Table 1. Application data.

Preemergence	Postemergence
1:45 p.m., June 22, 1999	8:30 a.m., July 15, 1999
No crop emergence	Crop 2 to 3 leaves
No weed emergence	Weeds 2 to 4 inches tall
100% cloud cover	50% cloud cover
Winds 2 to 5 mph from SW	Winds 0 to 2 mph from SE
Air temp. = 57 F	Air temp. = 66 F
Soil temp (4 in.) = 50 F	Soil temp. (4 in.) = 51 F
Relative humidity = 45%	Relative humidity = 59%
Soil surface moist	No dew, soil surface dry

Table 2. Weed control and cauliflower injury as affected by herbicide treatment.

Treatment[a]	Timing[a]	Rate	Crop injury 7/21	Crop injury 8/12	Weed control 7/21	Weed control 8/12	Head number	Head weight
		lb/A	%		%		no./10 ft.	lbs/10 ft.
Pendimethalin	PRE	1.5	98	62	100	98	—	—
Clopyralid	PRE	0.25	0	0	50	10	9.0	8.5
Thiazopyr	PRE	0.5	100	100	99	99	—	—
Fluroxypyr	PRE	0.25	2	3	85	60	10.0	8.9
Dimethenamid	PRE	1.0	68	60	99	99	2.3	1.6
Azafenidin	PRE	0.025	100	100	93	90	—	—
S-Metolachlor	PRE	0.95	5	5	98	96	10.3	8.7
Sulfentrazone	PRE	0.25	100	100	100	99	—	—
Clopyralid	POST	0.125	0	0	52	40	6.3	5.9
Clopyralid	POST	0.25	2	5	40	20	9.7	6.7
Pyridate	POST	0.5	3	0	85	85	13.0	13.3
Pyridate	POST	1.0	12	0	93	93	8.7	9.9
Sulfentrazone	POST	0.125	0	0	85	73	10.7	10.9
Sulfentrazone	POST	0.25	3	0	90	92	11.3	15.5
Clopyralid	POST	0.125	3	0	87	77	10.7	11.6
+ sulfentrazone	POST	0.125						
Clopyralid	POST	0.125	5	0	87	85	10.0	10.3
+ pyridate	POST	0.5						
Untreated check	—	—	0	0	0	0	9.7	6.9
$LSD_{0.05}$	—	—	7	23	14	21	4.4	5.4
r^2	—	—	0.99	0.93	0.94	0.92	0.83	0.78
C.V.	—	—	15.2	53.3	10.7	17.5	36.9	46.7

[a]PRE = preemergence, applied 6/22/99; POST = postemergence, applied 7/15/99.

Tolerance of cucumber to numerous herbicides. Timothy W. Miller and Carl R. Libbey. (Washington State University, Mount Vernon, WA 98273) Few herbicides are currently registered for use in cucumber. To identify potentially useful products and combinations, thirty-five herbicides in a total of 49 treatments were tested in three field studies conducted at the WSU Mount Vernon Research and Extension Unit in 1999. For all trials, pickling cucumber cultivar 'Calypso' was seeded into 10 by 10-ft plots on July 8. The major weed species present in these studies were common chickweed, common groundsel, common lambsquarters, shepherd's-purse, and pale smartweed. Preplant incorporated and preemergence herbicides were applied July 8 and 10, respectively. Postemergence applications were made at three timings: cotyledon (July 19), 1- to 2-leaf (July 27), and 2-to 4-leaf (August 6). All herbicides were applied using a tractor-mounted sprayer delivering 29.7 gpa at 15 psi. Weed control and crop injury was visually estimated August 3 and 12. Fruits were harvested in the sulfonylurea/imidazolinone (SU/IMI) and the herbicide trials (September 22 and 28, respectively), and total fruit number and weight were recorded. Experimental designs for all trials were randomized complete blocks with four replicates each. Data were analyzed using a general linear models procedure. Means were separated using Fisher's Protected LSD. Herbicide application data are listed in Tables 1 and 2, and results from the herbicide trial, the SU/IMI trial, and the new herbicide trial are listed in Tables 3, 4, and 5 (respectively).

Table 1. Application data, preplant incorporated and preemergence treatments.

Date:	9:30 a.m., July 8, 1999	5:45 a.m., July 10, 1999
Type:	Broadcast, preplant incorporated	Broadcast, preemergence
Crop stage:	—	—
Weed stage:	—	—
Cloud cover:	0%, clear	0%, clear
Winds:	calm	calm
Air temp.:	12 C	13 C
Soil temp (4"):	8 C	10 C
Relative humidity:	84%	79%
Comments:	No dew; soil surface damp	No dew; soil surface damp

Table 2. Application data, postemergence treatments.

Date:	9:10 a.m., July 19, 1999	8:45 a.m., July 27, 1999	5:55 a.m., August 6, 1999
Type:	Broadcast, postemergence	Broadcast, postemergence	Broadcast, postemergence
Crop stage:	Cotyledon	1- to 2-leaf	3- to 4-leaf
Weed stage:	Cotyledon	< 1 in.	2 to 3 in.
Cloud cover:	0%, clear	0%, clear	100%, overcast
Winds:	0 to 3 mph from SW	1 to 3 mph from SW	0 to 1 mph from S
Air temp.:	16 C	17 C	16 C
Soil temp (4"):	10 C	9 C	13 C
Relative humidity:	90%	69%	89%
Comments:	Dew; soil surface damp	Dew; soil surface damp	Dew; soil surface damp

Registered products clomazone (PPI) and ethalfluralin (PRE) caused only slight (< 10%) cucumber injury. Non-registered products causing slight injury were preemergence fluroxypyr and flumiclorac and postemergence bentazon, bentazon + naptalam (cotyledon), and halosulfuron. Moderate (10 to 20%) crop injury was caused by preemergence pendimethalin and clopyralid, and postemergence bentazon + naptalam (at 1- to 2-leaf or 2- to 4-leaf). Although early season weed control was generally good, weed control at harvest was inadequate for all treatments in all trials. Continued evaluation of combination treatments remains necessary in 2000. There was no significant difference in fruit number or weight between any herbicide treatments in any trial.

Table 3. Injury to and yield of cucumbers and weed control after treatment with various herbicides and herbicide combinations.

Treatment	Timing[a]	Rate	Crop injury 8/3[b]	Crop injury 8/12	Weed control 8/3[b]	Weed control 8/12	Yield per plot[c] number	Yield per plot[c] weight
		lb/A	%					kg
clomazone	PPI	0.075	0	0	89	84	50	2.3
clomazone	PPI	0.1	1	0	94	92	39	2.4
clomazone	PPI	0.125	1	0	91	90	53	2.7
clomazone	PPI	0.15	3	0	95	91	59	3.8
ethalfluralin	PRE	1.12	4	3	95	94	41	2.6
pendimethalin	PRE	0.75	13	6	99	99	49	3.2
pendimethalin	PRE	1.0	21	18	98	97	48	2.9
bentazon	POST1	0.25	5	1	91	93	53	2.8
bentazon	POST1	0.5	8	4	94	94	61	3.4
bentazon	POST2	0.5	4	4	99	99	61	3.3
bentazon	POST3	0.5	-	6	-	97	43	2.1
bentazon +	POST1	0.25	8	4	97	97	50	2.3
naptalam	POST1	2.0						
bentazon +	POST1	0.5	4	5	93	97	51	2.4
naptalam	POST1	2.0						
bentazon +	POST2	0.5	19	10	99	99	60	3.5
naptalam	POST2	2.0						
bentazon +	POST3	0.5	-	15	-	94	41	1.9
naptalam	POST3	2.0						
handweeded	—	—	0	0	0	0	54	2.7
$LSD_{0.05}$	—	—	4	4	6	7	ns	ns

[a]PPI = preplant-incorporated, applied 7/8/99; PRE = preemergence, applied 7/10/99; POST1=postemergence at cotyledon, applied 7/19/99; POST2=postemergence at 1-2 leaves, applied 7/27/99; and POST3=postemergence at 2-4 leaves, applied 8/6/99.

[b]On this date, postemergence treatments at 2-4 leaves had not yet been applied.

[c]Cucumbers harvested 9/28/99.

Table 4. Injury to and yield of cucumbers and weed control after postemergence[a] treatment with sulfonylurea/imidazolinone herbicides.

Treatment	Rate	Crop injury[b]	Weed control[b]	Yield per plot[c] number	Yield per plot[c] weight
	lb/A	%	%		kg
rimsulfuron	0.023	48	80	26	1.0
halosulfuron	0.032	4	86	30	1.6
nicosulfuron	0.0156	40	58	2	0.03
prosulfuron	0.009	34	84	22	1.8
primisulfuron	0.0178	50	69	0	0
imazamethabenz	0.235	48	49	0	0
imazethapyr	0.047	40	91	6	0.1
imazamox	0.032	48	81	0	0
chlorimuron	0.0078	36	73	24	0.8
triasulfuron	0.0078	48	88	2	0.02
untreated check	—	0	0	27	1.4
$LSD_{0.05}$	—	13	23	ns	ns

[a]Treatments applied at 2-4 leaves, 8/6/99; treatments did not include non-ionic surfactant.

[b]Evaluated 8/12/99.

[c]Cucumbers harvested 9/22/99

Table 5. Injury to cucumbers and weed control after treatment with several herbicides.

Treatment	Timing	Rate	Crop injury		Weed control	
			8/3	8/12	8/3	8/12
		lb/A	------ % ------		—— % ——	
metribuzin +flufenocet	PRE	0.75	99	100	100	100
chloransulam	PRE	0.032	94	98	99	98
flumetsulam	PRE	0.055	55	55	100	98
acetochlor	PRE	2.0	99	100	100	99
flumiclorac	PRE	0.04	3	1	23	54
isoxaflutole	PRE	0.094	79	80	100	99
quinclorac	PRE	0.25	55	58	49	60
napropamide	PRE	1.5	58	55	91	91
fluroxypyr	PRE	0.25	4	3	61	75
clopyralid	PRE	0.25	10	8	45	83
oxyfluorfen	PRE	0.38	84	80	93	95
s-metolachlor	PRE	0.75	46	50	97	96
alachlor	PRE	2.0	88	91	100	99
fluroxypyr	POST	0.125	-	18	-	88
clopyralid	POST	0.125	-	16	-	86
sulfentrazone	POST	0.125	-	100	-	94
phenmedipham	POST	0.5	-	24	-	90
bromoxynil	POST	0.5	-	24	-	96
pyridate	POST	0.9	-	65	-	90
acifluorfen	POST	0.5	-	100	-	93
lactofen	POST	0.5	-	100	-	98
untreated check	POST	—	0	0	0	0
$LSD_{0.05}$		—	10	12	19	18

[a]PRE = preemergence, applied 7/10/99; POST= postemergence at 2-4 leaves, applied 8/6/99.
[b]On this date, postemergence treatments had not yet been applied.
[c]Cucumbers harvested 9/28/99.

PROJECT 3: WEEDS OF AGRONOMIC CROPS

Drew Lyon, Chair

Broadleaf weed control in spring-seeded alfalfa. R.N. Arnold and Dan Smeal. (New Mexico State University Agricultural Science Center, Farmington, NM 87499) Research plots were established on May 18, 1999 at the Agricultural Science Center, Farmington, New Mexico to evaluate the response of spring-seeded alfalfa (var. Legend) and annual broadleaf weeds to postemergence applications of AC 299-263 and imazethapyr 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 ga/A at 30 psi. Treatments were applied on June 16 when alfalfa was in the second trifoliolate leaf stage and weeds were small. Black nightshade, redroot and prostrate pigweed, and common lambsquarters infestations were heavy and Russian thistle infestations were light throughout the experimental area. Plots were evaluated on July 15. Alfalfa was harvested on August 24, using a self-propelled Almaco plot harvester.

AC 299-263 plus buctril applied at 0.024 plus 0.25 lb/A had the highest injury level of 5. All treatments gave good to excellent control of broadleaf weeds except the check. The weedy check had significantly higher yields as compared to herbicide treatments. This is possibly attributed to the heavy weed pressure during harvest.

Table. Broadleaf weed control in spring-seeded alfalfa.

Treatment[a]	Rate	Alfalfa injury	Weed control SOLNI	AMARE	AMABL	SASKR	CHEAL	Alfalfa yield
	lb/A	%						t/A
AC 299-263	0.024	0	94	100	100	98	99	1.4
AC 299-263	0.032	0	100	100	100	98	100	1.6
AC 299-263	0.040	1	100	100	100	100	100	1.3
AC 299-263	0.047	4	100	100	100	100	100	1.4
AC 299-263 + bromoxynil	0.024+0.25	5	100	100	100	100	100	1.5
AC 299-263 + 2,4-DB	0.024+0.5	0	100	100	100	100	100	1.4
AC 299-263 + bromoxynil	0.032+0.25	0	100	100	100	100	100	1.7
AC 299-263 + 2,4-DB	0.032+0.5	0	100	100	100	100	100	1.5
AC 299-263 + bromoxynil	0.04+0.25	0	100	100	100	100	100	1.6
AC 299-263 + 2,4-DB	0.04+0.5	4	100	100	100	100	100	1.5
Imazethapyr	0.063	2	100	100	100	100	100	1.5
Imazethapyr	0.047	0	97	100	100	100	100	1.5
Sethoxydim + bromoxynil	0.19+0.25	0	97	93	92	100	100	1.6
Sethoxydim + 2,4-DB	0.19+0.5	0	100	98	100	100	100	1.6
Sethoxydim + AC 299-263	0.19+0.024	0	97	98	100	100	100	1.8
Weedy check		0	0	0	0	0	0	2.2
LSD 0.05		2	3	1	1	1	1	0.5

[a]All treatments were applied with NIS and 32-0-0 at 0.25% and 1% v/v. Sethoxydim combinations were applied with a COC and 32-0-0 both at 1.0%.

Grass and broadleaf weed control with imazamox and imazethapyr in seedling alfalfa. John O. Evans, Kevin Kelley, and R. William Mace. (Department of Plants, Soils and Biometeorology, Utah State University, Logan, Utah 84322-4820). Two plantings of seedling alfalfa located in Cache county, UT, were treated with various dosages of imazamox and imazethapyr herbicides. These were applied alone and in combination with bromoxynil and clethodim to evaluate their efficacy for controlling wild oat (AVEFA), green foxtail (SETVI), shepherdspurse (CAPBU), tansy mustard (DESPI) and kochia (KOCSC). Individual treatments were applied to 10 by 30 foot plots with a CO_2 backpack sprayer using flatfan 8002 nozzles providing a 10 foot spray width calibrated to deliver 25 gpa at 39 psi. The soils at both locations were silty clay loams near 7.4 pH and O.M. content less than 2%. Treatments were applied postemergence in the spring in a randomized block design, using three replications. Alfalfa was 2 to 6 inches in height at both sites at application time. The wild oats were 6 to 8 inches tall and tansy mustard 2 to 4 inches tall at the Wellsville, UT site on the application date, while in North Logan, shepherds purse, kochia and green foxtail were 1 to 4 inches in height.

There was no injury to alfalfa from any treatment at either site. All treatments satisfactorily controlled tansy mustard at Wellsville, but wild oats were too mature for good control. This is a dryland setting and very little precipitation occurred during the critical period subsequent to the applications which limited the action on wild oat. In North Logan, shepherdspurse was controlled best with either of the imadazolinone herbicides provided the treatment included bromoxynil as a tank mix partner. Imazamox alone gave 90 percent control of green foxtail at the later evaluation date while the other treatments faded considerably. Kochia control proved difficult unless bromoxynil was included as a tank mix partner. In August, kochia had recovered from the spring herbicide treatments. (Utah Agricultural Experiment Station, Logan, UT. 84322-4820)

Table 1. Grass and broadleaf weed control in seedling alfalfa Wellsville, UT.

Treatment[a]	Rate	Alfalfa Injury 7/15	Alfalfa Injury 8/25	Weed control AVEFA 7/15	AVEFA 8/25	DESPI 7/15	DESPI 8/25
	lb ai/A	%		%			
Imazethapyr	0.094	0	0	57	0	88	98
Imazamox	0.04	0	0	62	61	75	98
Imazamox[b]	0.04	0	0	72	66	83	99
Imazethapyr+ bromoxynil	0.063+ 0.25	0	0	37	0	77	96
Imazamox+ bromoxynil	0.032+ 0.25	0	0	58	33	87	97
Imazethapyr+ clethodim	0.063+ 0.125	0	0	82	60	87	92
Imazamox+ clethodim	0.032+ 0.125	0	0	82	66	80	96
check		0	0	0	0	0	0
$LSD_{(0.05)}$		0	0	9.2	79	26	8.3

[a] Nonionic surfactant applied at 0.25% v/v and N at 1qt/A with all treatments but #3. [B] Methylated seed oil applied at 1% v/v and N at 1qt/A.

Table 2. Grass and broadleaf weed control in seedling alfalfa, North Logan, UT.

Treatment[a]	Rate	Alfalfa Injury 6/14	Alfalfa Injury 8/9	Weed control CAPBU 6/14	SETVI 6/14	SETVI 8/9	KOCSC 6/14	KOCSC 8/9
	lb ai/A	%		%				
Imazethapyr	0.094	0	0	47	90	73	50	0
Imazamox	0.04	0	0	50	90	68	40	0
Imazamox[b]	0.04	0	0	53	93	92	50	3
Imazethapyr+ bromoxynil	0.063+ 0.25	0	0	90	92	75	90	27
Imazamox+ bromoxynil	0.032+ 0.25	0	0	90	90	60	92	40
Imazethapyr+ clethodim	0.063+ 0.125	0	0	40	88	80	30	0
Imazamox+ clethodim	0.032+ 0.125	0	0	43	90	73	23	0
check		0	0	0	0	0	0	0
$LSD_{(0.05)}$		0	0	5.6	6.8	26	20	35

[a] Nonionic surfactant applied at 0.25% v/v and N at 1qt/A with all treatments but #3. [B] Methylated seed oil applied at 1% v/v and N at 1qt/A.

Weed control with bromoxynil formulations in spring barley. Joan Campbell and Donn Thill. (Plant Science Division, University of Idaho, Moscow, Idaho 83844-2339) An experiment was established east of Moscow, Idaho to evaluate weed control with bromoxynil formulations in 'Baroness' spring barley. The experimental design was a randomized complete block with four replications and plot size was 8 by 30 ft. Herbicides were applied on June 10, 1999 with a CO_2 pressurized backpack sprayer calibrated to deliver 10 gal/A at 32 psi. Field pennycress (THLAR), redroot pigweed (AMARE), mayweed chamomile (ANTCO), and henbit (LAMAM) were 4 lf to bud, 2 to 4 lf, 1 to 2 inch diameter, and 4 lf, respectively, at the time of application. Air and soil temperatures and relative humidity were 65 F, 61 F, and 49%, respectively. Weed control was evaluated visually on July 12, 1999. Wheat grain was harvested at maturity on August 19, 1999.

Table. Weed control and barley grain yield.

Treatment[a]	Formulation[b]	Rate	Weed control				Barley grain yield
			THLAR	AMARE	ANTCO	LAMAM	
		lb/A	%				lb/A
Untreated control	--	--	--	--	--	--	4903
Bromoxynil	2 EC	0.25	91	98	95	100	4853
Bromoxynil	4 EC	0.25	88	90	98	96	5033
Bromoxynil/MCPA	4 EC	0.5	98	99	98	95	4727
Bromoxynil/MCPA	5 EC	0.5	95	99	98	99	4861
Bromoxynil	2 EW	0.25	88	99	99	98	4811
Bromxynil	4 EW	0.25	91	94	88	99	4773
Bromoxynil/MCPA	4 EW	0.5	100	98	97	96	4166
Bromoxynil + COC	2 EW	0.25	88	95	100	99	4651
Bromoxynil + COC	4 EW	0.25	96	97	100	99	4623
Bromoxynil/MCPA + COC	4 EW	0.5	98	100	100	94	4518
LSD (0.05)			NS	NS	NS	NS	NS

[a] COC was Moract applied at 1% v/v

[b] EC is an emulsifiable concentrate, EW is a water emulsifiable

Weed control of all weed species was 88% or better with all treatments, and there was no difference among treatments (Table). Barley grain yield ranged from 4,166 to 5,033 lb/A and was not different among treatments.

Integrated effects of barley variety, fertilizer placement, and tralkoxydim rate on wild oat control. M. Ann Pool, Don W. Morishita, and Michael J. Wille. (Twin Falls Research and Extension Center, University of Idaho, Twin Falls, ID 83303-1827). A study was initiated under sprinkler irrigation to determine the effect of barley variety, fertilizer placement, and tralkoxydim rate on wild oat control. The study was conducted at the University of Idaho Research and Extension Center near Kimberly, Idaho. The experimental design was a 2 by 3 by 4 factorial randomized complete block with four replications. Individual plots were 8 by 30 feet. Fertilizer was applied broadcast prior to planting or injected two inches below seed depth at planting. Tralkoxydim was applied at three rates: 0X, 0.5X and 1X (1X=0.18 lb/A). Barley varieties ('Galena', 'Harrington', 'Colter', and 'Nebula') were seeded April 28, 1999. Soil type was a Portneuf silt loam soil (29.4% sand, 65% silt, and 5.6% clay), with a pH of 8.1, 1.6% organic matter and a CEC of 14 meq/100 g soil. Tralkoxydim was applied May 27, at the 1 to 3 leaf wild oat stage using a CO_2-pressurized bicycle-wheel sprayer calibrated to deliver 10 gpa. Environmental conditions at application were: air temperature 77 F, soil temperature 70 F, relative humidity 36%, wind 3 mph, and 10% cloud cover. Wild oat and barley stand counts were taken from May 20 to June 1, to determine populations. Wild oat plant densities averaged 23 plants/ft^2. Barley and wild oat biomass was collected from July 16 to July 26, 1999, from each plot. Barley was harvested with a small-plot combine August 30.

Wild oat control ranged from 53 to 55% for Galena, Harrington, and Colter varieties and did not differ (Table 1). Average control for Nebula was 44%. Test weights for Galena averaged 46 lb/bu; significantly higher than Harrington and Colter at 45 to 44 bu/A; and Nebula had the lowest test weights at 41 lb/bu. Wild oat control at 0.18 lb/A averaged 89% and was better than the 0.5X rate (Table 2). However, barley yield was equal between the 0.5X and 1X tralkoxydim rates.

Table 1. Spring barley variety effect on weed control, barley yield and test weight

Barley variety	Plant[a] height	Wild oat control	Yield	Test weight
	inches	%	bu/A	lb/bu
Two-row				
Harrington	41	55	77	45
Galena	35	53	79	46
Six-row				
Colter	40	54	83	44
Nebula	36	44	72	41
LSD (0.05)		8	9	1

[a]Plant heights based on 1998 University of Idaho variety trials at Kimberly, ID.

Table 2. Effect of tralkoxydim rate on wild oat control and barley grain yield.

Tralkoxydim rate	Wild oat control	Barley yield
lb/A	%	bu/A
0.18	89	87
0.09	66	86
0.00	---	61
LSD (0.05)	11	12

Weed control in dry beans. Brian Jenks, Kent McKay, and Gary Willoughby. (NDSU, North Central Research Extension Center, Minot, ND 58701). Dry beans (Maverick) were planted May 27 in Washburn, ND. Flumioxazin, sulfentrazone, and flumetsulam were applied preemergence immediately after seeding. Postemergence treatments of imazamox and bentazon plus various adjuvants were applied on June 24. Individual plots were 10 x 30 ft arranged in a RCBD with three replications. PRE treatments were applied with a CO_2 pressurized bicycle sprayer delivering 20 gpa at 30 psi using XR80015 flat fan nozzles. All postemergence treatments were applied with XR8001 flat fan nozzles delivering 10 gpa at 40 psi. The dry beans were 1-2 trifoliate at time of application. Dry beans were harvested on September 16.

Table. Weed control in dry beans.

Treatment	Rate	Jul 8 Crop Injury	Jul 26 Crop Injury	July 8 SET[a]	July 8 AMARE	July 8 POLCO	Sept 14 SET[a]	Sept 14 AMARE	Sept 14 POLCO	Yield
	lb/A	%	%	Control (%)			Control (%)			lb/A
Untreated		0	0	0	0	0	0	0	0	755
Imazamox + NIS	0.023 0.25%	1	0	97	97	55	99	99	36	1950
Imazamox + NIS	0.031 0.25%	2	0	97	98	56	99	99	40	2189
Imazamox + Quad 7	0.031 1%	3	0	99	99	64	100	99	35	2070
Imazamox + COC	0.031 1%	2	0	98	99	56	99	99	35	1903
Imazamox + NIS + 28 % N	0.031 0.25% 1 qt	1	0	98	98	59	99	99	36	1989
Imazamox + Bentazon + NIS + 28 % N	0.031 0.25 0.25% 1 qt	0	0	97	98	59	99	98	38	1845
Imazamox + Bentazon + NIS + 28 % N	0.031 0.50 0.25% 1 qt	1	0	99	98	69	99	99	35	2028
Imazamox + Bentazon + NIS + 28 % N	0.016 0.25 0.25% 1 qt	0	0	89	94	48	93	97	35	1920
Flumioxazin	0.078	10	4	69	96	89	40	97	74	1520
Flumioxazin	0.125	12	5	69	94	82	43	95	68	1376
Sulfentrazone	0.125	0	0	25	68	70	18	70	58	1107
Sulfentrazone	0.25	0	0	50	89	68	33	86	59	1483
Flumetsulam	0.50	0	0	28	100	23	18	97	13	1400
LSD		3	1	10	8	14	8	6	10	423
CV		89	98	10	7	17	8	5	18	18

[a] SET=Green and yellow foxtail

Dry bean stands were reduced approximately 25% in the flumioxazin treatments. Sulfentrazone did not cause a stand reduction. Imazamox + Quad 7 caused some initial leaf discoloration, but the dry beans quickly recovered. Dry bean yield in the sulfentrazone plot was lower than that of flumioxazin primarily due to lack of grass control.

Imazamox or imazamox + bentazon combinations effectively controlled foxtails, wild oat, redroot pigweed, and wild mustard. Imazamox was notably weaker on wild buckwheat which made harvest more difficult. Flumioxazin, sulfentrazone, and flumetsulam were fair to excellent on redroot pigweed. Flumioxazin and sulfentrazone somewhat suppressed wild buckwheat, however, lack of grass control probably aided in shading and holding down wild buckwheat.

Dry bean response to postemergence herbicides. Richard K. Zollinger and Scott A. Fitterer. (Department of Plant Sciences, North Dakota State University, Fargo, ND 58105) An experiment was conducted near Hatton, ND to evaluate dry bean response to herbicides applied POST. A single row each of 'Maverick' and 'Remington' pinto and 'Navigator' and 'Norstar' navy bean were planted in each plot on June 7, 1999. POST treatments were applied on July 2, 1999 at 9:00 to 10:00 am with 62 F air, 65 F soil surface, 83% relative humidity, 50% clouds, 0 to 3 mph SW wind, dry soil surface, moist subsoil, good crop vigor, dew present, and 1 to 2 trifoliolate dry bean. Treatments were applied to the entire area of the 10 by 40 ft plots with a bicycle-wheel-type sprayer equipped with drift cones delivering 8.5 gpa at 40 psi through 8001 flat fan nozzles. The experiment had a randomized complete block design with three replicates per treatment.

Experiment was maintained weed free throughout the season. Minimal crop injury was observed on June 16 and no injury was visible on July 30 (data not shown) from all treatments. Treatments provided excellent crop safety to dry bean varieties tested. Imazamox at 0.031lb/A plus NIS or Quad 7 reduced yields of Maverick compared to the untreated check. Yields of Remington, Navigator, and Norstar were not significantly reduce compared to the untreated checks.

Table. Dry bean response to postemergence herbicides.

		July 16				Drybean yields			
Treatment[a]	Rate	Mav[b]	Rem[b]	Nav[b]	Nor[b]	Mav	Rem	Nav	Nor
	lb/A	% injury				lb/A			
Imazamox+NIS	0.023+0.25%	0	0	0	0	1736	1573	2143	1790
Imazamox+NIS	0.031+0.25%	0	0	0	0	1523	1815	1972	2038
Imazamox+Quad 7	0.031+1%	0	2	0	0	1529	1865	1538	1874
Imazamox+PO	0.031+1%	0	0	0	0	2161	2050	2062	1413
Imazamox+NIS+28% UAN	0.031+0.25%+1qt	3	3	0	0	1847	1767	1720	1943
Imazamox+bentazon+NIS+28% UAN	0.031+0.5+0.25%+1qt	0	0	0	0	2212	2293	2072	1871
Imazamox+bentazon+NIS+28% UAN	0.031+1.0+0.25%+1qt	0	0	0	0	2163	2183	2311	2085
Imazethapyr+NIS	0.032+0.25%	3	3	0	2	1963	2028	1971	1808
Fomesafen&adjuvant+PO	0.188+1%	0	5	7	3	-	-	-	-
Fomesafen&adjuvant+PO	0.235+1%	5	0	0	0	-	-	-	-
Fomesafen+PO	0.083+1%	0	0	0	0	-	-	-	-
Fomesafen+PO	0.125+1%	0	0	0	0	-	-	-	-
Fomesafen+PO	0.188+1%	0	0	0	0	-	-	-	-
Fomesafen+PO	0.25+1%	0	0	0	0	-	-	-	-
Fomesafen+imazamox+PO	0.188+0.031+1%	2	2	2	2	-	-	-	-
Fomesafen+bentazon+PO	0.188+0.5+1%	3	0	0	0	-	-	-	-
Fomesafen+bentazon+PO	0.188+0.75+1%	0	0	0	0	-	-	-	-
Untreated		0	0	0	0	2156	1825	2167	1825
LSD (0.05)		NS	NS	5	NS	534	430	681	430

[a]NIS = nonionic surfactant = Activator 90, Quad 7 = basic blend adjuvant, PO = petroleum oil = Herbimax, and UAN = urea ammonium nitrate.
[b]Mav = Maverick, Rem = Remington, Nav = Navigator, and Nor = Norstar,

<u>Dry bean response to preemergence herbicides</u>. Richard K. Zollinger and Scott A. Fitterer. (Department of Plant Sciences, North Dakota State University, Fargo, ND 58105) An experiment was conducted near Prosper, ND to evaluate dry bean response to herbicides applied PRE. A single row of 'Navigator' and 'Norstar' navy and 'Remington' and 'Maverick' pinto bean were planted in each plot and PRE treatments were applied on June 1, 1999 at 2:30 to 3:00 pm with 64 F air, 60 F soil at a 2 to 4 inch depth, 56% relative humidity, 90% clouds, 5 to 12 mph S wind, dry soil surface, and moist subsoil. Treatments were applied to the entire area of the 10 by 40 ft plots with a bicycle-wheel-type sprayer equipped with drift cones delivering 17 gpa at 40 psi through 8002 flat fan nozzles. The experiment had a randomized complete block design with three replicates per treatment.

The first precipitation occurred four weeks after treatment applications. Herbicides were not activated because of low precipitation, which resulted in poor weed control from most treatments. Under these conditions, sulfentrazone treatments provided good to excellent control of redroot pigweed and common lambsquarters. FOE5043 at 0.6 lb/A, sulfentrazone at 0.25 and 0.375 lb/A, and all rates of flumioxazin caused dry bean injury on June 29. Dry beans generally recovered from injury before July 12 except dry beans treated with flumioxazin at 0.094 lb/A.

Table. Dry bean response to preemergence herbicides.

		June 29				July 12				June 22				June 29				
Treatment	Rate	Nav[a]	Nor[a]	Rem[a]	Mav[a]	Nav[a]	Nor[a]	Rem[a]	Mav[a]	Fxtl[b]	Rrpw[b]	Colq[b]	Cocb[b]	Fxtl[b]	Wimu[b]	Rrpw[b]	Colq[b]	Cocb[b]
	lb/A	% injury								% control								
FOE5043	0.525	0	3	0	0	0	0	0	0	80	32	52	0	45	30	30	30	10
FOE5043	0.6	7	10	10	10	0	0	0	0	70	20	63	0	-	33	33	33	13
FOE5043	0.678	0	0	0	0	0	0	0	0	70	12	53	3	20	33	53	53	7
Sulfentrazone	0.125	0	0	0	0	0	0	2	0	75	80	85	0	15	40	63	63	13
Sulfentrazone	0.187	0	0	0	0	0	0	0	0	72	85	94	0	50	33	50	50	23
Sulfentrazone	0.25	3	10	13	5	2	2	2	2	78	93	96	0	40	63	60	57	0
Sulfentrazone	0.375	5	7	5	0	0	0	0	0	70	92	96	7	0	0	30	23	7
Flumioxazin	0.031	0	10	5	5	0	0	0	0	70	58	88	7	0	46	46	46	10
Flumioxazin	0.046	7	10	13	10	0	0	0	0	53	73	94	0	0	0	0	0	0
Flumioxazin	0.062	17	20	22	10	2	2	3	2	67	37	85	7	0	23	60	63	7
Flumioxazin	0.094	13	22	20	17	6	8	7	6	67	63	88	7	30	23	50	50	7
Untreated		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
LSD (0.05)		10	14	13	14	3	5	6	3	30	38	33	NS	72	61	77	74	28

[a]Nav = Navigator, Nor = Norstar, Rem = Remington, Mav = Maverick.
[b]Fxtl = green foxtail and yellow foxtail, Rrpw = redroot pigweed, Colq = common lambsquarters, Cocb = common cocklebur, Wimu = wild mustard.

Dry bean response to preplant incorporated herbicides-Hatton, ND. Richard K. Zollinger and Scott A. Fitterer. (Department of Plant Sciences, North Dakota State University, Fargo, ND 58105) An experiment was conducted near Hatton, ND to evaluate dry bean response to herbicides applied PPI. PPI treatments were applied and incorporated with a rototiller operated 2 inches deep on June 7, 1999 at 10:00 to 11:00 am with 93 F air, 69 F soil surface, 65% relative humidity, 5% clouds, 0 to 5 mph NW wind, dry soil surface, and moist subsoil. A single row of 'Norstar' and 'Navigator' navy and 'Remington' and 'Maverick' pinto bean were planted in each plot on June 7, 1999. Treatments were applied to the entire area of the 10 by 40 ft plots with a bicycle-wheel-type sprayer equipped with drift cones delivering 17 gpa at 40 psi through 8002 flat fan nozzles. The experiment had a randomized complete block design with three replicates per treatment.

All treatments provided complete control of green and yellow foxtail, wild mustard, and redroot pigweed (data not shown). Dry bean tolerance of sulfentrazone at rates of 0.25 lb/A or less, flumioxazin rates of 0.047 lb/A or less, flumetsulam+ethalfluralin at 0.046+0.94 lb/A, and ethalfluralin at 0.94 lb/A was generally acceptable. No injury was observed on August 2 or later in the season (data not shown).

Table. Dry bean response to preplant incorporated herbicides-Hatton, ND.

		June 23				July 1				July 19			
Treatment	Rate	Nor[a]	Nav[a]	Rem[a]	Mav[a]	Nor[a]	Nav[a]	Rem[a]	Mav[a]	Nor[a]	Nav[a]	Rem[a]	Mav[a]
	lb/A	% injury											
Sulfentrazone	0.125	3	2	2	2	3	0	0	3	0	0	0	0
Sulfentrazone	0.188	0	0	0	0	0	3	0	3	0	3	0	0
Sulfentrazone	0.25	0	0	0	0	5	7	2	0	0	0	0	0
Sulfentrazone	0.375	2	10	5	2	10	27	2	0	5	50	18	3
Flumioxazin	0.031	5	0	3	0	3	0	0	0	0	0	0	0
Flumioxazin	0.047	15	7	0	0	7	0	0	0	5	0	0	0
Flumioxazin	0.062	9	7	2	5	10	2	2	10	0	3	3	10
Flumioxazin	0.094	31	12	6	7	33	10	8	5	4	8	3	30
Flumetsulam+ethalfluralin	0.046+0.94	3	0	6	5	0	0	0	3	5	8	0	0
Flumetsulam+ethalfluralin	0.063+0.94	8	2	7	7	8	7	5	10	10	10	7	7
Flumetsulam+ethalfluralin	0.094+0.94	17	9	12	2	10	3	7	3	8	15	4	0
Flumetsulam+ethalfluralin	0.125+0.94	5	5	12	5	13	8	13	7	2	7	5	0
Flumetsulam+ethalfluralin	0.125+1.88	8	8	8	12	10	7	7	8	5	13	9	9
Ethalfluralin	0.94	9	2	2	5	0	0	2	0	4	5	1	0
Ethalfluralin	1.88	10	5	8	5	7	0	0	3	2	0	0	0
Pendimethalin&imazethapyr+pend	0.45&0.061+0.72	4	5	10	5	7	0	0	0	12	12	3	5
Untreated		0	0	0	0	0	0	0	0	0	0	0	0
LSD (0.05)		13	9	8	9	26	9	9	9	9	11	14	15

[a]Nor = Norstar, Nav = Navigator, Rem = Remington, Mav = Maverick.

Dry bean response to preplant incorporated herbicides-Prosper, ND. Richard K. Zollinger and Scott A. Fitterer. (Department of Plant Sciences, North Dakota State University, Fargo, ND 58105) An experiment was conducted, near Prosper, ND to evaluate dry bean response to herbicides applied PPI. PPI treatments were applied and incorporated with a rototiller operated 2 inches deep on May 26, 1999 at 3:00 pm with 93 F air, 62 F soil at a 2 to 4 inch depth, 55% relative humidity, 0% clouds, 5 to 12 mph SW wind, dry soil surface, and moist subsoil. 'Remington' pinto and 'Norstar' navy bean were planted in each plot on June 1, 1999. Treatments were applied to the center 6.67 ft of the 10 by 40 ft plots with a bicycle-wheel-type sprayer equipped with drift cones delivering 17 gpa at 40 psi through 8002 flat fan nozzles. The experiment had a randomized complete block design with three replicates per treatment.

First precipitation occurred four weeks after applications. Lower rates of sulfentrazone and flumetsulam+ ethalfluralin, and all rates of flumioxazin, ethalfluralin, and pendimethalin&imazethapyr showed good crop safety throughout the season. Sulfentrazone and flumetsulam provided less than 75% control of green and yellow foxtail. All treatments provided less than 47% control of common cocklebur. All rates of flumetsulam+ethalfluralin controlled green and yellow foxtail, redroot pigweed, and common lambsquarters on June 22 and 29 plus wild mustard on June 29.

Table. Dry bean response to preplant incorporated herbicides-Prosper, ND.

		June 18		June 22				June 29		June 29					July 12	
Treatment	Rate	Rem[a]	Nor[a]	Fxtl[b]	Cocb[b]	Rrpw[b]	Colq[b]	Rem[a]	Nor[a]	Fxtl[b]	Rrpw[b]	Colq[b]	Wimu[b]	Cocb[b]	Rem[a]	Nor[a]
	lb/A	% injury		% control				% injury		% control					% injury	
Sulfentrazone	0.125	0	0	50	13	83	95	2	0	57	99	99	23	23	3	2
Sulfentrazone	0.188	2	5	63	23	90	98	5	2	58	95	99	40	17	2	0
Sulfentrazone	0.25	3	10	75	30	94	95	5	3	57	96	99	46	17	1	7
Sulfentrazone	0.375	0	10	62	43	95	98	5	0	57	99	99	60	13	5	8
Flumioxazin	0.031	0	2	70	20	80	83	3	0	37	13	13	20	7	0	2
Flumioxazin	0.047	0	0	73	13	91	81	2	2	33	33	33	33	7	0	0
Flumioxazin	0.062	2	3	57	20	82	88	5	0	54	66	66	60	25	2	2
Flumioxazin	0.094	3	7	60	23	92	93	3	3	53	73	70	43	20	5	3
Flumetsulam+ethalfluralin	0.046+0.94	2	3	99	30	99	98	0	0	99	99	99	99	37	5	4
Flumetsulam+ethalfluralin	0.063+0.94	3	2	99	43	98	99	3	0	99	99	99	99	47	5	3
Flumetsulam+ethalfluralin	0.094+0.94	8	8	88	23	99	99	5	3	96	99	99	99	40	11	9
Flumetsulam+ethalfluralin	0.125+0.94	8	13	96	27	99	98	3	3	86	99	99	99	43	5	10
Flumetsulam+ethalfluralin	0.125+1.88	3	8	98	23	98	96	3	3	99	99	99	99	33	7	8
Ethalfluralin	0.94	0	0	93	20	96	98	2	2	83	99	89	23	7	2	0
Ethalfluralin	1.88	0	0	99	13	98	98	2	5	99	99	96	33	10	2	2
Pendimethalin&imazethapyr+ pendimethalin	0.45&0.061+ 0.72	0	0	98	23	98	93	2	0	98	99	99	99	30	2	2
Untreated		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
LSD (0.05)		5	9	26	23	15	13	NS	NS	34	20	20	38	21	7	8

[a]Rem = Remington and Nor = Norstar.
[b]Fxtl = green foxtail and yellow foxtail, Cocb = common cocklebur, Rrpw = redroot pigweed, Colq = common lambsquarters, Wimu = wild mustard.

Dry bean tolerance to imazamox. Richard K. Zollinger and Scott A. Fitterer. (Department of Plant Sciences, North Dakota State University, Fargo, ND 58105) An experiment was conducted near Prosper, ND to evaluate dry bean tolerance to imazamox applied POST. Dry bean was planted on June 1, 1999. Treatments were applied to nine dry bean varieties: 'Maverick' and 'Remington' (pinto), 'Frontier', 'Navigator', and 'Agri-1' (navy), 'T-39' and 'Shadow' (black), and 'Cal Early LRK' and 'Montcalm' (kidney). Treatments were applied on July 1, 1999 at 10:00 to 11:00 am with 63 F air, 68 F soil, 83% relative humidity, 100% clouds, 0 to 5 mph NW wind, moist soil surface, wet subsoil, good crop vigor, no dew present, and 2 to 4 trifoliolate dry bean. Weeds present were: 1 to 3 inch, foxtail (2 to 5/ft^2); 1 to 3 inch, redroot pigweed (2 to 5/ft^2); cotyledon, wild mustard (2 to 5/ft^2); and 1 to 3 inch, common cocklebur (1 to 2/ft^2). Treatments were applied to the center 6.67 ft of the 10 by 40 ft plots with a bicycle-wheel type sprayer equipped with a wind shield delivering 8.5 gpa at 40 psi through 8001 flat fan nozzles. The experiment had a randomized complete block design with three replicates per treatment

Plots were oversprayed with bentazon at 0.75 lb/A and sethoxydim at 0.18 lb/A to control common cocklebur and green and yellow foxtail. Dry bean injury was less than 2%, chlorosis was less than 5%, and growth reduction was less than 8% from treatments for all varieties on July 8 (data not shown). No injury of any type was observed on or after July 16. Dry bean yields were less for untreated plots than for treated plots probably due to competition from a second flush of green and yellow foxtail that only emerged in the untreated plots.

Table. Dry bean tolerance to imazamox.

		Dry bean yield								
Treatment[a]	Rate	Mav[b]	Rem[b]	Fron[b]	Nav[b]	Agri[b]	T-39	Shad[b]	Cal E[b]	Mont[b]
	lb/A	lb/A								
Imazamox+NIS+28%	0.024+0.25%+1%	1386	1697	2857	1913	2548	3544	2868	1477	1494
Imazamox+NIS	0.032+0.25%	1105	1645	2730	2065	2725	3043	2428	1828	1078
Imazamox+NIS+28%	0.032+0.25%+1%	1299	1486	2687	2765	2826	3082	3174	1934	1118
Imazamox+bentazon+NIS +28%	0.032+0.36+0.25%+1%	1188	1288	2886	2081	2507	3321	2772	1800	1334
Untreated		1048	1398	2451	2176	2236	2880	2412	1177	1106
LSD (0.05)		818	494	807	646	343	1040	869	746	570

[a]NIS = nonionic surfactant = Activator 90 and 28% = 28-0-0 nitrogen fertilizer.
[b]Mav = Maverick, Rem = Remington, Fron = Frontier, Nav = Navigator, Agri = Agri-1, Shad = Shadow, Cal E = Cal Early LRK, Mont = Montcalm.

Glyphosate tolerant canola injury and seed yield. Joan Campbell and Donn Thill. (Plant Science Division, University of Idaho, Moscow, Idaho 83843) An experiment was established east of Moscow, Idaho to evaluate glyphosate tolerant canola response to application timings and rates of glyphosate. The experimental design was a randomized complete block with four replications and plot size was 8 by 30 ft. Roundup Ready (Iola 357), Liberty Link (InVigor 2373), and Clearfield (Pioneer 45A71) canola varieties were seeded on April 24, 1999. Liberty Link canola was reseeded on May 11, 1999 due to poor emergence. Herbicides were applied with a CO_2 pressurized backpack sprayer calibrated to deliver 10 gal/A at 32 psi (Table 1). Glyphosate and trifluralin + quizalofop were applied to Roundup Ready, glufosinate was applied to Liberty Link, and imazamox was applied to Clearfield. Canola plant height and percent flower were evaluated on June 24, 1999. Canola seed was harvested on August 30, 1999.

Table 1. Application data.

Application date	April 23, 1999	May 24, 1999	June 1, 1999	June 10, 1999
Growth stage	PPI	1 to 2 leaf	3 to 4 leaf	5 to 6 leaf
Air temperature (F)	70	88	56	58
Relative humidity (%)	30	50	51	45
Wind (mph,direction)	2, N	2,W	1,W	0
Cloud cover (%)	0	0	100	0
Soil temperature at 2 inch (F)	60	75	59	56

Table 2. Canola flowering, height, and seed yield.

			Canola		
Treatment	Rate	Timing	Flowering	Height	Seed yield
	lb/A		%	inch	lb/A
Glyphosate	0.5	3-4 lf	90	25.2	1838
Glyphosate	0.75	3-4 lf	89	25.6	1933
Glyphosate	1.0	3-4 lf	88	25.2	1821
Glyphosate	1.5	3-4 lf	84	24.4	1699
Glyphosate	0.5	5-6 lf	82	25.6	1587
Glyphosate	0.75	5-6 lf	79	25.2	1807
Glyphosate	1.0	5-6 lf	76	26.0	1698
Glyphosate	1.5	5-6 lf	66	23.2	1285
Glyphosate + glyphosate	0.5 + 0.5	1-2 + 5-6 lf	82	24.4	1918
Glyphosate + glyphosate	0.75 + 0.5	1-2 + 5-6 lf	71	22.0	1612
Glyphosate + glyphosate	0.75 + 0.75	1-2 + 5-6 lf	72	21.7	1563
Glyphosate + glyphosate	1.0 + 0.5	1-2 + 5-6 lf	72	22.0	1725
Glyphosate + glyphosate	1.0 + 1.0	1-2 + 5-6 lf	68	21.7	1686
Glyphosate + glyphosate	1.5 + 1.5	1-2 + 5-6 lf	61	20.1	1302
Control (glyphosate)	--	--	90	28.0	1772
Trifluralin + quizalofop	0.75 + 0.055	PPI + 5-6 lf	88	26.8	1900
Glufosinate	0.37	3-4 lf	--	--	933
Control (glufosinate)	--	--	--	--	896
Imazamox[a]	0.031	3-4 lf	50	20.9	914
Control (imazamox)	--	--	55	24.8	1172
LSD (0.05)			5	2.4	457

[a] Applied with a nonionic surfactant at 0.25% v/v and UAN at 1 qt/A.

Flowering of Roundup Ready canola was delayed in response to increases in glyphosate (Table 2). The flowering delay was affected least at the 3 to 4 leaf stage compared to the 1 to 2 and 5 to 6 leaf stage. Plants were shorter with glyphosate rates higher than 1 lb/A total applied at the 5 to 6 leaf, or 1 to 2 + 5 to 6 leaf stage. Yield was reduced with 1.5 lb/A glyphosate applied at the 5 to 6 leaf stage and with 1.5 + 1.5 lb/A glyphosate at the 1 to 2 + 5 to 6 leaf stage compared to Roundup Ready canola treated with trifluralin + quizalofop. Liberty Link canola was not evaluated for height or flowering due to delayed planting date. Clearfield canola flowered later than Roundup Ready, and the imazamox treated canola flowered later than the untreated control. Clearfield and Liberty Link canola yield was not affected by herbicide application.

Canada thistle control in glyphosate resistant canola. Katheryn M. Christianson and Rodney G. Lym. (Department of Plant Sciences, North Dakota State University, Fargo, ND 58105). There are very few herbicides registered for broadleaf control in canola especially for a perennial weed such as Canada thistle. The objective of this experiment was to determine the effect glyphosate applied at various canola growth stages on crop yield and Canada thistle control.

The experiment was established at Fargo in a dense Canada thistle stand. Fertilizer was added based on soil tests for the site and incorporated May 24, 1999 and Monsanto 3753 canola was seeded later on the same date. Herbicides were applied at the 1- to 2-leaf, 3- to 4-leaf, and 5- to 6-leaf canola growth stages, on June 9, June 15, and June 24, respectively. The treatments were applied with a CO_2 backpack sprayer delivering 8.5 gpa at 35 psi. The plots were 10 by 30 feet, and the experiment was a randomized complete block design with four replicates. Canola chlorosis, plant height reduction, flowering, and Canada thistle control were evaluated and compared to the untreated check.

Glyphosate application caused minimal chlorosis when applied at all growth stages except the 5- to 6-leaf stage which averaged 23% (Table). Also, there was a tendency for plant height to be reduced when glyphosate was applied to canola at the 5- to 6-leaf stage. Plant height was reduced 31% when clopyralid plus quizalofop was applied at the 3- to 4-leaf stage. There was no significant difference in flowering 37 DAT regardless of treatment.

Canola production was the greatest, 1134 lb/A, when glyphosate was applied at 0.56 lb/A to the 1- to 2-leaf stage followed by glyphosate at 0.375 lb/A at the 5- to 6-leaf stage (Table). Canola yield tended to decline when glyphosate was applied later in the growing season. For instance, canola yield averaged 1028 lb/A when glyphosate was applied at the 1-to 2-leaf and again at the 5- to 6-leaf growth stage compared to an average of 988 lb/A and 775 lb/A when plants were treated once at the 3- to 4-leaf or 5- to 6-leaf stage, respectively. In general, canola production was lower than average due to early wet conditions delaying the planting date followed by hot dry conditions after planting.

All herbicide treatments provided greater than 90 and 95% Canada thistle control 30 DAT and at harvest, respectively. Canada thistle control still averaged 93% at 30 days after harvest regardless of the herbicide treatment.

In summary, Canada thistle control was similar regardless of the canola growth stage at application. However, canola yield tended to decline the later in the growing season the initial glyphosate application was made.

Table. Canada thistle control in glyphosate resistant canola.

			Canola				Canada thistle	
Treatment	Rate	Crop growth stage	Chlorosis 30 DAT[a]	Height Reduct.	Flowering 37 DAT[a]	Yield	30 DAT[a]	30 DAH[b]
	lb/A		— % —			lb/A	— % control —	
Glyphosate	0.375 / 0.375	1 to 2 lf / 5 to 6 lf	3/6	0/0	31	1012	98	98
Glyphosate	0.56 / 0.375	1 to 2 lf / 5 to 6 lf	3/0	1/0	33	1134	100	98
Glyphosate	0.75 / 0.375	1 to 2 lf / 5 to 6 lf	10/21	1/11	25	940	98	93
Glyphosate	0.375	3 to 4 lf	9	8	31	913	95	97
Glyphosate	0.56	3 to 4 lf	1	5	38	1124	100	97
Glyphosate	0.75	3 to 4 lf	5	11	30	957	100	97
Glyphosate	0.375	5 to 6 lf	15	16	25	592	93	93
Glyphosate	0.56	5 to 6 lf	28	6	28	846	90	98
Glyphosate	0.75	5 to 6 lf	26	20	31	886	95	96
Clopyralid + quizalofop + 1% PO	0.19+0.068+1%	3 to 4 lf	13	31	23	810	98	99
Untreated check	...	...	0	0	15	359	0	0
LSD (0.05)			11	15	15	178	NS	NS

[a] DAT is days after treatment.
[b] DAH is days after harvest.

Canada thistle control in glyphosate-tolerant canola. Brian Jenks and Gary Willoughby. (NDSU, North Central Research Extension Center, Minot, ND 58701). Roundup Ready canola (LG3235) was seeded May 19 into 7.5-inch rows at 700,000 pls/acre in a conventional tillage system. Individual plots (12 x 30 ft) received either a single application or a split application of glyphosate at various canola stages. All postemergence treatments were applied with XR8001 flat fan nozzles delivering 10 gpa at 40 psi. Each treatment was replicated four times. Treatments were applied on June 5 (1-4" weeds), June 10 (2-10" weeds), and June 16 (4-12" weeds). Canada thistle present in the entire plot were counted on June 5. Canola was harvested August 25.

Table. Canada Thistle Control in glyphosate-tolerant canola.

Treatment[a]	Rate	Timing[b]	June 5 CIRAR	Jun 28 CIRAR	Sep 1 CIRAR	August 25 Yield
	lb/A		density[c]	---------Control (%)-------		lb/A
Glyphosate	0.38	B	323	80	67	1476
Glyphosate	0.38	C	155	75	88	1221
Glyphosate / Glyphosate	0.38 / 0.38	A / C	198	85	90	1563
Glyphosate	0.56	B	246	83	84	1608
Glyphosate	0.56	C	171	77	85	1486
Glyphosate / Glyphosate	0.56 / 0.38	A / C	277	85	85	1688
Glyphosate	0.75	B	283	84	78	1463
Glyphosate	0.75	C	234	80	86	1371
Glyphosate / Glyphosate	0.75 / 0.38	A / C	166	87	87	1633
Clopyralid + Quizalofop	0.188 + 0.069	B	102	87	97	1035[d]
Weedy Check			360	0	0	376
LSD			214	7	11	261
CV			65	7	10	13

[a] All Glyphosate treatments applied with AMS (1%)

[b] A=coty to 2-leaf canola (Jun 5), B=3 to 4-leaf canola (Jun 10), C=5 to 6-leaf canola (Jun 16)

[c] These numbers represent the average Canada thistle density over the four replications

[d] The low yield was due to a high population of lambsquarters, not lack of Canada thistle control

Flea beetle pressure was extremely high this year. Even though the canola seed was treated with Gaucho, we had to make a foliar insecticide application to help reduce the flea beetle pressure. The canola crop emerged very nicely, but remained in the cotyledon to 2-leaf stage for an extended period. Much of the slow growth can be attributed to the heavy flea beetle pressure. This allowed the Canada thistle to get a good start without a lot of early shading from the canola crop.

Glyphosate at higher rates tended to burn down the thistle plants faster than the lower rate (0.38 lb). On June 28, Canada thistle control with the 3-4 leaf and split applications were somewhat higher than the late application (5-6 leaf canola), primarily due to the earlier spray date or more time to kill the plant. The final rating on September 1 generally showed better season-long control with the 5-6 leaf and split applications compared to the 3-4 leaf application. The 5-6 leaf and split applications tended to have fewer plants and the plants present were usually much shorter than those in the 3-4 leaf application. Some plots had much higher Canada thistle populations than others. With such high populations and varied emergence, it is likely that some plants were covered by others and were not sprayed.

Although we saw better control at the end of the season with the late treatment, delaying the application also allowed the Canada thistle to grow quickly which effectively reduced canola yield. Yields were 100-300 lbs higher with the 3-4 leaf or split applications than the 5-6 leaf application. The canola stand that received only the late application appeared more thin and somewhat shorter compared to plots where Canada thistle has been taken out earlier. The field also had a fairly heavy lambsquarters population that also contributed to yield reduction in late-applied treatments.

Clopyralid was very effective in controlling Canada thistle. However, because we did not put down a soil-applied product such as trifluralin, the heavy lambsquarters population was primarily responsible for reducing the canola yield in the clopyralid plots.

Dormant versus spring-seeded canola. Brian Jenks, Kent McKay, and Gary Willoughby. (NDSU, North Central Research Extension Center, Minot, ND 58701). Roundup Ready canola was seeded December 3, 1998 and April 23, 1999 into 7.5-inch rows at 700,000 pls/A. The canola was seeded into standing wheat stubble (very low residue). The canola not treated with a coating that inhibits germination. Individual plots were 12 x 30 ft and each treatment was replicated four times. Trifluralin and ethalfluralin granules were spread over individual plots with a Gandy granular applicator on December 4. One application of glyphosate was applied in the spring on May 25. The canola was harvested on August 9.

Table. Dormant versus spring-seeded canola.

		June 26			July 26			May 26	
Treatment	Rate	CHEAL	AMARE	SET[a]	CHEAL	AMARE	SET[a]	Canola	Yield
	lb/A	Control (%)						per sq ft	lb/A
Ethalfluralin (F)	1.15	75	91	89	71	85	74	4.8	1219
Ethalfluralin (S)	1.15	96	98	96	93	97	94	10.6	2063
Trifluralin (F)	1.15	60	85	87	58	83	76	4.5	1270
Trifluralin (S)	1.15	86	95	95	91	96	96	14.4	1935
Glyphosate (F)	0.38	85	89	76	81	88	53	4.7	1312
Glyphosate (S)	0.38	95	98	95	93	95	75	9.5	1914
Check (F)		0	0	0	0	0	0	6.3	1035
Check (S)		0	0	0	0	0	0	10.4	1676
LSD		14	13	6	11	12	13	2	341
CV		16	13	6	12	12	15	20	15

[a] SET=green and yellow foxtail
(F)—fall seeded
(S)—spring seeded

We waited in late October and early November 1998 for the temperatures to go down low enough to inhibit seed germination. When that finally happened, we were greeted with 10 inches of snow in early November. Warm temperatures in November allowed the snow to melt and the soil to partially dry. We decided to seed in early December into wet, but hopefully frozen soil. The soil was not completely frozen at the time of seeding and soil moisture was very high in some areas.

The December-seeded canola began emerging about April 12. Time of emergence was quite variable, which resulted in varying stages of growth in May (i.e., some plants at 5-leaf stage while others in cotyledon stage). The dry month of April resulted in some stand loss due to soil crusting. We chose to try to break up the crust by going through the plot area with an empty drill. Stand counts taken on May 26 showed a significant difference in canola population in the fall vs. spring seeding. Stand counts ranged from 4-6 plants/ft^2 in the fall seeded plots compared to 10-14 plants/ft^2 in the spring seeded plots. Canola yields in the fall seeded plots were consistently 600 to 800 lb/A lower than the spring seeded plots. At least some of the stand loss and yield difference can be attributed to the soil crusting in April.

Weed control was better and more consistent in the spring seeded plots. Emergence of the spring seeded canola was more uniform and provided good suppression of weeds through crop competition. The low plant population of the fall seeded canola did not compete as well with weeds, even though herbicides provided some control. For example, glyphosate was applied May 25 and effectively controlled all emerged weeds. The higher canola population in the spring seeded plots helped shade out later emerging weeds, while the lower canola population in the fall seeded plots allowed later emerging weeds to be competitive through the remaining growing season. The same scenario occurred in the ethalfluralin and trifluralin plots, i.e., better weed control with a more competitive crop.

Redroot pigweed control in glufosinate-tolerant canola. Brian Jenks and Gary Willoughby. (NDSU, North Central Research Extension Center, Minot, ND 58701). Liberty Link canola (Invigor 2373) was seeded May 18 into 7.5-inch rows at 700,000 pls/A. Herbicide treatments were applied early-post (June 5), mid-post (June 10), or late-postemergence (June 16). Individual plots were 10 x 30 ft arranged in a RCBD with three replications. PPI treatments were applied with a CO_2 pressurized bicycle sprayer delivering 20 gpa at 30 psi using XR80015 flat fan nozzles. All postemergence treatments were applied with XR8001 flat fan nozzles delivering 10 gpa at 40 psi. Canola was harvested on August 26.

Glufosinate was effective on pigweed at any stage or rate. The highest canola yield was obtained with the full rate of glufosinate at 2 to 3-leaf canola or the split application. Clopyralid did provide some suppression of pigweed.

Application date	June 5	June 10	June 16
Application timing	POST I	POST II	POST III
Temperature (°F)			
Air	68	57	57
Soil	64	59	58
Relative humidity (%)	71	64	63
Canola stage	1 to 2- leaf	2 to 3-leaf	4 to 5-leaf
AMARE size / density	0.5-1" / 84 per sq ft	1" / 84 per sq ft	1-4" / 12 per sq ft

Table. Redroot pigweed control in glufosinate-tolerant canola.

Treatment[a]	Rate	Timing[b]	June 19 AMARE	Aug 19 AMARE	Yield
	lb/A		Control (%)		lb/A
Untreated			0	0	1097
Glufosinate	0.26	A	95	94	2102
Glufosinate	0.37	A	95	93	1993
Glufosinate	0.44	A	96	95	2125
Glufosinate	0.37	B	99	99	2204
Glufosinate	0.44	B	99	99	2436
Glufosinate / Glufosinate	0.37 / 0.37	A / C	100	99	2392
Glufosinate + Sethoxydim	0.37 + 0.08	C	95	97	2073
Sethoxydim + Clopyralid + MSO	0.08 + 0.188 + 1%	A	0	30	1663
Sethoxydim + Clopyralid + MSO	0.08 + 0.188 + 1%	B	0	23	1377
LSD			1	11	474
CV			1	9	14

[a] All glufosinate treatments applied with AMS (3 lb/A)
[b] A=1 to 2-lf canola; B=2 to 3-lf canola; C=4 to 5-leaf canola

Timing of weed control in imidazolinone-tolerant canola. Brian Jenks, Kent McKay, and Gary Willoughby. (NDSU, North Central Research Extension Center, Minot, ND 58701). Clearfield canola (45A71) was seeded May 3 into 7.5-inch rows at 700,000 pls/A. Herbicide treatments were applied preplant incorporated (Apr 30), early-post (June 1), mid-post (June 7), or late-postemergence (June 11). Individual plots were 10 x 30 ft arranged in a RCBD with three replications. PPI treatments were applied with a CO_2 pressurized bicycle sprayer delivering 20 gpa at 30 psi using XR80015 flat fan nozzles. All postemergence treatments were applied with XR8001 flat fan nozzles delivering 10 gpa at 40 psi. Heavy rains began the night the canola was seeded. We received almost 7 inches of rainfall before the early-post application (June 1). A portion of the first replication was under water for most of May. Canola was harvested August 10.

Table. Timing of weed control in imidazolinone-tolerant canola.

			June 25				July 26	
Treatment[a]	Rate	Timing[b]	KCHSC	SET[c]	CHEAL	AMARE	KCHSC	Yield
	lb/A		Control (%)					lb/A
Trifluralin	0.75	A	93	93	98	92	88	1495
Trifluralin / Quizalofop	0.75 / 0.055	A / C	94	95	97	98	79	1482
Ethalfluralin	0.75	A	92	93	97	99	89	1713
Ethalfluralin / Quizalofop	0.75 / 0.055	A / C	93	98	98	98	87	1558
Trifluralin / Imazamox	0.75 / 0.016	A / C	93	98	100	100	88	1530
Ethalfluralin / Imazamox	0.75 / 0.016	A / C	97	100	100	100	95	1563
Imazamox	0.016	B	65	78	63	96	62	1493
Imazamox	0.016	C	72	94	95	97	63	1444
Imazamox	0.016	D	78	95	90	97	63	1679
Imazamox	0.031	B	65	95	95	100	42	1374
Imazamox	0.031	C	85	99	100	100	67	1502
Imazamox	0.031	D	85	95	87	99	70	1418
Imazamox / Imazamox	0.016 / 0.016	B / D	70	100	100	100	62	1474
Imazamox / Imazamox	0.008 / 0.008	B / D	78	98	90	100	60	1492
Handweed check +			99	100	100	100	98	1491
Trifluralin / Imazamox	0.75 / 0.016	A / C						
Weedy check			0	0	0	0	0	1329
LSD			13	10	8	5	17	444
CV			10	7	5	3	14	17

[a] All imazamox treatments included NIS (0.25%) and 28% Nitrogen (1qt)
[b] A=PPI; B=cotyledon to 2-lf canola; C=3 to 4-lf canola; D=5 to 6-leaf canola
[c] SET=green and yellow foxtail

Flea beetle pressure was extremely high in this field. Even though the canola seed was treated with Gaucho, we had to make a foliar insecticide application to help reduce the flea beetle pressure. The canola remained in the cotyledon to 2-leaf stage for an extended period due to the flea beetles and wet soil.

The objective of this study was to compare weed control from soil-applied products with imazamox at different rates and timings. The primary weeds were kochia, foxtails, lambsquarters, and pigweed. Other species present were shepherdspurse, field pennycress, and biennial wormwood. Trifluralin and ethalfluralin did not control the mustard species or biennial wormwood, but generally provided good control of kochia, foxtails, lambsquarters, and pigweed. Trifluralin or ethalfluralin followed by a postemergence application of imazamox was as effective or better than trifluralin or ethalfluralin alone.

Imazamox controlled foxtails, lambsquarters, pigweed, shepherdspurse, and field pennycress, but was weaker on kochia and biennial wormwood. The early application (cotyledon to 2-leaf) was not as effective as the later applications as it missed later flushes of weeds. Weed control with imazamox was generally higher with 0.031 lb compared to 0.016 lb. The split application of imazamox (0.016 lb + 0.016 lb) was also very effective on all weeds except kochia and biennial wormwood.

Timing of weed control in glufosinate-tolerant canola. Brian Jenks, Kent McKay, and Gary Willoughby. (NDSU, North Central Research Extension Center, Minot, ND 58701). Liberty Link canola (Invigor 2373) was seeded May 3 into 7.5-inch rows at 700,000 pls/A. Herbicide treatments were applied preplant incorporated (Apr 30), early-post (June 1), mid-post (June 7), or late-postemergence (June 11). Individual plots were 10 x 30 ft arranged in a RCBD with three replications. PPI treatments were applied with a CO_2 pressurized bicycle sprayer delivering 20 gpa at 30 psi using XR80015 flat fan nozzles. All postemergence treatments were applied with XR8001 flat fan nozzles delivering 10 gpa at 40 psi. Heavy rains began the night the canola was seeded. We received almost 7 inches of rainfall before the early-post application (June 1). Canola was harvested August 10.

Table. Timing of weed control in glufosinate-tolerant canola.

Treatment[a]	Rate	Timing[b]	June 25 KCHSC	June 25 SET[c]	June 25 CHEAL	June 25 AMARE	July 26 KCHSC	Yield
	lb/A		Control (%)					lb/A
Trifluralin	0.75	A	80	90	93	90	72	1203
Trifluralin / Quizalofop	0.75 / 0.055	A / C	73	98	94	94	72	1330
Ethalfluralin	0.75	A	80	95	100	100	77	1308
Ethalfluralin / Quizalofop	0.75 / 0.055	A / C	92	96	100	98	87	1228
Trifluralin / Glufosinate	0.75 / 0.26	A / C	99	100	100	100	97	1366
Ethalfluralin / Glufosinate	0.75 / 0.26	A / C	99	100	100	100	97	1310
Glufosinate	0.35	B	63	68	77	68	53	1252
Glufosinate	0.35	C	98	95	100	97	93	1456
Glufosinate	0.35	D	100	100	100	100	95	1385
Glufosinate	0.44	B	68	68	80	77	63	1521
Glufosinate	0.44	C	99	98	99	98	95	1384
Glufosinate	0.44	D	100	100	100	100	99	1528
Glufosinate / Glufosinate	0.22 / 0.22	B / D	99	100	100	100	95	1362
Glufosinate / Glufosinate	0.13 / 0.13	B / D	94	95	100	95	89	1469
Glufosinate + Quizalofop	0.26 + 0.034	C	97	94	97	100	89	1603
Handweed Check			100	99	100	99	96	1276
Trifluralin / Glufosinate	0.75 / 0.26	A / C						
Weedy Check			0	0	0	0	0	1198
LSD			10	8	13	12	12	248
CV			7	5	9	8	9	11

[a] All glufosinate treatments included AMS (3 lb/A)
[b] A=PPI; B=cotyledon to 2-lf canola; C=3 to 4-lf canola; D=5 to 6-leaf canola
[c] SET=green and yellow foxtail

Flea beetle pressure was extremely high. The canola seed was treated with Gaucho, but we needed a foliar insecticide application to help reduce the flea beetle pressure. The canola remained in the cotyledon to 2-leaf stage for an extended period due to the flea beetles and wet soil.

The objective of this study was to compare weed control from soil-applied products with glufosinate at different rates and timings. The primary weeds were kochia, foxtails, lambsquarters, and pigweed. Other species present were shepherdspurse, field pennycress, and biennial wormwood. Trifluralin and ethalfluralin did not control the mustard species or biennial wormwood, but generally provided good control of kochia, foxtails, lambsquarters, and pigweed. Trifluralin or ethalfluralin followed by a postemergence application of glufosinate was as effective or better than trifluralin or ethalfluralin alone, however, canola yields were not significantly different.

Glufosinate was effective at any rate on kochia, foxtails, lambsquarters, redroot pigweed, biennial wormwood, field pennycress, and shepherdspurse. Glufosinate applied only at cotyledon to 2-leaf canola controlled emerged weeds, but missed a new flush of weeds that emerged soon after application. Canola yield was lower where 0.35 lb of glufosinate was applied at the cotyledon to 2-leaf stage compared to later applications of that same rate. However, where 0.44 lb was applied at the cotyledon to 2-leaf stage, canola yield was similar to the later applications. The split applications of glufosinate also provided effective weed control.

Timing of weed control in glyphosate-tolerant canola. Brian Jenks, Kent McKay, and Gary Willoughby. (NDSU, North Central Research Extension Center, Minot, ND 58701). Roundup Ready canola (LG3235) was seeded May 3 into 7.5-inch rows at 700,000 pls/A. Herbicide treatments were applied preplant incorporated (Apr 30), early-post (June 1), mid-post (June 7), or late-postemergence (June 11). Individual plots were 10 x 30 ft arranged in a RCBD with three replications. PPI treatments were applied with a CO_2 pressurized bicycle sprayer delivering 20 gpa at 30 psi using XR80015 flat fan nozzles. All postemergence treatments were applied with XR8001 flat fan nozzles delivering 10 gpa at 40 psi. Heavy rains began the night the canola was seeded. We received almost 7 inches of rainfall before the early-post application (June 1). Canola was harvested August 10.

Table. Timing of weed control in glyphosate-tolerant canola.

Treatment[a]	Rate	Timing[b]	June 25 KCHSC	June 25 SET[c]	June 25 CHEAL	June 25 AMARE	July 26 KCHSC	Yield
	lb/A		Control (%)					lb/A
Trifluralin	0.75	A	78	91	100	100	58	1050
Trifluralin / Quizalofop	0.75 / 0.055	A / C	68	98	96	95	60	918
Ethalfluralin	0.75	A	79	97	100	98	68	828
Ethalfluralin / Quizalofop	0.75 / 0.055	A / C	81	99	97	98	73	775
Trifluralin / Glyphosate	0.75 / 0.38	A / C	100	100	100	100	96	1010
Ethalfluralin / Glyphosate	0.75 / 0.38	A / C	100	100	100	100	94	1093
Glyphosate	0.38	B	78	85	87	78	58	1110
Glyphosate	0.38	C	98	98	100	99	90	1206
Glyphosate	0.38	D	100	100	100	100	97	1386
Glyphosate / Glyphosate	0.38 / 0.38	B / D	100	99	100	100	95	1219
Glyphosate / Glyphosate	0.19 / 0.19	B / D	93	100	95	97	85	1330
Handweed Check +			100	100	100	100	96	1100
Trifluralin / Glyphosate	0.75 / 0.38	A / C						
Weedy Check			0	0	0	0	0	611
LSD			6	6	6	6	6	295
CV			4	4	4	4	5	17

[a] All glyphosate treatments included AMS (1%)
[b] A=PPI; B=cotyledon to 2-lf canola; C=3 to 4-lf canola; D=5 to 6-leaf canola
[c] SET=green and yellow foxtail

Flea beetle pressure was extremely high in 1999. The canola seed was treated with Gaucho, but a foliar insecticide application was needed to help reduce the flea beetle pressure. The canola remained in the cotyledon to 2-leaf stage for an extended period due to the flea beetles and wet soil. The Roundup Ready canola emerged before other canola varieties in this same field but was hit hard by the flea beetles and never really looked good the rest of the year.

The objective of this study was to compare weed control from soil-applied products with glyphosate at different rates and timings. The primary weeds were kochia, foxtails, lambsquarters, and pigweed. Other species present were shepherdspurse, field pennycress, and biennial wormwood. Trifluralin and ethalfluralin did not control the mustard species or biennial wormwood, but generally provided good control of kochia, foxtails, lambsquarters, and pigweed. Trifluralin or ethalfluralin followed by a postemergence application of glyphosate was as effective or better than trifluralin or ethalfluralin alone.

Glyphosate was effective at any rate on kochia, foxtails, lambsquarters, redroot pigweed, biennial wormwood, field pennycress, and shepherdspurse. Glyphosate applied only at cotyledon to 2-leaf canola controlled emerged weeds, but missed a new flush of weeds that emerged soon after application. Canola yields were higher with the later application timings compared to the cotyledon to 2-leaf application. The split applications of glufosinate also provided effective weed control.

Wild oat and lambsquarters control with imazamox in imidazolinone-tolerant canola. Brian Jenks and Gary Willoughby. (NDSU, North Central Research Extension Center, Minot, ND 58701). Clearfield canola (45A71) was seeded May 18 into 7.5-inch rows at 700,000 pls/A. Herbicide treatments were applied preplant incorporated (May 17), early-post (June 1), mid-post (June 5), or late-postemergence (June 10). Individual plots were 10 x 30 ft arranged in a RCBD with three replications. PPI treatments were applied with a CO_2 pressurized bicycle sprayer delivering 20 gpa at 30 psi using XR80015 flat fan nozzles. All postemergence treatments were applied with XR8001 flat fan nozzles delivering 10 gpa at 40 psi. Canola was harvested September 9.

Table. Wild oat and lambsquarters control with imazamox in imidazolinone-tolerant canola.

Treatment[a]	Rate	Timing[b]	June 21 AVEFA	June 21 CHEAL	July 26 AVEFA	July 26 CHEAL	Yield
	lb/A		Control (%)				lb/A
Trifluralin	0.75	A	48	57	48	40	575
Trifluralin / Imazamox	0.75 / 0.031	A / D	90	94	96	88	1270
Imazamox / Imazamox	0.016 / 0.016	B / D	98	93	97	82	1511
Imazamox	0.023	C	92	85	89	73	1405
Imazamox	0.031	C	96	87	95	73	1428
Imazamox	0.039	C	98	87	95	75	1567
Imazamox	0.047	C	98	91	97	83	1776
Imazamox	0.023	D	75	73	88	58	1354
Imazamox	0.031	D	86	75	93	65	1229
Imazamox	0.039	D	85	78	93	70	1306
Imazamox	0.047	D	86	84	94	68	1232
Untreated			0	0	0	0	77
LSD			6	10	6	12	340
CV			5	8	4	11	16

[a] Imazamox applied with nonionic surfactant and 28% N.
[b] A=PPI; B=cot to 2-lf canola (Jun 1); C=2 to 3-lf canola, 1-2" weeds (Jun 5); D=4 to 5-lf canola, 4-6" weeds (Jun 10)

Flea beetle pressure was extremely high and definitely slowed canola growth. In addition to the Gaucho-treated seed, we made a foliar insecticide application to help reduce flea beetle pressure. The canola remained in the cotyledon to 2-leaf stage for an extended period due to the flea beetles and wet soil.

Wild oat and lambsquarters densities were very high in this trial as evidenced by the low yield in the untreated check. Trifluralin provided only slight suppression of wild oat and lambsquarters. Imazamox was more effective on smaller wild oat (2 to 3 leaf) than on larger wild oat (5 to 6-leaf). Although imazamox controlled even the large wild oat, the later application time allowed wild oat and lambsquarters to reduce canola yield. Once wild oat was controlled, lambsquarters became much more competitive. Imazamox was weaker on lambsquarters compared to wild oat.

Wild oat control in glufosinate-tolerant canola. Brian Jenks and Gary Willoughby. (NDSU, North Central Research Extension Center, Minot, ND 58701). Liberty Link canola (Invigor 2373) was seeded May 18 into 7.5-inch rows at 700,000 pls/A. Herbicide treatments were applied preplant incorporated (May 17), early-post (June 5), and mid-postemergence (June 11). Individual plots were 10 x 30 ft arranged in a RCBD with three replications. PPI treatments were applied with a CO_2 pressurized bicycle sprayer delivering 20 gpa at 30 psi using XR80015 flat fan nozzles. All postemergence treatments were applied with XR8001 flat fan nozzles delivering 10 gpa at 40 psi.

Due to heavy rains in early May the canola was not seeded until May 18. Flea beetle populations were high and caused significant damage to the canola. We originally planned to apply all postemergence treatments at the same time. However, wild oat pressure was heavy and the plants much larger in the glufosinate alone treatments (30 plants/sq ft, 3-4 leaf wild oat) that we decided to apply them earlier than the other treatments. Other plots had about 10 plants per sq ft and wild oat was about 1-leaf on June 5. We treated the remaining plots on June 11 when wild oat were in the 2 to 3-leaf stage. Glufosinate was more effective on the smaller wild oat compared to the plots where the wild oat density was higher and plants were larger. Increasing the rate of trifluralin above 0.50 lb did not improve weed control or yield. Glufosinate was more effective on lambsquarters than trifluralin or ethalfluralin.

Table. Wild oat control in glufosinate-tolerant canola.

			June 21		July 26		Sept 8
Treatment[a]	Rate	Timing[b]	AVEFA	CHEAL	AVEFA	CHEAL	Yield
	lb/A		Control (%)				lb/A
Untreated			0	0	0	0	391
Glufosinate	0.37	B	76	83	63	75	1215
Glufosinate	0.44	B	77	85	75	77	1296
Trifluralin / Glufosinate	0.50 / 0.26	A / C	91	100	91	93	1401
Trifluralin / Glufosinate	0.50 / 0.37	A / C	97	100	96	94	1592
Trifluralin / Glufosinate	0.50 / 0.44	A / C	98	100	98	97	1457
Trifluralin / Glufosinate	0.75 / 0.26	A / C	97	100	95	96	1265
Trifluralin / Glufosinate	0.75 / 0.37	A / C	100	100	99	98	1426
Trifluralin / Glufosinate	0.75 / 0.44	A / C	100	100	95	90	1418
Trifluralin / Glufosinate	1.0 / 0.37	A / C	98	100	93	90	1325
Trifluralin / Sethoxydim	0.75 / 0.07	A / C	99	83	97	67	1246
Ethalfluralin / Glufosinate	0.75 / 0.44	A / C	100	100	100	97	1344
Ethalfluralin / Sethoxydim	0.75 / 0.07	A / C	99	82	100	73	1460
LSD			10	9	11	14	462
CV			7	6	8	11	21

[a] All glufosinate treatments included AMS (3 lb/A), sethoxydim applied with 2.5% MSO (Dash)

[b] A=PPI; B=coty to 2-leaf canola; C=3-leaf canola

Broadleaf weed control and crop tolerance in imidazolinone-resistant canola. Traci A. Rauch and Donald C. Thill. (Plant Science Division, University of Idaho, Moscow, ID 83844-2339) Three studies in 'Pioneer 45A71' imidazolinone-resistant (Clearfield™) canola were established on the University of Idaho Plant Science Farm near Moscow, Idaho. In experiment one, broadleaf weed control and canola response to imazamox was examined. Plots were 8 by 21 ft arranged in a randomized complete block with four replications. Experiment two examined broadleaf weed control and canola for cross resistance to sulfonylurea herbicides. Plots were 8 by 20 ft arranged in a randomized complete block with four replications. In experiment three, crop response of imidazolinone-resistant canola compared to 'Sunrise' canola at low rates of imazethapyr was examined. The experimental design was a strip plot. Main plots were two canola varieties, 'Sunrise' and imidazolinone–resistant, (10.5 by 48 ft) and five herbicide treatments plus an untreated check (8 by 10.5 ft) were the sub-plots. Herbicide treatments were 1.5, 3, 6, 12.5 and 25 % of the labeled rate of imazethapyr (0.047 lb/A) used in pea and lentil crops and were applied preplant incorporated. All herbicide treatments were applied with a CO_2 pressurized backpack sprayer calibrated to deliver 10 gpa at 30 psi and 3 mph (Table 1). Canola injury for experiment three was evaluated visually on May 14, June 4, and 24, 1999; and experiments one and two on June 9 and 24, 1999. Canola flowering was evaluated visually on May 24, 1999 in experiment two. Weed control for experiment one and two was evaluated visually on June 30, 1999. Canola seed was harvested with a small plot combine from a 4 by 18 (experiment one), 4 by 17 (experiment two), and 4 by 7.5 (experiment three) ft area in each plot on August 27, 1999.

Table 1. Application data.

		Experiment one	Experiment two	Experiment three
Application date		June 4, 1999	May 26, 1999	April 24, 1999
Planting date		April 24, 1999	April 24, 1999	April 24, 1999
Application timing		Postemergence	Postemergence	Preplant incorporated
Canola growth stage		3 to 4 leaf	2 to 3 leaf	–
Mayweed chamomile growth stage		½ to 1 in. diameter	cotyledon	--
Wild oat growth stage		3 to 4 leaf	1 to 2 leaf	--
Air temp (F)		62	70	40
Relative humidity (%)		68	38	64
Wind (mph, direction)		0-2, NE	1, W	0
Cloud cover (%)		50	0	0
Soil temperature at 2 in (F)		55	75	48
pH	4.9			
OM (%)	4.5			
CEC (meq/100g)	39.8			
Texture	clay loam			

In experiment one, no treatment injured canola (data not shown). All rates of imazamox controlled mayweed chamomile (ANTCO) and wild oat (AVEFA) 94% or better (Table 2). Seed yield for canola treated with imazamox at 0.024, 0.032, and 0.080 lb/A rates 25% greater than the untreated check.

In experiment two, all rates of thifensulfuron + quizalofop and thifensulfuron/tribenuron + quizalofop injured canola 14 to 18 and 16 to 20%, respectively, on June 9, 1999 (Table 3). All nicosulfuron treatments injured canola 5%. By June 24, 1999, no injury was visible in any treatment. Canola injury delayed flowering. All thifensulfuron + quizalofop and thifensulfuron/tribenuron + quizalofop treatments suppressed canola flowering 28 to 50 and 40 to 50%, respectively, compared to the untreated check. All herbicide treatments controlled mayweed chamomile and wild oat 94% or better. All rates of thifensulfuron + quizalofop and the highest rate of thifensulfuron/tribenuron + quizalofop reduced canola seed yield 16 to 28% compared to the untreated check.

In experiment three, no treatment injured either variety of canola at any evaluation date (data not shown). The interaction (herbicide treatment by canola variety) and the main effect (herbicide treatment) were not significant for canola seed yield (Table 4). Seed yield, averaged over herbicide treatment, for 'Sunrise' and imidazolinone-resistant canola was 1512 and 1099 lb/A, respectively. 'Sunrise' canola likely was not injured by imazethapyr due to moderate rainfall (1.75 in.) and warm temperatures (average high 63 F) for 30 days after planting. The optimal weather allowed the canola roots to grow through the imazethapyr-treated soil with minimal herbicide uptake. In the same experiment in 1998, imazethapyr injured 'Legend' canola, a non-imidazolinone-resistant variety (1999 WSWS Research Progress Report, p.128-129). 'Legend' injury and stand reduction from imazethapyr likely were enhanced by slow growth due to waterlogging (5 in. of precipitation) and a hailstrom in the 30 days following seeding.

Table 2. Weed control and canola seed yield in experiment one.

Treatment[a]	Rate	Weed control ANTCO	Weed control AVEFA	Canola yield
	lb/A	%	%	lb/A
Imazamox	0.024	94	99	1497
Imazamox	0.032	94	99	1452
Imazamox	0.040	98	98	1281
Imazamox	0.048	96	99	1332
Imazamox	0.080	95	99	1416
Untreated check	–	--	--	1168
LSD (0.05)		NS	NS	218
Plants/ft^2		11	3	

[a]All treatments were applied with 32% UAN (urea ammonium nitrate) at 1 quart/A and 90% NIS (nonionic surfactant) at 0.25% v/v.

Table 3. Canola injury, flowering, seed yield, and weed control in experiment two.

Treatment[a]	Rate	Canola injury[b]	Canola flowering[c]	Canola yield	Weed control ANTCO	Weed control AVEFA
	lb/A	%	%	lb/A	%	%
Thifensulfuron + quizalofop	0.016 + 0.05	14	72	1230	99	99
Thifensulfuron + quizalofop	0.023 + 0.05	18	50	1442	98	98
Thifensulfuron + quizalofop	0.031 + 0.05	18	50	1274	99	99
Thifen/triben + quizalofop	0.013 + 0.05	20	58	1583	99	99
Thifen/triben + quizalofop	0.016 + 0.05	19	60	1513	98	99
Thifen/triben + quizalofop	0.019 + 0.05	16	50	1361	98	99
Nicosulfuron	0.023	5	100	1694	99	94
Nicosulfuron	0.031	5	100	1833	99	94
Nicosulfuron	0.046	5	98	1593	99	95
Untreated check	--	--	100	1719	--	–
LSD (0.05)		5	17	267	NS	2
Plants/ft^2					4	2

[a]Thifen/triben is the commercial formulation of thifensulfuron/tribenuron. All treatments were applied with 90% NIS (nonionic surfactant) at 0.25% v/v.
[b]June 9, 1999 evaluation date.
[c]June 24, 1999 evaluation date.

Table 4. Canola seed yield in experiment three.

Treatment	Rate	% of label rate[b]	Canola variety[a]	Canola yield
	lb/A			lb/A
Imazethapyr	0.0007	1.5	Imi	1058
Imazethapyr	0.0015	3	Imi	1158
Imazethapyr	0.0029	6	Imi	1123
Imazethapyr	0.0059	12.5	Imi	1248
Imazethapyr	0.0118	25	Imi	1043
Untreated check	–	-	Imi	966
Imazethapyr	0.0007	1.5	Sunrise	1387
Imazethapyr	0.0015	3	Sunrise	1440
Imazethapyr	0.0029	6	Sunrise	1568
Imazethapyr	0.0059	12.5	Sunrise	1581
Imazethapyr	0.0118	25	Sunrise	1623
Untreated check	--	--	Sunrise	1461
LSD (0.05)				NS

[a]Imi = imidazolinone-resistant canola.
[b]Labeled rate of imazethapyr in pea and lentil (0.047 lb/A).

Weed control and crop response to herbicides in chickpea production. Joseph P. Yenish and Pete Schneider. (Washington State University, Pullman, WA 99164-6420) Chickpeas are an important rotational crop in dryland agriculture in the Pacific Northwest. There are few herbicides labeled for use in the production of grain legumes. This study was conducted to determine what herbicides could be developed for use in chickpea production comparing them to currently labeled herbicides. The study was done at the Washington State University Cunningham Farm located near Pullman.

Preplant incorporated treatments (PPI) of imazethapyr and sulfentrazone effectively controlled common lambsquarters throughout the season. Both rates of flufenacet plus metribuzin gave acceptable early season control of common lambsquarters, but the control level was reduced by the end of the season.

The POST treatment of pyridate provided season long control of common lambsquarter. However, applications of fomesafen and flumiclorac did not provide the same long-term level of control. The reduced control of these two treatments was due to significant chickpea injury which reduced the ability of the crop to suppress late-emerging weeds.

All PPI treatments gave greater chickpea yields than the weedy check except the higher rate of flufenacet plus metribuzin and flumetsulam. None of the POST treatments had significantly greater chickpea yield than the weedy check. Yields were reduced with fomesafen and flumiclorac because of crop injury. Likely, yields were not greater with pyridate due to the competitive impact of the weeds on the crop prior to control by the herbicide application. Yield differences were statistically different, but random variability was great.

Table. Weed control in conventionally-tilled chickpeas.

			Control		Chickpeas	
			Common lambsquarters		Injury	Yield
Name	Rate	Appl. timing	6/21/99	8/19/99	6/21/99	9/2/99
	lb/A		%			lbs/A
Weedy check			0	0	0	525
Imazethapyr	0.047	PPI	85	71	0	865
Sulfentrazone	0.375	PPI	91	85	4	875
Sulfentrazone	0.25	PPI	91	85	1	985
Flufenacet + metribuzin	0.4 + 0.1	PPI	51	21	6	665
Flufenacet + metribuzin	0.3 + 0.075	PPI	86	52	0	865
Flumetsulam	0.055	PPI	57	31	2	620
Fomesafen	0.25	POST	60	13	64	470
Flumiclorac	0.04	POST	71	41	24	610
Pyridate	0.94	POST	89	82	3	690
LSD (p=0.05)			23	26	15	325

Broadleaf weed control in field corn with postemergence herbicides. R.N. Arnold and Dan Smeal. (New Mexico State University Agricultural Science Center, Farmington, NM 87499) Research plots were established on May 10, 1999 at the Agricultural Science Center, Farmington, New Mexico to evaluate the response of field corn (var. Pioneer 34K77) 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. 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 May10. The preemergence treatment was applied on May 11 and immediately incorporated with 0.75 in of sprinkler applied water. Postemergence treatments were applied on June 1 when corn was in the 4[th] leaf stage and weeds were small. Black nightshade infestations were heavy and redroot and prostrate pigweed, common lambsquarters infestations were moderate and Russian thistle infestations were light throughout the experimental area. The preemergence treatment was evaluated on June 14 and postemergence treatments on July 1.

Nicosulfuron plus rimsulfuron plus atrazine (pm) plus dicamba plus diflufenzopyr applied at 0.78 plus 0.263 lb/A caused the highest injury rating of 3. All treatments except the check gave excellent control of broadleaf weeds.

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

Treatment[a]	Rate	Corn injury	Weed control AMARE	AMABL	SOLNI	SASKR	CHEAL
	lb/A	%					
Clopyralid +flumetsulam + nicosulfuron[b] (pm)	0.152	0	100	100	100	100	100
Nicosulfuron + rimsulfuron + atrazine[b] (pm)	0.78	0	100	100	100	100	100
Dicamba + nicosulfuron (Co-Pack)	0.0313+0.262	0	100	100	100	100	100
Dicamba + nicosulfuron (Co-Pack)	0.0313+0.175	0	100	100	100	100	100
Diflufenzopyr + dicamba (pm) + nicosulfuron	0.263+0.016	2	100	100	100	100	100
Nicosulfuron + rimsulfuron + atrazine (pm) + diflufenzopyr + dicamba	0.78+0.175	0	100	100	100	100	100
Nicosulfuron + rimsulfuron + atrazine (pm) + diflufenzopyr + dicamba	0.78+0.263	3	100	100	100	100	100
Nicosulfuron + rimsulfuron + atrazine (pm) + dicamba	0.78+0.125	0	100	100	100	100	100
Nicosulfuron + rimsulfuron + atrazine (pm) + dicamba	0.78+0.25	0	100	100	100	100	100
Nicosulfuron + rimsulfuron + atrazine (pm) + pyridate[b]	0.78+0.47	2	100	100	100	100	100
Nicosulfuron + rimsulfuron + atrazine (pm) + dicamba + atrazine (pm)	0.78+0.4	0	100	100	100	100	100
Nicosulfuron + rimsulfuron + atrazine (pm) + dicamba + atrazine (pm)	0.78+0.8	2	100	100	100	100	100
Diflufenzopyr + dicamba (pm) + atrazine	0.175+0.7	0	100	100	100	100	100
Diflufenzopyr + dicamba (pm) + atrazine	0.263+0.7	0	100	100	100	100	100
Atrazine[c]		0	100	100	100	100	100
Weedy check		0	0	0	0	0	0
LSD 0.05		1	1	1	1	1	1

[a] pm = packaged mix.
[b] Treatments applied with COC and 32-0-0 at 1% v/v.
[c] Treatment applied preemergence.

Broadleaf weed control in field corn with preemergence herbicides. R. N. Arnold and Dan Smeal. (New Mexico State University Agricultural Science Center, Farmington, NM 87499) Research plots were established on May 10, 1999 at the Agricultural Science Center, Farmington, New Mexico to evaluate the response of field corn (var. Pioneer 34K77) 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 10. Treatments were applied on May 11and immediately incorporated with 0.75 in of sprinkler applied water. Black nightshade, common lambsquarters, and prostrate pigweed infestations were heavy and redrood pigweed infestations were moderate and Russian thistle infestations were light throughout the experimental area. Evaluations were made on June 14.

Flufenacet plus isoxaflutole (pm) applied at 0.254 lb/A had the highest injury rating of 4. All treatments except the check gave excellent control of common lambsquarters. Black nightshade, redroot and prostrate pigweed, and Russian thistle control were excellent with all treatments except flufenacet plus metribuzin (pm) applied at 0.34 lb/A and the check.

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

Treatment[a]	Rate	Corn injury	Weed control				
			CHEAL	AMARE	AMABL	SOLNI	SASKR
	lb/A	%					
Flufenacet + metribuzin	0.34	3	100	87	83	33	100
Flufenacet + metribuzin (pm) + atrazine	0.17+0.78	0	100	100	100	100	100
Flufenacet + metribuzin (pm) + isoxaflutole	0.17+0.0234	3	100	100	100	100	100
Flufenacet + isoxaflutole (pm)	0.181	0	100	100	100	100	100
Flufenacet + isoxaflutole (pm) + atrazine	0.181+0.78	0	100	100	100	100	100
Flufenacet + isoxaflutole (pm)	0.218	0	100	100	100	100	100
Flufenacet + isoxaflutole (pm) + atrazine	0.218+0.78	2	100	100	100	100	100
Flufenacet + isoxaflutole (pm)	0.254	4	100	100	100	100	100
Flufenacet + isoxaflutole (pm) + atrazine	0.254+0.78	3	100	100	100	100	100
Flufenacet + metribuzin (pm) + isoxaflutole	0.17+0.0314	3	100	100	100	100	100
Flufenacet + metribuzin (pm) + flufenacet + isoxaflutole (pm)	0.17+0.145	0	100	100	100	100	100
Isoxaflutole + atrazine	0.047+0.78	3	100	100	100	100	100
Dimethenamid + atrazine (pm)	2.2	0	100	100	100	100	100
S-metolachlor + atrazine (pm)	1.9	0	100	100	100	100	100
Atrazine	1.5	0	100	100	100	100	100
Weedy check		0	0	0	0	0	0
LSD 0.05							

[a] pm = packaged mix

Broadleaf weed control in field corn with preemergence followed by postemergence herbicides. R.N. Arnold and Dan Smeal. (New Mexico State University Agricultural Science Center, Farmington, NM 87499) Research plots were established on May 10, 1999 at the Agricultural Science Center, Farmington, New Mexico to evaluate the response of field corn (var. Pioneer 34K77) and annual broadleaf weeds to preemergence followed by postemergence herbicides. Soil type was a Wall sandy loam with a pH of 7.8 and an organic matter content 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 10. Preemergence treatments were applied on May 11 and immediately incorporated with 0.75 in of sprinkler applied water. Postemergence treatments were applied on June 1 when corn was in the 4th leaf stage and weeds were small. Black nightshade and common lambsquarters infestations were heavy, redroot and prostrate pigweed infestations were moderate and Russian thistle infestations were light throughout the experimental area. The preemergence treatment was evaluated on June 14 and postemergence treatments on July 1.

S-dimethenamid applied preemergence at 0.53 lb/A followed by a postemergence treatment of diflufenzopyr plus dicamba (pm) plus atrazine at 0.263 plus 0.5 lb/A had the highest injury rating of 9. Black nightshade, redroot and prostrate pigweed, and common lambsquarters control were excellent with all treatments except the check. Russian thistle control were good to excellent with all treatments except S-dimethenamid and S-metolachlor applied preemergence at 0.53 and 1.0 lb/A followed by a postemergence treatment of flumetsulam at 0.05 lb/A and the check.

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

Treatment[a]	Rate	Corn injury	Weed control: AMARE	AMABL	SOLNI	CHEAL	SASKR
	lb/A	%					
S-metolachlor + atrazine (pm)/ clopyralid + flumetsulam[b] (pm)	2.3/0.086	3	100	100	100	100	100
S-metolachlor + atrazine (pm)/ clopyralid + flumetsulam[b] (pm) + atrazine	2.3/0.086+1.25	0	100	100	100	100	100
S-metolachlor/ clopyralid + flumetsulam[b] (pm) + atrazine	1.0/0.086+1.25	0	100	100	100	100	83
S-dimethenamid/ clopyralid + flumetsulam[b] (pm) + atrazine	0.53/0.086+1.25	2	100	100	100	100	82
Dimethenamid + atrazine/ (pm) + clopyralid + flumetsulam[b] (pm) + atrazine	2.1/0.086+1.25	4	100	100	100	100	100
Dimethenamid + atrazine (pm)/ clopyralid + flumetsulam[b] (pm)	2.1/0.086	5	100	100	100	100	100
S-dimethenamid/ diflufenzopyr + dicamba[c] (pm)	0.53/0.263	5	100	100	100	100	100
Dimethenamid + atrazine (pm)/ diflufenzopyr + dicamba[c] (pm)	2.1/0.263	2	100	100	100	100	100
S-dimethenamid/ atrazine + dicamba[c] (pm)	0.53/0.8	4	100	100	100	100	100
S-dimethenamid/ Diflufenzopyr + dicamba[c] (pm) + atrazine	0.53/0.263+0.5	9	100	100	100	100	100
S-metolachlor + atrazine (pm)/ flumetsulam	2.3/0.05	0	100	100	100	100	100
S-metolachlor/flumetsulam	1.0/0.05	0	100	100	100	100	47
Dimethenamid + atrazine (pm)/ flumetsulam	2.1/0.05	4	100	100	100	100	100
S-dimethenamid/flumetsulam	0.53/0.05	5	100	100	100	100	47
Atrazine[d]	1.5	0	100	100	100	100	100
Weedy check		0	0	0	0	0	0
LSD 0.05		1	1	1	1	1	16

[a] pm = packaged mix.
[b] COC added at 1% v/v.
[c] NIS plus 32-0-0 added at 0.25% and 1.25%.
[d] Treatment applied preemergence.

Preemergence weed control in field corn. R.N. Arnold and Dan Smeal. (New Mexico State University Agricultural Science Center, Farmington, NM 87499) Research plots were established on May 10, 1999 at the Agricultural Science Center, Farmington, New Mexico to evaluate the response of field corn (var. Pioneer 34K77) 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 10. Treatments were applied on May 11 and immediately incorporated with 0.75 in of sprinkler applied water. Black nightshade and redroot and prostrate pigweed infestation were heavy and Russian thistle and common lambsquarters infestations were light throughout the experimental area. Evaluations were made on June 14.

Dimethenamid applied at 1.2 lb/A had the highest injury rating of 5. All treatments except the check gave good to excellent control of black nightshade, redroot and prostrate pigweed , and common lambsquarters. Russian thistle control was good to excellent with all treatments except acetochlor, S-metolachlor, and S-dimethenamid applied at 1.6, 1.25, and 0.5 lb/A and the check.

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

Treatment[a]	Rate	Corn injury	Weed control				
			AMARE	AMABL	SOLNI	SASKR	CHEAL
	lb/A	%					
Acetochlor + atrazine (pm)	2.5	0	100	100	100	100	100
Acetochlor + atrazine (pm)	2.25	0	100	100	100	100	100
Acetochlor	1.2	0	100	98	100	93	100
Acetochlor	1.6	0	100	99	100	70	98
S-metolachlor	0.94	0	100	100	100	100	98
Dimethenamid + atrazine (pm)	2.4	0	100	100	100	100	100
Dimethenamid + atrazine (pm)	2.2	0	100	100	100	100	100
Dimethenamid	0.9	0	100	100	100	100	100
Dimethenamid	1.2	5	100	100	100	99	100
S-dimethenamid	0.5	0	100	100	100	47	89
S-dimethenamid	0.66	0	100	100	100	100	100
S-metolachlor + atrazine (pm)	2.4	0	100	100	100	100	100
S-metolachlor + atrazine (pm)	2.7	0	100	100	100	100	100
S-metolachlor	1.25	0	100	99	97	65	99
Atrazine	1.5	0	100	100	100	100	100
Weedy check		0	0	0	0	0	0
LSD 0.05		1	1	1	1	12	1

[a] pm = packaged mix.

Annual weed control in corn using thiafluamide tank mixes. John O. Evans, William S. Rigby and R. William Mace. (Department of Plants, Soils and Biometeorology, Utah State University, Logan, Utah 84322-4820) Preemergence treatments of thiafluamide and isoxaflutole, alone or in combination with other herbicides were applied to Dekalb 656 field corn for common purslane (POROL) control on the USU Animal Science farm in Wellsville, UT. The soil type was Nibley silty clay loam with 7.6 pH and an O.M. content of less than 2%. Treatments were established May 22, 1999 five days after the corn was planted. Treatments were applied in a randomized block design, with three replications of 10 by 30 foot plots with a CO_2 backpack sprayer using flatfan 8002 nozzles providing a 10 foot spray width calibrated to deliver 25 gpa at 39 psi. Visual weed control evaluations were recorded June 29 and July 28. Plots were harvested September 24.

All treatments gave excellent control of purslane in corn. There were no visible signs of injury to the corp at either evaluation date. Similarly, yields were very consistent between all treatments with no measurable differences. (Utah Agricultural Experiment Station, Logan, UT. 84322-4820)

Table. Evaluation of thiafluamide for preemergent annual weed control in corn.

		Corn			Weed Control	
		injury		Yield	POROL	
Treatment	Rate	6/29	7/29	9/28	6/29	7/29
	lb ai/A	—%—		T/A	—%—	
Check		0	0	22.5	0	0
Thiafluamide/metrabuzin	0.54	0	0	22.1	100	100
Thiafluamide/isoxaflutole/metribuzin	0.18	0	0	24.9	98	100
Thiafluamide/isoxaflutole/metribuzin	0.22	0	0	24.7	100	100
Thiafluamide/isoxaflutole/metribuzin	0.26	0	0	23.6	100	100
Thiafluamide/isoxaflutole/metribuzin+	0.22+	0	0	22.2	100	100
atrazine	0.75					
Metolachlor/atrazine	2.66	0	0	23.1	100	100
Isoxaflutole	0.94	0	0	23.5	100	100
LSD(0.05)		0	0	5.3	1.8	NA

Isoxaflutole controls purslane in field corn. John O. Evans, William S. Rigby and R. William Mace. (Department of Plants, Soils and Biometeorology, Utah State University, Logan, Utah 84322-4820) Preemergence treatments of isoxaflutole, alone or in combination with other herbicides were applied to Dekalb 656 field corn for common purslane (POROL) control. The trial was established on the USU Animal Science farm on a Nibley silty clay loam soil with 7.6 pH and an O.M. content of less than 2%. Treatments were applied May 22, 1999 five days after corn planting and were arranged in a randomized block design, with three replications. Individual treatment size was 10 by 30 foot. Plots were treated with a CO_2 backpack sprayer using flatfan 8002 nozzles providing a 10 foot spray width calibrated to deliver 25 gpa at 39 psi. Visual weed control evaluations were recorded June 29 and July 28. Plots were harvested September 24.

Injury was not observed with any treatment. Excellent control of purslane was recorded with all treatments and corn yields were not significantly different among treatments. (Utah Agricultural Experiment Station, Logan, UT. 84322-4820)

Table. Isoxaflutole controls purslane in field corn.

		Corn			Weed Control	
		injury		Yield	POROL	
Treatment	Rate	6/29	7/29	9/28	6/29	7/29
	oz ai/A	——%——		T/A	——%——	
Isoxaflutole	0.75	0	0	20.4	100	100
Isoxaflutole	0.94	0	0	22.1	100	100
Isoxaflutole+ atrazine	0.94+ 16	0	0	24.7	100	100
Isoxaflutole+ acetochlor	0.94+ 18.2	0	0	21.9	100	100
Isoxaflutole+ acetochlor/atrazine	0.94+ 15.12	0	0	26.0	100	100
Isoxaflutole+ thiafluamide/metribuzin	0.94+ 6.4	0	0	26.8	100	100
Isoxaflutole+ metolachlor	0.94+ 24	0	0	21.5	100	100
Isoxaflutole+ dimethanamide	0.94+ 18	0	0	22.2	100	100
Isoxaflutole+ alachlor	0.94+ 10.1	0	0	23.9	100	100
Acetochlor	16	0	0	19.7	100	100
Untreated		0	0	24.9	0	0
LSD(0.05)		0	0	5.1	NA	NA

Evaluation of RPA 201772 in no-till, dryland corn. Patrick W. Geier and Phillip W. Stahlman. (Kansas State University Agricultural Research Center, Hays, KS 67601). An experiment was conducted at Colby, KS in 1999 to evaluate the efficacy of crop response to RPA 201772 alone and in tank mixtures in dryland, no-till corn. Soil was Keith silt loam with pH 6.5 and 1.2% organic matter. 'Pioneer 9935IR' corn was seeded 1.5 inches deep on May 6 in rows spaced 30 inches apart at 19,800 kernels/A. Seasonal precipitation (May through September) totaled 17.9 inches. The experiment was a randomized complete block with four replicates and plots were 10 by 32 ft. All herbicides were applied PRE on May 7 using a tractor-mounted compressed-air plot sprayer delivering 12 gpa at 24 psi and 3.0 mph.

Kochia control ranged from 93 to 100% at 62 days after treatment (DAT), with RPA 201772 alone at either rate or with acetochlor being slightly less efficacious than other treatments (Table 1). All treatments provided excellent (95% or more) control of Russian thistle, tumble pigweed, and redroot pigweed at 62 DAT, though control of these species tended to be lower with RPA 201772 alone. Control of longspine sandbur was poor with most treatments; only EXP 31130A plus acetochlor & atrazine provided better than 70% control. Most treatments caused minor corn stunting at 40 DAT (Table 2), but injury did not persist. Herbicide-treated corn yielded 56 to 81 bu/A more than untreated corn (63.9 bu/a), and corn receiving RPA 201772 at 0.09 lb/A alone outyielded corn treated with RPA 201772 plus acetochlor or flufenacet & metribuzin. Grain from untreated corn was 1.5 to 3.5% wetter at harvest than herbicide-treated corn. Likewise, test weight from untreated corn was 1.9 to 2.4 lb/bu heavier than herbicide-treated corn.

Table 1. Weed control with RPA 201772 in dryland, no-till corn.[a]

Treatment	Rate	KCHSC	SASKR	AMAAL	AMARE	CCHPA
	(lb/A)			(%)		
RPA 201772	0.07	93	99	96	95	45
RPA 201772	0.09	96	100	96	96	65
RPA 201772+atrazine	0.07+1.5	100	100	98	100	65
RPA 201772+atrazine	0.09+1.5	100	100	100	100	68
RPA 201772+acetochlor	0.09+1.6	97	100	98	97	58
RPA 201772+acetochlor&atrazine[b]	0.09+1.2&0.8	100	100	99	100	75
RPA 201772+flufenocet&metribuzin	0.09+0.38&0.08	98	100	100	98	58
RPA 201772+atrazine&S-metolachlor	0.07+0.67&0.83	100	100	100	100	55
RPA 201772&flufenacet	0.08&0.36	99	100	100	98	40
LSD (0.05)		3	<1	3	4	20

[a] Weed control values are at 62 days after treatment.
[b] Microencapsulated formulation of acetochlor

Table 2. Effects of EXP 31130A in dryland, no-till corn.

Treatment	Rate	Stunting[a]	Yield	Moisture	Test weight
	(lb/A)	(%)	(bu/A)	(%)	(lb/bu)
RPA 201772	0.07	8	125.5	14.9	57.1
RPA 201772	0.09	5	144.5	15.6	57.1
RPA 201772+atrazine	0.07+1.5	8	129.1	15.6	56.8
RPA 201772+atrazine	0.09+1.5	10	139.1	16.2	56.8
RPA 201772+acetochlor	0.09+1.6	11	121.2	16.0	57.0
RPA 201772+acetochlor&atrazine[b]	0.09+1.2&0.8	10	130.6	16.3	57.3
RPA 201772+flufenocet&metribuzin	0.09+0.38&0.08	10	119.9	16.9	57.3
RPA 201772+atrazine&S-metolachlor	0.07+0.67&0.83	10	136.0	16.2	56.8
RPA 201772&flufenacet	0.08&0.36	8	127.6	15.6	57.0
Untreated	--	0	63.9	18.4	59.2
LSD (0.05)		6	20.8	1.3	1.1

[a] Stunting is a visual estimate at 40 days after treatment.
[b] Microencapsulated formulation of acetochlor.

Evaluation of transgenic no-till corn. Patrick W. Geier and Phillip W. Stahlman. (Kansas State University Agricultural Research Center, Hays, KS 67601). An experiment was conducted near Colby, KS in 1999 to compare the efficacy of PRE and POST applications in glufosinate-resistant, imidazolinone-tolerant, dryland corn. Soil was a Keith silt loam with pH 6.5 and 1.2% organic matter. 'Garst 8540 LL/IT' corn was seeded 1.5 inches deep on May 7. The seeding rate was 19,800 kernels/A in rows spaced 30 inches apart. Growing season precipitation (May through September) totaled 17.9 inches. The experimental design was a randomized complete block with four replicates. Plots were 10 by 32 ft. Details on applications, environmental conditions, and plants are listed below.

Date	May 12	May 27	Jun 10
Treatment	PRE	EPOST	POST
Sprayer			
gpa	12	12	12
psi	24	24	24
Temperature (C)			
Air	17	22	20
soil (2 inch)	12	16	24
Soil moisture	moist	moist	moist
Wind (mph)	2-5 SW	3-4 E	calm
Sky cloudy	clear	p. cloud	cloudy
Relative humidity (%)	54	50	52
Corn			
leaf no.	-	spike	5-6
height (inch)	-	1-1.5	11-14
Kochia			
leaf no.	-	cotyl	10-30
height (inch)	-	<1	2-8
Infestation	-	15/m^2	30/m^2
Longspine Sandbur			
leaf no.	-	-	8-10
height (inch)	-	-	1-3
Infestation	-	-	20/m^2
Russian thistle			
leaf no.	-	Cotyl	10-30
height (inch)	-	<1	4-6
infestation	-	1/m^2	1-2/m^2

On June 16, all PRE and EPOST herbicide treatments controlled kochia 93 to 100%, as did the POST treatments of glufosinate plus AMS following either RPA 201772 or pendimenthalin (Table 1). By July 8, all treatments provided at least 89% kochia control. Longspine sandbur was controlled 91% on June 16 with imazethapyr & imazapyr with COC and UAN, and 95% by imazethapyr & imazapyr with flufenacet & metribuzin plus NIS and UAN. However, by July 8, only the tank mix and premix of glufosinate with atrazine plus AMS provided better than 80% sandbur control. All treatments provided complete control of Russian thistle (data not shown). Corn receiving herbicide treatments yielded 101 to 145 bu/A, compared to 61 bu/A for untreated corn (Table 2). Corn receiving most EPOST or POST treatments outyielded PRE- treated corn; the exception to this being the premix of glufosinate & atrazine with AMS. Test weights of harvested grain were lower for herbicide-treated corn than for untreated corn, except when pendimethalin plus RPA 201772 was applied PRE.

Table 1. Weed control in transgenic no-till corn.

Treatment [a]	Rate	Timing	Kochia 6/16	Kochia 7/8	Longspine sandbur 6/16	Longspine sandbur 7/8
	(lb/A)					
Pendametholin+atrazine	1.0+1.0	PRE	100	100	68	40
Pendametholin+RPA 201772	1.0+0.05	PRE	97	91	83	45
Pendametholin+RPA 201772+atrazine	0.8+0.05+0.75	PRE	100	100	80	48
RPA 201772+atrazine	0.05+0.75	PRE	99	100	85	53
Imazethapyr&imaxapyr+COC+UAN	0.05&0.02+1%+2qt	EPOST	93	89	91	75
Imep&impr+diflufeuacet&dicamba+NIS+UAN	0.05&0.02+0.03+0.09+0.25%+2qt	EPOST	100	99	95	76
RPA 201772/glufosinate+AMS	0.06/0.44	PRE/POST	100	99	79	60
Pendamethalin/flufosinate+AMS	1.0/0.37+3.0	PRE/POST	94	93	80	58
Glufosinate+atrazine+AMS	0.44+1.0+3.0	POST	75	100	63	82
Glufosinate&atrazine+AMS	0.37+1.2+3.0	POST	74	100	69	84
LSD (0.05)			7	5	15	16

[a] Imep = imazethapyr; impr = imazapyr; COC = crop oil concentrate; UAN = 28% urea ammonium nitrate; NIS = activator 90; AMS = ammonium sulfate.

Table 2. Yield components in transgenic corn.

Treatment [a]	Rate	Timing	Yield	Tests weight
	(lb/A)		bu/A	lb/bu
Pendametholin+atrazine	1.0+1.0	PRE	120.2	57.8
Pendametholin+RPA 201772	1.0+0.05	PRE	100.9	59.3
Pendametholin+RPA 201772+atrazine	0.8+0.05+0.75	PRE	119.6	57.7
RPA 201772+atrazine	0.05+0.75	PRE	121.7	58.1
Imazethapyr&imaxapyr+COC+UAN	0.05&0.02+1%+2qt	EPOST	126.0	58.1
Imep&impr+diflufeuacet&dicamba+NIS+UAN	0.05&0.02+0.03+0.09+0.25%+2qt	EPOST	145.4	57.8
RPA 201772/glufosinate+AMS	0.06/0.44	PRE/POST	134.0	57.6
Pendamethalin/flufosinate+AMS	1.0/0.37+3.0	PRE/POST	127.2	57.7
Glufosinate+atrazine+AMS	0.44+1.0+3.0	POST	125.8	57.8
Glufosinate&atrazine+AMS	0.37+1.2+3.0	POST	119.9	57.3
Untreated	—	—	60.7	59.4
LSD (0.05)			22.9	1.2

[a] Imep = imazethapyr; impr = imazapyr; COC = crop oil concentrate; UAN = 28% urea ammonium nitrate; NIS = activator 90; AMS = ammonium sulfate.

Sweet corn tolerance to s-dimethenamid. Bradley D. Hanson, Bill D. Brewster, and Carol Mallory-Smith. (Department of Crop and Soil Science, Oregon State University, Corvallis, OR 97331-3002) Two field trials were established at the Hyslop Research Farm near Corvallis, OR to determine the effects of s-dimethenamid on growth and yield of sweet corn. Effects on 'Jubilee' and 'Super Sweet Jubilee' sweet corn varieties were examined in separate experiments. Both varieties of sweet corn were seeded in 30-inch rows on June 8, 1999. Individual plots in each experiment were 10 by 35 ft arranged in a randomized complete block with four replications. Herbicide treatments were applied preemergence with a single-wheel, compressed-air, plot sprayer calibrated to deliver 20 gpa at 19 psi and 3 mph (Table 1). The experiments were over-sprayed with atrazine at 0.5 lb/A to control weeds on June 9, 1999. Sweet corn yield was determined by harvesting the primary ears from 24 feet of the middle two rows in each plot on September 16, 1999.

Table 1. Application data.

Variety	'Jubilee'	'Super Sweet Jubilee'
Application date	June 8, 1999	June 9, 1999
Air temp (F)	64	46
Soil temp (F)	65	50
RH (%)	70	72
Cloud cover (%)	100	0
Soil texture	Silt loam	Silt loam
Organic matter (%)	2.0	2.8
pH	5.4	6.4

'Jubilee' sweet corn was injured 6% or less at both ratings; ear yield was not significantly different among treatments (Table 2). 'Super Sweet Jubilee' was injured at least 35% by all herbicide treatments. Although injury symptoms diminished throughout the season, all herbicide treatments reduced ear yield of 'Super Sweet Jubilee'.

Table 2. Sweet corn injury and ear yield following preemergence herbicide applications.

Treatment	Rate	Jubilee			Super Sweet Jubilee		
		injury			injury		
		June 23, 1999	Aug. 23, 1999	yield	June 23, 1999	Aug. 23, 1999	yield
	lb/A	%		ton/A	%		ton/A
Atrazine check	--	0	0	7.4	0	0	6.0
Dimethenamid	2.34	5	6	6.5	53	50	3.0
S-dimethenamid	0.64	3	4	6.1	64	45	2.8
S-dimethenamid	1.29	0	3	6.2	61	48	2.4
S-metolachlor + benoxacor	2.6 + 0.13	3	4	6.6	53	35	3.5
$LSD_{(0.05)}$		ns	ns	ns	19	16	1.6

Weed control in fallow with sulfosate. Joan Campbell and Donn Thill. (Plant Science Division, University of Idaho, Moscow, Idaho 83844-2339) Two experiments were established near Lewiston, Idaho to evaluate weed control with sulfosate in fallow. The experimental design was a randomized complete block with four replications and plot size was 8 by 30 ft. Herbicides were applied with a CO_2 pressurized backpack sprayer calibrated to deliver 10 gal/A at 32 psi (Table 1). Weed control was evaluated on May 27 and May14 for experiment one and two, respectively.

Table 1. Application data.

	Experiment one	Experiment two
Application date	May 10, 1999	April 19, 1999
Growth stage / density (plants/ft^2)		
BROTE (downy brome)	boot / 3	4 tiller / 75
LACSE (prickly lettuce)	6 in. rosette / 0.25	--
TRIAZ (volunteer wheat)	tillered / 0.5	--
Air temperature (F)	70	61
Soil temperature at 2 inch (F)	54	60
Relative humidity (%)	40	57
Wind (mph) / direction	0 to 3 / S	4 / NE
Cloud cover (%)	0	100
Soil moisture	dry	moderate

Table 2. Weed control in fallow.

		Weed control			
		Experiment one			Experiment two
Treatment	Rate	BROTE	LACSE	TRIAZ	BROTE
	lb/A	-----%-----			
Sulfosate + AMS	0.375 + 17	100	95	100	92
Sulfosate + AMS	0.5 + 17	100	99	100	96
Sulfosate + AMS	0.625 + 17	100	99	100	98
Sulfosate + AMS	0.375 + 8.5	100	98	100	93
Sulfosate + AMS	0.5 + 8.5	100	98	100	95
Sulfosate + AMS	0.625 + 8.5	100	98	100	96
Sulfosate + AMS + NIS	0.375 + 17 + 0.25	100	100	100	96
Sulfosate + AMS + NIS	0.5 + 17 + 0.25	100	98	100	98
Sulfosate + AMS + NIS	0.625 + 17 + 0.25	100	98	100	98
Glyphosate + AMS	0.375 + 8.5	100	98	100	93
Glyphosate + AMS	0.5 + 8.5	100	99	100	98
Glyphosate + AMS	0.625 + 8.5	100	99	100	98
Sulfosate + dicamba + AMS	0.375 + 0.25 + 8.5	100	98	100	92
Sulfosate + dicamba + AMS	0.5 + 0.25 + 8.5	100	99	100	93
Sulfosate + dicamba + AMS	0.625 + 0.25 + 8.5	100	98	100	97
Glyphosate + dicamba + AMS	0.375 + 0.25 + 8.5	100	99	100	88
Sulfosate + 2,4-D ester + AMS	0.375 + 0.5 + 8.5	100	98	99	99
Sulfosate + 2,4-D ester + AMS	0.5 + 0.5 + 8.5	100	98	100	99
Sulfosate + 2,4-D ester + AMS	0.625 + 0.5 + 8.5	100	99	100	98
Glyphosate + 2,4-D ester + AMS	0.375 + 0.5 + 8.5	100	96	100	not applied
Untreated control	--	--	--	--	--
LSD (0.05)		NS	NS	NS	5

All treatments controlled downy brome, prickly lettuce, and volunteer wheat 95 to 100% in experiment one (Table 2). Downy brome control in experiment two ranged from 92 to 99. Control was 93, 96, and 98% with 0.375, 0.5, and 0.625 lb/A, respectively, when averaged over treatments. Ammonium sulfate rate and the addition of nonionic surfactant did not affect downy brome control. Downy brome control was improved when 2,4-D ester was added to the sulfosate + ammonium sulfate at 0.375 + 8.5 lb/A rate.

Effects of glufosinate application timing on perennial grass seed crops. Bradley D. Hanson, Bill D. Brewster, Paul E. Hendrickson, and Carol A. Mallory-Smith. (Department of Crop and Soil Science, Oregon State University, Corvallis, OR 97331-3002) Four trials were conducted at the Hyslop Research Farm near Corvallis, Oregon to determine the effects of glufosinate application timing on the growth and yield of established stands of chewings fescue, creeping red fescue, tall fescue, and perennial ryegrass. Three rates of glufosinate were applied to chewings fescue, creeping red fescue, and tall fescue. The perennial ryegrass experiment was treated with two rates of glufosinate. Individual plots were 8 by 25 ft arranged in a randomized complete block with four replications. Herbicide treatments were applied with a single-wheel, compressed-air, plot sprayer calibrated to deliver 20 gpa at 19 psi and 3 mph (Table 1). Crop injury was evaluated visually at monthly intervals during the winter and spring. A 5 by 21 ft area was swathed in each plot in early July, allowed to dry for 1 to 2 weeks, and harvested with a small plot combine.

Table 1. Application data and crop growth stage.

Application date	December 9, 1998	January 25, 1999	February 26, 1999	March 19, 1999
Air temp (F)	7	39	36	50
Soil temp (F)	40	40	36	45
RH (%)	79	80	88	46
Cloud cover (%)	100	100	100	10
Growth stage (in.)				
Chewings fescue	4-5	4-5	4-5	5-6
Creeping red fescue	4-5	4-5	4-6	5-7
Tall fescue	6-8	6-8	7-9	8-12
Perennial ryegrass	4-6	4-6	5-7	6-10

Crop injury ranged from 5 to 91% on the April 11, 1999 rating (Table 2). The injury symptoms generally were most severe in plots treated in December or January and decreased with later timings and lower doses. Seed yield of chewings fescue and creeping red fescue was reduced 0 to 86% by all treatments applied in December or January and 16 to 86% by 0.75 lb/A glufosinate at all timings compared to the untreated control. Tall fescue seed yield was reduced 15 to 33% by glufosinate rates of 0.375 lb/A or higher in December and January and 19% by 0.75 lb/A in March compared to the untreated control. Perennial ryegrass seed yield was reduced 42% by 0.75 lb/A applied in December. Sensitivity to glufosinate differed greatly among these perennial grass seed crops (chewings fescue > creeping red fescue > tall fescue > perennial ryegrass).

Table 2. Effects of glufosinate application timing on perennial grass seed crops.

		Chewings fescue		Creeping red fescue		Tall fescue		Perennial ryegrass	
Treatment	Rate	injury[a]	yield	injury	yield	injury	yield	injury	yield
	lb/A	%	lb/A	%	lb/A	%	lb/A	%	lb/A
Untreated	--	0	1247	0	1144	0	2304	0	1220
December									
Glufosinate[b]	0.25	5	1232	8	1215	14	2038		
Glufosinate	0.375	10	1045	8	1065	18	1897	60	1323
Glufosinate	0.75	48	507	55	614	35	1807	96	701
January									
Glufosinate	0.25	23	703	15	854	11	2167		
Glufosinate	0.375	45	505	25	760	23	1952	38	1254
Glufosinate	0.75	91	171	84	303	40	1551	93	1019
February									
Glufosinate	0.25	8	1148	5	992	10	2327		
Glufosinate	0.375	5	1062	3	1050	11	2244	8	1301
Glufosinate	0.75	35	834	15	955	25	2081	13	1329
March									
Glufosinate	0.25	8	1238	5	1090	8	2259		
Glufosinate	0.375	20	1046	8	1038	18	2331	30	1372
Glufosinate	0.75	30	658	30	838	38	1866	60	1026
$LSD_{0.05}$			342		184		328		240

[a]April 11, 1999 rating.
[b]R-11, a nonionic surfactant, was added at 0.25% v/v to all glufosinate treatments.

Response of tall fescue and perennial ryegrass to prohexadione-calcium. Bradley D. Hanson, Bill D. Brewster, Paul E. Hendrickson, and Carol A. Mallory-Smith. (Department of Crop and Soil Science, Oregon State University, Corvallis, OR 97331-3002) Two experiments were performed in established stands of tall fescue and perennial ryegrass near Tangent, Oregon to determine the effects of prohexadione, a plant growth regulator, on the growth and yield of the grass seed crop. Single (Experiment 1) and split application (Experiment 2) treatments of prohexadione were included in these experiments along with a standard treatment of trinexapac and an untreated control. Plots were 8 by 25 ft arranged in a randomized complete block design with four replications. Growth regulator treatments were applied with a single-wheel, compressed-air, plot sprayer calibrated to deliver 20 gpa at 19 psi and 3 mph (Table 1). R-11, a nonionic surfactant, was added to all treatments at 0.5% v/v. A 5 by 21 ft area was swathed in each plot in early July, allowed to dry for 1 to 2 weeks, and harvested with a small plot combine.

Table 1. Application data.

	Experiment 1		Experiment 2	
	Tall fescue	P. ryegrass	Tall fescue	P. ryegrass
2 node application	April 29, 1999	May 5, 1999	May 5, 1999	April 23, 1999
Air temp (F)	45	54	45	55
Relative humidity (%)	71	69	77	69
Cloud cover (%)	0	10	10	0
3 node application	May 5, 1999	May 16, 1999	May 16, 1999	May 5, 1999
Air temp (F)	52	61	59	54
Relative humidity (%)	67	89	89	55
Cloud cover (%)	10	100	100	10
Early heading application	May 10, 1999	May 24, 1999	May 19, 1999	May 21, 1999
Air temp (F)	56	54	57	50
Relative humidity (%)	73	76	68	73
Cloud cover (%)	100	0	20	10

Tall fescue did not lodge in either experiment in treated or untreated plots. Tall fescue height reduction ranged from 17 to 38% with all single application treatments, however, seed yield was variable and not statistically different among treatments (Table 2). Lodging of perennial ryegrass was reduced 25 to 57% with all treatments; height was reduced in all treated plots but there were no differences among treatments. Perennial ryegrass seed yield increased when treated with prohexadione at 0.125 lb/A at the 2 node, 0.5 lb/A at 3 node, and 0.25 lb/A at early heading; while trinexapac increased yield at the 2 node timing.

Split applications of prohexadione reduced tall fescue height 22 to 40% (Table 3); height reductions were similar at all timings, although higher rates tended to have the greatest reductions. Tall fescue seed yield was not greatly affected by prohexadione rate or timing. Lodging of perennial ryegrass was less than the control in all treatments; the lowest lodging occurred with higher rates and later timings of prohexadione. Although perennial ryegrass height was reduced by all treatments, the greatest reductions occurred when an application at early heading was included in the treatment. Perennial ryegrass seed yield increased by up to 731 lb/A when treated with prohexadione.

Table 2. Effects of prohexadione rate and timing on tall fescue and perennial ryegrass (Experiment 1).

		Tall fescue		Perennial ryegrass		
Treatment	Rate	height	seed yield	lodging	height	seed yield
	lb/A	in	lb/A	%	in	lb/A
Untreated	--	52	2035	63	39	1724
2 node						
Prohexadione	0.125	43	2480	38	32	2278
Prohexadione	0.25	41	2697	38	30	2106
Prohexadione	0.38	38	2529	15	29	2110
Prohexadione	0.5	36	2633	9	30	2155
Trinexapac	0.25	38	2591	19	30	2199
3 node						
Prohexadione	0.125	42	2705	50	32	1649
Prohexadione	0.25	38	2658	21	32	1823
Prohexadione	0.38	34	2668	33	33	2157
Prohexadione	0.5	32	2524	25	30	2266
Trinexapac	0.25	35	2780	30	32	1990
Early heading						
Prohexadione	0.125	42	2704	16	31	1897
Prohexadione	0.25	40	2843	13	31	2233
Prohexadione	0.38	34	2660	6	31	2136
Prohexadione	0.5	34	2668	8	32	1714
Trinexapac	0.25	39	2583	10	32	1787
$LSD_{(0.05)}$		4	ns	11	2	433

Table 3. Effects of prohexadione split-applications on tall fescue and perennial ryegrass (Experiment 2).

		Tall fescue		Perennial ryegrass		
Treatment	Rate	height	seed yield	lodging	height	seed yield
	lb/A	in	lb/A	%	in	lb/A
Untreated	--	50	825	68	36	1318
2 node / 3 node						
Prohexadione	0.125 / 0.125	39	921	14	28	1743
Prohexadione	0.18 / 0.18	34	735	18	28	1782
Prohexadione	0.25 / 0.25	30	748	0	27	1829
Trinexapac	0.125 / 0.125	36	858	16	29	1733
3 node / E. head						
Prohexadione	0.125 / 0.125	35	651	4	26	2017
Prohexadione	0.18 / 0.18	36	791	0	22	1818
Prohexadione	0.25 / 0.25	37	898	0	22	2049
Trinexapac	0.125 / 0.125	38	771	19	27	1732
2 node / 3 node / E. head						
Prohexadione	0.08 / 0.08 / 0.08	33	798	6	26	1998
Prohexadione	0.125 / 0.125 / 0.125	30	838	0	24	1967
$LSD_{(0.05)}$		5	ns	9	2	299

Tall fescue tolerance to s-dimethenamid. Bradley D. Hanson, Bill D. Brewster, Paul E. Hendrickson, and Carol Mallory-Smith. (Department of Crop and Soil Science, Oregon State University, Corvallis, OR 97331-3002) A study was established in a tall fescue field at the Hyslop Research Farm near Corvallis, OR to determine the effects of s-dimethenamid applied alone and in combinations on tall fescue growth and yield and control of seedling volunteer tall fescue. Individual plots were 8 by 25 ft arranged in a randomized complete block with four replications. Herbicide treatments were applied with a single-wheel, compressed-air, plot sprayer calibrated to deliver 20 gpa at 19 psi and 3 mph (Table 1). A 6 by 14 ft area was swathed in each plot in early July, allowed to dry in the windrow, and harvested with a small plot combine.

Table 1. Application data and crop growth stage.

Application date	October 6, 1998	October 16, 1998
Timing	PRE	POST
Air temp (F)	72	67
Soil temp (F)	68	60
RH (%)	66	74
Cloud cover (%)	5	5
Growth stage		
Tall fescue	4 - 6 in	4 - 6 in
Volunteer tall fescue	Pre - 1 leaf	1 - 2 leaf
Soil texture	Silt loam	
Organic matter (%)	2.8	
pH	5.9	

Seedling volunteer tall fescue was controlled at least 83% by all treatments on October 30, 1998 (Table 2). Metolachlor at 6.0 lb ai/A, and s-dimethenamid at 1.3 and 2.6 lb/A controlled volunteer tall fescue as well as s-dimethenamid or metolachlor followed by oxyfluorfen plus diuron. Volunteer tall fescue control followed a similar trend at later ratings but was not statistically different among treatments. Tall fescue was injured 3 to 5% by all PRE treatments and 30% with all combination treatments but injury symptoms were not apparent at later ratings. Tall fescue seed yield did not differ from the untreated control with any of the herbicide treatments.

Table 2. Control of seedling volunteer tall fescue and tall fescue crop safety with s-dimethenamid.

Treatment	Rate	Application timing	Vol. tall fescue control[a]	Tall fescue injury[b]	Tall fescue yield
	lb/A		%	%	lb/A
Untreated check	--	--	0	0	1645
Metolachlor	6.0	PRE	96	5	1693
Dimethenamid	1.17	PRE	83	3	1484
S-dimethenamid	0.65	PRE	90	5	1700
S-dimethenamid	0.82	PRE	89	5	1541
S-dimethenamid	1.3	PRE	91	4	1710
S-dimethenamid	2.6	PRE	95	5	1711
S-dimethenamid / oxyfluorfen + diuron	0.65 / 0.25+1.2	PRE / POST	98	30	1767
S-dimethenamid / oxyfluorfen + diuron	0.82 / 0.25+1.2	PRE / POST	99	30	1883
Metolachlor / oxyfluorfen + diuron	1.5 / 0.25+1.2	PRE / POST	98	30	1622
$LSD_{(0.05)}$			7	2	NS

[a]November 30, 1998 rating.
[b]October 30, 1998 rating.

Downy brome control and seedling tall fescue crop tolerance with glufosinate. Devesh Singh and Daniel A. Ball. (Columbia Basin Agricultural Research Center, Oregon State University, Pendleton, 97801). Two trials were conducted to evaluate the effect of application rate and timing of glufosinate for downy brome control and crop tolerance in seedling tall fescue. Both trials (first in 1997-98 and second in 1998-99) were conducted under center-pivot irrigation at the Hermiston Agricultural Research & Extension Center. Soil characteristics for these trials are summarized in Table 1. Herbicide treatments were applied with a hand-held CO_2 backpack sprayer with 15 GPA water at 30 psi. Application timings and climatic conditions at time of application are summarized in Table 2. No surfactant was mixed with glufosinate treatments.

Table 1. Soil characteristics of experiment sites.

	First trial (1997-98)	Second trial (1998-99)
Soil Texture	Sandy loam	Loamy sand
Organic Matter (%)	0.79	1.04
pH	6.7	6.8
CEC (meq/100 g)	10.2	10.4

Table 2. Application description.

	Tall fescue	Air temperature	Relative humidity	Soil temperature (2")
		F	%	F
First trial				
Feb 17, 98	4-6 tillers, 3" tall	60	-	54
Feb 27, 98	4-7 tillers, 3.5"tall	56	70	50
Mar 25, 98	Multiple tillers, 4" tall	54	85	52
Second trial				
Feb 23, 99	5-6 tillers, 2-3" tall	54	74	50
Mar 15, 99	8 tillers, 3-4" tall	46	70	52
Apr 2, 99	Fully tillered, 3-4" tall	58	48	42

In the first trial (1997-98) early and mid-spring applications of glufosinate provided good control of downy brome in seedling tall fescue (Table 3). Crop injury was evident 14 days after treatment (data not shown) but had diminished by the time of evaluation. Downy brome control provided by glufosinate had no significant effect on clean seed yield. Late spring applications of glufosinate were less effective at controlling downy brome. In the second trial (1998-99) all application timings of glufosinate produced crop injury on seedling tall fescue (Table 4). Clean seed yield was not significantly reduced by glufosinate. In the second trial, clean seed yields were greatly reduced due to seed shattering from a heavy hail and windstorm on June 24, 1999 just before swathing, which likely masked potential seed yield reductions due to substantial injury to seedling tall fescue from glufosinate treatment. Further assessments of crop injury are needed before glufosinate treatment can be considered for use in tall fescue seed production.

Table 3. First trial: Effect of glufosinate treatments in seedling tall fescue (variety Barlexas).

			April 28, 98		
Treatment	Rate	Timing	Crop injury	Downy brome control	Clean seed yield
	lb/A		%		lb/A
Glufosinate	0.25	Feb 17, 98	0	85	1741
Glufosinate	0.38	Feb 17, 98	3	93	1809
Glufosinate / Glufosinate	0.25 / 0.25	Feb 17 / Feb 28, 98	7	93	1775
Glufosinate	0.25	Feb 28, 98	0	100	1977
Glufosinate	0.38	Feb 28, 98	3	92	1715
Glufosinate / Glufosinate	0.25 / 0.25	Feb 28 / Mar 25, 98	0	83	1869
Glufosinate	0.25	Mar 25, 98	0	67	1464
Glufosinate	0.38	Mar 25, 98	7	67	1504
Untreated			0	0	1799
L.S.D (0.05)			NS	46	NS

Table 4. Second trial: Effect of glufosinate treatments in seedling tall fescue (variety Bravo).

Treatment	Rate	Timing	Crop injury (April 29, 99)	Clean seed yield
	lb/A		%	lb/A
Glufosinate	0.25	Feb 23, 99	15	532
Glufosinate	0.38	Feb 23, 99	15	530
Glufosinate / Glufosinate	0.25 / 0.25	Feb 23 / Mar 15, 99	8	569
Glufosinate	0.25	Mar 15, 99	17	417
Glufosinate	0.38	Mar 15, 99	28	403
Glufosinate / Glufosinate	0.25 / 0.25	Mar 15 / Apr 2, 99	23	451
Glufosinate	0.25	Apr 2, 99	17	463
Glufosinate	0.38	Apr 2, 99	22	567
Untreated			0	623
Weed-free Check			0	674
L.S.D (0.05)			20	NS

Italian ryegrass control in spring lentil with grass herbicides. Traci A. Rauch and Donald C. Thill. (Plant Science Division, University of Idaho, Moscow, ID 83844-2339) A study was established near Troy, Idaho in 'Pardina' spring lentil to evaluate suspected diclofop-resistant Italian ryegrass control with grass herbicides. Plots were 8 by 30 ft arranged in a randomized complete block with four replications. All herbicide treatments were applied with a CO_2 pressurized backpack sprayer calibrated to deliver 10 gpa at 30 psi and 3 mph (Table 1). Spring lentil injury and Italian ryegrass control were evaluated visually on June 15, June 30, and July 28, 1999. Lentil seed was not harvested.

Table 1. Application data and soil analysis.

Application date	June 7, 1999
Lentil growth stage	3 inches
Italian ryegrass growth stage	2 to 4 leaf
Air temperature (F)	60
Relative humidity (%)	50
Wind (mph, direction)	1, W
Cloud cover (%)	60
Soil temperature at 2 in (F)	55
pH	5.1
OM (%)	3.7
CEC (meq/100g)	23
Texture	slit loam

Tralkoxydim and clodinafop injured lentil 11 and 20%, respectively, when evaluated on June 15, but no injury was visible by June 30, 1999 (Table 2). Clodinafop, quizalofop, sethoxydim and clethodim controlled Italian ryegrass 75 to 97% on June 30, 1999. By July 28, clodinafop only suppressed Italian ryegrass (46%) while quizalofop, sethoxydim and clethodim controlled Italian ryegrass 81 to 98%. All other treatments did not control Italian ryegrass. These data indicate that some Italian ryegrass plants in this field were resistant to diclofop but were susceptible to sethoxydim, clethodim, and quizalofop.

Table 2. Lentil injury and Italian ryegrass control with grass herbicides.

Treatment[a]	Rate	Lentil injury[b]	Italian ryegrass control June 30	Italian ryegrass control July 28
	lb/A	---------------	%	---------------
Flufenacet/metribuzin	0.27	0	11	10
Flufenacet/metribuzin	0.40	1	9	0
Tralkoxydim + TF8035	0.18 + 0.5	11	36	16
Sethoxydim +COC	0.19 + 2.5	0	94	98
Clethodim + COC	0.094 + 1	0	97	98
Quizalofop + COC	0.04 + 1	0	86	81
Clodinafop + COC	0.05 + 0.8	20	75	46
Fenoxaprop/safener	0.083	1	8	0
Diclofop	1	1	40	25
Untreated check	--	--	--	--
LSD (0.05)		3	28	29
plants/ft²			1	

[a]TF8035 (crop oil, nonionic surfactant blend) and COC (crop oil concentrate) applied at % v/v rate.
[b]June 15, 1999 evaluation.

Weed control and crop response to herbicides in lentil production. Joseph P. Yenish and Pete Schneider. (Washington State University, Pullman, WA 99164-6420) Lentils are an important rotational crop in dryland agriculture in the Palouse region of Idaho, Oregon, and Washington. There are few herbicides labeled for use in the production of grain legumes. This study was conducted to evaluate herbicides that could be developed for use in lentil production comparing them to currently labeled herbicides. The study was done at the Washington State University Cunningham Farm located near Pullman.

Imazethapyr and sulfentrazone were the only preplant incorporated treatments (PPI) that provided acceptable control of common lambsquarters. Slight crop injury was noted with PPI treatments of sulfentrazone and flumesulam, but injury ratings were not significantly different than the weedy check in ratings taken after May 27 (data not shown).[a]

The best common lambsquarters control of the preemergence (PREE) applications was with the lower rate of sulfentrazone and cloransulam-methyl. However, only sulfentrazone, regardless of rate, had a preharvest common lambsquarters control rating exceeding 60%. No PREE treatment had early season injury ratings which were significantly greater than the weedy check.

Of the postemergence treatments (POST), only 2,4-DB provided season-long control of common lambsquarters. No significant lentil injury was noted with any of the POST treatments.

Lentil yields were not significant due to a high degree of variability between replications.

Table. Weed control in conventionally-tilled lentils.

			Weed control		Lentils	
		Appl.	Common lambsquarters		Injury	Yield
Name	Rate	Timing	6/20/99	8/18/99	5/27/99	8/18/99
	lb/A		%			lbs./A
Weedy Check			0	0	0	1435
Imazethapyr	0.047	PPI	83	78	6	1665
Sulfentrazone	0.375	PPI	82	85	7	1585
Sulfentrazone	0.25	PPI	73	83	9	1640
Flufenacet + metribuzin	0.4 + 0.1	PPI	56	53	3	1730
Flufenacet + metribuzin	0.3 + 0.075	PPI	39	40	1	1600
Flumetsulam	0.055	PPI	51	13	7	1585
Sulfentrazone	0.375	PREE	58	60	4	1315
Sulfentrazone	0.25	PREE	79	61	1	1630
Flufenacet + metribuzin	0.4 + 0.1	PREE	31	13	1	1435
Flufenacet + metribuzin	0.3 + 0.075	PREE	33	6	0	1455
Flumetsulam	0.055	PREE	50	36	5	1365
Cloransulam-methyl	0.032	PREE	71	41	2	1540
Fomesafen	0.25	POST	51	26	NA[a]	1595
Metribuzin	0.25	POST	77	38	NA[a]	1415
2,4-DB	0.5	POST	93	84	NA[a]	1585
LSD (p=0.05)			27	22	6	NS

[a]POST treatments had not been applied prior to this rating date.

Weed control and crop response to herbicides in no-tillage lentils. Joseph P. Yenish and Pete Schneider. (Washington State University, Pullman, WA 99164-6420) Lentils are an important rotational crop in dryland agriculture in the Palouse region of Idaho, Oregon, and Washington. Producing crops under conservation tillage is important due to the high soil erosion conditions of the area. Few herbicides are label for use in the production of no-tillage grain legumes. This study was conducted to evaluate currently labeled herbicides for no-tillage lentil production and evaluate additional herbicides to be developed for use in no-tillage production. The study was conducted at the Washington State University Cunningham Farm located near Pullman.

Imazethapyr was applied in December of the year prior to planting lentils in the spring. Spring application of imazethapyr was applied approximately four weeks prior to lentil planting. Both fall and early spring applications of imazethapyr were intended to allow precipitation to incorporate the herbicide in place of mechanical incorporation. All other herbicides were applied either preemergence to lentil and weeds or postemergence.

All preemergence treatments provided good to excellent control of common lambsquaters at the earliest rating date. Control remained good to excellent at later rating dates with imazethapyr and sulfentrazone. Common lambsquarters control declined somewhat later in the season with flufenacet plus metribuzin, flumetsulam, cloransulam-methyl, and metribuzin. Lentil injury was noted in sulfentrazone treatments with greater injury observed at the higher rate. No other preemergence treatment had a greater crop injury rating than the weedy check at any rating date. The early spring preemergence application of imazethapyr and preemergence application of metribuzin had the greatest lentil yields. Imazethapyr applied in the fall had the lowest lentil yield of preemergence treatments. Likely, the low lentil yields with fall preemergence imazethapyr was due to poor control of prickly lettuce and mayweed chamomile (ratings not shown) which are typically less satisfactory than with spring applications of imazethapyr.

Postemergence applications of 2,4-DB and metribuzin provided good to excellent control of common lambsquaters at both rating dates. Common lambsquarters control with fomesafen was much poorer than other treatments at both rating dates. Of the postemergence treatments, only fomesafen injured lentils at greater levels than the weedy check. Greatest lentil yields of postemergence treatments was with 0.375 lbs/A 2,4-DB while poorest yields were with fomesafen and the 0.5 lbs/A rate of 2,4-DB. The low yield in the fomesafen treatment was due to poor weed control and crop injury. The growth regulating mode of action of 2,4-DB may have resulted in some pod sterility at the higher rate.

Table. Weed control in no-tillage lentils.

			Weed Control		Lentils		
			Common lambsquarters		Injury		Yield
Treatment	Rate	Appl. timing	6/20/99	8/18/99	6/3/99	6/20/99	8/19/99
	lb/A		%				lbs/A
Weedy Check			0	0	0	0	1705
Imazethapyr	0.047	Fall PREE	94	92	2	1	1545
Imazethapyr	0.047	Early Spring PREE	94	94	4	0	2250
Sulfentrazone	0.25	Spring PREE	91	84	9	3	1865
Sulfentrazone	0.375	Spring PREE	93	94	11	22	1770
Flufenacet + metribuzin	0.4 + 0.1	Spring PREE	66	36	2	0	1900
Flumetsulam	0.055	Spring PREE	70	48	3	1	1935
Cloransulam	0.032	Spring PREE	73	56	3	3	1920
Metribuzin	0.25	Spring PREE	83	68	3	1	2220
Fomesafen	0.25	POST	37	10	15	0	1570
Metribuzin	0.25	POST	86	76	2	2	1710
2,4-DB	0.375	POST	81	59	0	1	1980
2,4-DB	0.5	POST	84	58	4	0	1560
LSD (p=0.05)			18	28	5	6	405

Meadowfoam tolerance to herbicides. Bradley D. Hanson, Bill D. Brewster, and Carol Mallory-Smith. (Department of Crop and Soil Science, Oregon State University, Corvallis, OR 97331-3002) A study was established at the Hyslop Research Farm near Corvallis, OR to determine the tolerance of meadowfoam to 1X, 2X, and 4X proposed use rates of several herbicides. Individual plots were 8 by 28 ft arranged in a randomized complete block with four replications. Meadowfoam was seeded at 40 lb/A in six-inch rows on September 30, 1998. Herbicide treatments were applied with a single-wheel, compressed-air, plot sprayer calibrated to deliver 20 gpa at 19 psi and 3 mph (Table 1). Meadowfoam seed yield was determined by collecting the aboveground biomass from a 2.7 by 25 ft area on July 1, 1999, with a forage harvester, air-drying the foliage, and threshing the seed with a stationary thresher.

Table 1. Application data.

Application timing	PRE	POST
Date	October 2, 1998	October 23, 1998
Meadowfoam growth stage	preemergance	2 leaf
Air temp (F)	59	48
Soil temp (F)	58	48
RH (%)	69	72
Cloud cover (%)	95	100
Soil texture	Silt loam	
Organic matter (%)	2.4	
pH	5.3	

All preemergence treatments injured meadowfoam. Injury tended to increase as herbicide rate increased (Table 2). Although meadowfoam was injured visually by most treatments, no treatment reduced seed yield compared to the untreated control. Treatments of metolachlor at 2.0 lb/A, propachlor at 8.0 lb/A, and dimethenamid at 0.59 and 1.17 lb/A increased seed yield of meadowfoam.

Table 2. Meadowfoam injury and yield following herbicide application.

			Meadowfoam	
Treatment	Rate	Timing	injury[a]	yield
			%	lb/A
Check 1	–	–	0	1656
Check 2	–	–	0	1655
Metolachlor	1.0	PRE	30	1659
Metolachlor	2.0	PRE	55	1939
Metolachlor	4.0	PRE	73	1643
Propachlor	2.0	PRE	5	1632
Propachlor	4.0	PRE	35	1755
Propachlor	8.0	PRE	60	1924
Dimethenamid	0.59	PRE	38	1887
Dimethenamid	1.17	PRE	60	1903
Dimethenamid	2.34	PRE	75	1631
Sulfentrazone	0.063	PRE	3	1619
Sulfentrazone	0.125	PRE	35	1702
Sulfentrazone	0.25	PRE	60	1832
Ethofumesate	1.5	POST	0	1615
Ethofumesate	3.0	POST	0	1619
Ethofumesate	6.0	POST	0	1706
$LSD_{(0.05)}$			8	228

[a] October 30, 1998, rating.

Clethodim timing in meadowfoam. Matthew D. Schuster and Carol A. Mallory-Smith. (Department of Crop and Soil Science, Oregon State University, Corvallis, OR 97331-3002). Trials were established in meadowfoam to determine the effects of clethodim applied at different timings on meadowfoam injury and yield and Italian ryegrass control. Two trials were established in 1997 at James VanLeeuwen and Jack Sayer Farm, Linn Co., near Halsey, OR, and in 1998 at James VanLeeuwen, Linn Co., near Halsey, OR and Steve Glaser Farms, Linn Co., near Tangent, OR. Individual plots were 8 by 25 ft arranged in a randomized complete block with four replications. A full application of 0.1 lb ai/A and a split application of 0.05 lb ai/A + 0.05 lb ai/A were applied at the beginning of each month. Herbicide treatments were applied with a CO_2 backpack sprayer calibrated to deliver 20 gpa at 32 psi and 3 mph. Meadowfoam seed yield was determined by collecting the aboveground biomass from a 2.7 by 25 ft area on June 27, 1998, at Site 2 and July 7, 1998, at Site 1, and July 2, 1999, at Site 1 and 2, with a forage harvester. Biomass was air-dried and seed was threshed with a stationary thresher. Site 1 in 1997-98 did not have a weed problem and was evaluated for injury only.

All treatments provided 98 to 100% Italian ryegrass control at Site 2 in 1997-98 and Site 1 in 1998-99 (Table 1). In 1998-99, severe water damage at Site 2 resulted in 13 to 72 % control and increased crop injury from the November, December, January and November/January treatments. The other treatments provided 94 to 100% Italian ryegrass control. In 1997-98, injury from the April treatment resulted in lower seed yields compared to the untreated check at both sites. All other treatments resulted in equal or higher seed yields (Table 2). In 1998-99, seed yield from the treated plots did not differ or was higher than the untreated check at Site 1 (Table 3). At Site 2, the crop injury from the November, December and April treatments resulted in lower yields compared to the untreated check. In the other treatments, yields were equal or higher than the untreated check.

Table 1. Control of Italian ryegrass at Site 2 for 1997-98 and Site 1 and 2 for 1998-99.

		6-May-98	— 27-May-99 —	
Treatment	Rate	Site2	Site 1	Site 2
	lb/A	%		
1. November	0.10	98	99	15
2. December	0.10	98	100	13
3. January	0.10	100	100	72
4. Feburary	0.10	100	100	94
5. March	0.10	100	99	100
6. April	0.10	100	100	100
7. November/	0.05	100	100	49
January	0.05			
8. December/	0.05	100	100	98
February	0.05			
9. January/	0.05	100	100	99
March	0.05			
10. Check	0.00	0	0	0
$LSD_{(0.05)}$		4	1	37

Table 2. Percent injury and yield of meadowfoam at Site 1 and 2 for 1997-98.

Treatment	Rate	– 4-Dec-97 –		– 8-Jan-98 –		– 11-Feb-98 –		– 5-Mar-98 –		– 7-Apr-98 –		– 11-May-98 -		7-Jul-98	27-Jun-98
		Site 1	Site 2	Site 1	Site 2	Site 1	Site 2	Site 1	Site 2	Site 1	Site 2	Site 1	Site 2	Site 1	Site 2
	lb/A	% injury												lbs/A	
1. November	0.10	35	9	38	6	36	21	25	13	8	1	6	1	768	662
2. December	0.10			31	21	23	34	13	16	3	0	6	10	768	641
3. January	0.10					21	33	10	15	6	5	6	0	759	676
4. February	0.10							4	8	0	0	14	25	677	609
5. March	0.10									4	10	20	15	685	647
6. April	0.10											69	85	422	211
7. November	0.05	16	15	9	6	36	44	23	31	3	5	15	9	763	653
January	0.05														
8. December	0.05			10		6	25	11	25	1	1	16	11	731	658
February	0.05														
9. January/	0.05					4	19	4	11	3	8	16	3	740	627
March	0.05														
10. Check	0.00	0	0	0	0	0	0	0	0	0	0	0	0	686	501
LSD $_{(0.05)}$		26	36	15	9	13	19	8	13	6	8	19	14	101	101

Table 3. Percent injury and yield of meadowfoam at Site 1 and 2 for 1998-99.

Treatment	Rate	– 3-Dec-98 –		– 7-Jan-99 –		– 9-Feb-99 –		– 5-Mar-99 –		– 6-Apr-99 –		– 27-May-99 -		2-Jul-99	2-Jul-99
		Site 1	Site 2	Site 1	Site 2	Site 1	Site 2	Site 1	Site 2	Site 1	Site 2	Site 1	Site 2	Site 1	Site 2
	lb/A	% injury												lbs/A	
1. November	0.10	43	44	66	84	75	80	66	75	46	66	3	41	1541	1478
2. December	0.10			71	79	83	79	70	73	50	63	1	29	1828	1481
3. January	0.10					34	51	30	32	20	29	0	20	1721	1759
4. February	0.10							30	14	20	11	0	1	1599	1713
5. March	0.10									34	9	5	4	1467	1746
6. April	0.10											18	19	1443	1537
7. November	0.05	25	38	49	66	51	63	40	72	25	65	0	34	1494	1614
January.	0.05														
8. December	0.05			39	29	35	28	33	34	20	15	3	4	1581	1754
February	0.05														
9. January/	0.05					15	4	3	5	16	8	0	5	1530	1639
March	0.05														
10. Check	0.00	0	0	0	0	0	0	0	0	0	0	0	0	1032	1764
LSD $_{(0.05)}$		33	8	28	31	26	28	25	29	24	32	4	31	412	205

Imazamox soil persistence in spring mustard. Traci A. Rauch and Donald C. Thill. (Plant Science Division, University of Idaho, Moscow, ID 83844-2339) A study was established near Moscow, Idaho in 'Idagold' spring mustard to evaluate soil persistence of imazamox. Treatments were applied to imidazolinone-resistant winter wheat during spring 1998 and planted to mustard on April 16, 1999. Plots were 16 by 30 ft arranged in a randomized complete block with four replications. All herbicide treatments were applied with a CO_2 pressurized backpack sprayer calibrated to deliver 10 gpa at 30 psi and 3 mph (Table 1). All plots were sprayed with quizalofop at 0.069 lb/A and clopyralid at 0.188 lb/A for wild oat and broadleaf weed control on May 27, 1999. Mustard injury was evaluated visually on June 9 and 30, 1999. Mustard seed was harvested with a small plot combine from a 4 by 27 ft area in each plot on August 25, 1999.

Table 1. Application data.

Application date	April 17, 1998	May 12, 1998
Wheat growth stage	4 to 5 leaf	jointing
Wild oat growth stage	1 to 2 leaf	4 to 5 leaf
Air temp (F)	42	70
Relative humidity (%)	68	57
Wind (mph, direction)	2, SW	3, SW
Cloud cover (%)	40	50
Soil temperature at 2 in (F)	40	58
pH	4.5	
OM (%)	5.7	
CEC (meq/100g)	33	
Texture	loam	

Imazamox at 0.08 lb/A applied at the 4 to 5 leaf stage in wheat visually injured mustard 14% on the June 6 evaluation (Table 2). By June 30, injury was not visible with any treatment (data not shown). Mustard yield for all treatments did not differ.

Table 2. The effect of imazamox soil persistence on mustard injury and yield.

		1998	Mustard	
Treatment[a]	Rate	Application timing	injury	yield
	lb/A		%	lb/A
Imazamox	0.024	1 to 2 leaf	0	564
Imazamox	0.032	1 to 2 leaf	0	610
Imazamox	0.040	1 to 2 leaf	0	623
Imazamox	0.048	1 to 2 leaf	1	609
Imazamox	0.080	1 to 2 leaf	2	664
Diclofop + thifen/triben	1.0 + 0.014	1 to 2 leaf	2	634
Imazamox + imazamox	0.024 + 0.024	1 to 2 leaf + 4 to 5 leaf	0	630
Imazamox	0.024	4 to 5 leaf	1	592
Imazamox	0.032	4 to 5 leaf	6	573
Imazamox	0.040	4 to 5 leaf	4	667
Imazamox	0.048	4 to 5 leaf	0	601
Imazamox	0.080	4 to 5 leaf	14	596
Imazamethabenz + thifen/triben	0.47 + 0.014	4 to 5 leaf	5	624
Untreated check			--	575
LSD (0.05)			NS	NS

[a]All treatments were applied with a 90% nonionic surfactant at 0.25% v/v and 32% UAN (urea ammonium nitrate) was mixed with the imazamox treatments at 2.5% v/v. Thifen/triben is the commercial formulation of thifensulfuron/tribenuron.

Field bindweed control and persistence of BAS 589 03H in rotational crops. Traci A. Rauch and Donald C. Thill. (Plant Science Division, University of Idaho, Moscow, ID 83844-2339) A study was established in 1996 near Moscow, Idaho to evaluate field bindweed control and persistence of BAS 589 03H in spring wheat and pea. The experimental design was a randomized split-block with four replications. Main plots were five herbicide treatments (applied sequentially to the same plots in 1996, 1997, and 1998) and an untreated check (16 by 30 ft). Subplots were two rotational crops (15 by 96 ft). The 1999 rotational crops, spring pea and spring wheat, (planted on half of each plot) were alternated with the spring pea and spring wheat planted in 1998. Treatments were applied with a CO_2 pressurized backpack sprayer (Table 1). Fertilizer (26-13-0-10) was applied at 250 lb/A and incorporated with a field cultivator on April 15, 1999. Rotational crops, 'Columbia' spring pea and 'Penawawa' spring wheat, were seeded at 120 lb/A perpendicular to the herbicide treatments on one-half of each plot on April 16, 1999. Metribuzin was applied to spring pea at 0.25 lb ai/A post-plant preemergence on April 23, 1999. Bromoxynil (0.375 lb ai/A) and MCPA amine (0.375 lb ai/A) were applied on May 24, 1999 to spring wheat for broadleaf weed control. Spring pea and spring wheat were harvested on August 5 and 23, 1999, respectively. Field bindweed control was evaluated visually on October 9, 1998 and August 5, 1999. Field bindweed control, crop yields, and application data for 1996 and 1997 were published in the 1998 and 1999 Western Society of Weed Science Research Progress Report, pg. 155 and 164, respectively.

Table 1. Application data and soil analysis.

Application date	September 21, 1998
Growth stage of field bindweed	8 to 11 inch runners/ blooming
Gpa	20
Psi	40
Air temperature (F)	73
Relative humidity (%)	50
Wind (mph)	1
Cloud cover (%)	10
Soil temperature at 2 in. (F)	66
pH	6.3
OM (%)	4.0
Texture	silt loam

No treatment visually injured the spring pea or wheat (data not shown). Dicamba + 2,4-D and glyphosate/2,4-D + AMS controlled field bindweed 91 and 94%, respectively, in October 1998 (Table 2). BAS 589 03H treatments controlled field bindweed 75 and 80% in fall 1998. In 1999, all treatments controlled field bindweed 91% or greater. The treatment by crop interaction and the treatment main effect were not significant for seed yield of spring pea or wheat.

Table 2. Field bindweed control and spring wheat and spring pea yield with BAS 589 03H and other herbicide combinations.

			Field bindweed control		Yield	
Treatment[a]	Rate	Timing	1998	1999	Spring pea	Spring wheat
	lb/A		%		lb/A	
BAS 589 03H	1.25	Summer 1996				
BAS 589 03H	0.62	Postharvest 1997				
BAS 589 03H	0.62	Postharvest 1998	80	91	2638	6917
BAS 589 03H	1.25	Summer 1996				
BAS 589 03H	1.25	Postharvest 1997				
BAS 589 03H	0.62	Postharvest 1998	75	94	2731	6792
Glyphosate/2,4-D + AMS	1+1.7	Summer 1996				
Glyphosate/2,4-D + AMS	1 +1.7	Postharvest 1997				
Glyphosate/2,4-D + AMS	1+1.7	Postharvest 1998	94	99	2477	6676
2,4-D	0.95	Summer 1996				
2,4-D	0.95	Postharvest 1997				
2,4-D	0.95	Postharvest 1998	60	92	2999	6532
Dicamba + 2,4-D	0.5 + 0.95	Summer 1996				
Dicamba + 2,4-D	0.5 + 0.95	Postharvest 1997				
Dicamba + 2,4-D	0.5 + 0.95	Postharvest 1998	91	93	2914	6278
Untreated check	–	–			2992	6436
LSD (0.05)			19	NS	NS	NS
Density (shoots/ft^2)			3			

[a] All BAS 589 03H treatments were applied with 0.94% v/v sunflower oil. Glyphosate/2,4-D is a commercial premix formulation. AMS = liquid ammonium sulfate.

Weed control and crop response to herbicides in dry pea production. Joseph P. Yenish and Pete Schneider. (Washington State University, Pullman, WA 99164-6420) Dry peas are an important rotational crop in dryland agriculture in the Pacific Northwest. There are few herbicides labeled for use in grain legume production. This study was conducted to determine what herbicides could be developed for use in dry pea production comparing them to currently labeled herbicides. The study was conducted at the Washington State University Cunningham Farm located near Pullman.

Good to excellent control of common lambsquarters was obtained with preplant incorporated (PPI) treatments of imazethapyr, sulfentrazone, and flufenacet plus metribuzin at the June 20 rating. Flumetsulam was less effective on common lambsquarters and mayweed chamomile than other PPI treatments. Within the PPI treatments, only 0.375 lbs/A sulfentrazone controlled common lambsquarters greater than 80% at preharvest (August 16, 1999). Best control of mayweed chamomile in PPI treatments was with sulfentrazone at either rates.

Within this study, sulfentrazone at 0.375 and 0.25 lbs/A provided best control of common lambsquarters and mayweed chamomile of the preemergence (PREE) treatments. However, control of common lambsquarters with the lower rate of sulfentrazone was unacceptable at preharvest. Control of mayweed chamomile was good to excellent with both rates of sulfentrazone PREE. Both rates of flufenacet plus metribuzin, flumetsulam, and cloransulam-methyl provided less than 20% control of common lambsquarters control and less than 65% control of mayweed chamomile on the August 16 rating date.

Imazamox applied postemergence (POST) controlled common lambsquarters, but not mayweed chamomile. Bentazon plus quizalofop applied POST controlled mayweed chamomile, but not common lambsquarters. POST applications of fomesafen did not provide acceptable control of either weed species.

Weed infestations were light and random variability was great in the measure harvest of pea seed. Yield was greatest in the weedy check and only the lower rate of flufenacet plus metribuzin and flumetsulam applied PPI, both rates of flufenacet plus metribuzin, flumetsulam, and cloransulam-methyl applied PREE, and fomesafen applied POST yielded less than the weedy check.

Table. Weed management in conventionally tilled dry peas.

Treatment	Rate	Appl. timing	Weed control: Common lambsquarters 6/20/99	Weed control: Common lambsquarters 8/16/99	Weed control: Mayweed chamomile 8/16/99	Dry pea yield 8/20/99
	lb/A		%	%	%	lbs./A
Weedy Check			0	0	0	1440
Imazethapyr	0.047	PPI	94	67	50	1380
Sulfentrazone	0.375	PPI	79	81	87	1190
Sulfentrazone	0.25	PPI	75	59	86	1420
Flufenacet + metribuzin	0.4 + 0.1	PPI	76	38	67	1255
Flufenacet + metribuzin	0.3 + 0.075	PPI	72	24	70	1095
Flumetsulam	0.055	PPI	48	18	29	1125
Sulfentrazone	0.375	PREE	85	74	93	1405
Sulfentrazone	0.25	PREE	90	52	81	1355
Flufenacet + metribuzin	0.4 + 0.1	PREE	58	13	50	1050
Flufenacet + metribuzin	0.3 + 0.075	PREE	47	14	51	1170
Flumetsulam	0.055	PREE	54	18	38	1115
Cloransulam-methyl	0.032	PREE	50	20	64	1030
Imazamox [a]	0.03	POST	89	91	44	1370
Fomesafen	0.25	POST	55	14	40	1070
Bentazon + quizalofop [b]	0.5 + 0.044	POST	70	48	84	1245
LSD (p=0.05)			21	21	33	295

[a]Applied with 0.25% v/v nonionic surfactant and 32% urea-ammonium nitrate solution at 1 qt/A.
[b]Applied with 0.25% v/v nonionic surfactant.

Weed control and crop response to herbicides in no-tillage dry pea production. Joseph P. Yenish and Pete Schneider. (Washington State University, Pullman, WA 99164-6420) Dry peas are an important rotational crop in dryland agriculture in the Palouse region of Idaho, Oregon, and Washington. Producing crops under conservation tillage is important to the region given the steep topography and season rainfall patterns which lead to soil erosion. There are few herbicides labeled for use in the production of no-tillage grain legumes. This study was conducted to evaluate current and pending labeled herbicides for no-tillage dry pea production. The study was conducted at the Washington State University Cunningham Farm located near Pullman.

Imazethapyr was applied in the very late fall of the year prior to planting dry peas in the spring of the following year. Spring application of imazethapyr was applied approximately four weeks prior to pea planting. Both fall and early spring applications of imazethapyr were intended to allow precipitation to incorporate the herbicide in place of mechanical incorporation. All other herbicides were applied either preemergence to dry peas and weeds or postermergence.

Fall and spring-applied imazethapyr and sulfentrazone provided the best control of common lambsquarters of those herbicides applied prior to crop and weed emergence. Fair to good control of this species was obtained with flufenacet plus metribuzin, flumetsulam, cloransulam-methyl, and metribuzin. None of the preemergence treatments provided excellent control of prickly lettuce or mayweed chamomile with no injury to dry peas. Generally, prickly lettuce control was greater than mayweed chamomile control. Greatest dry pea yields of the preemergence treatments were with fall and early spring applied imazethapyr and flufenacet plus metribuzin.

Postemergence applications of imazamox, flumiclorac, bentazon plus quizalofop, bentazon, metribuzin, and MCPA-amine provided good to excellent control of common lambsquaters while fomesafen provided only fair control. Fair to good control of prickly lettuce was seen with all postemergence treatments with greatest control by imazamox, bentazon, and metribuzin. Postemergence control of mayweed chamomile was poor to fair with greatest control by bentazon plus quizalofop. Slight crop injury was noted in the early rating of flumiclorac and fomesafen and the later rating with MCPA-amine. Greatest pea yield in postemergence applications was with imazamox and bentazon plus quizalofop.

In summary, effective weed control in no-tillage dry peas is possible using current and pending labeled products.

Table. Weed control in no-tillage dry peas.

			Weed control				Dry peas		
			Common lambsquarters		Prickly lettuce	Mayweed chamomile	Injury		Yield
Treatment	Rate	Appl. timing	6/20/99	8/16/99	8/16/99	8/16/99	6/3/99	6/20/99	8/20/99
	lb/A		%						lbs/A
Weedy Check			0	0	0	0	0	0	825
Imazethapyr	0.047	Fall PREE	92	94	51	33	1	0	1450
Imazethapyr	0.047	Early Spring PREE	95	97	74	60	0	0	1350
Sulfentrazone	0.25	Spring PREE	86	95	74	59	1	0	1160
Flufenacet + metribuzin	0.4 + 0.1	Spring PREE	70	63	63	40	0	0	1385
Flumetsulam	0.055	Spring PREE	45	71	63	51	3	0	1065
Cloransulam-methyl	0.032	Spring PREE	63	80	76	48	0	0	1140
Metribuzin	0.25	Spring PREE	65	81	74	50	1	0	1140
Imazamox[a]	0.03	POST	96	86	85	38	3	0	1320
Flumiclorac[b]	0.027	POST	65	80	66	6	5	0	1070
Fomesafen	0.25	POST	79	55	74	45	8	0	1060
Bentazon + quizalofop[b]	0.5 + 0.05	POST	85	76	55	61	2	0	1410
Bentazon[c]	0.5	POST	53	75	84	61	1	0	900
Metribuzin	0.25	POST	88	88	85	31	3	0	910
MCPA-amine	0.25	POST	92	94	68	24	0	5	760
LSD (p=0.05)			22	21	26	28	3	2	410

[a]Applied with 0.25% v/v nonionic surfactant and 32% urea-ammonium nitrate solution at 1 qt/A.
[b]Applied with 0.25% v/v nonionic surfactant.
[c]Applied with 1 qt/A crop oil concentrate.

Preemergence weed control in potatoes. Timothy W. Miller and Carl R. Libbey. (Washington State University, Mount Vernon, WA 98273) A field study was designed to test several preemergence herbicides for use in potatoes. The study was conducted during 1999 near Mount Vernon, WA. Two rows of 'White Rose' potatoes (2.5 oz, single drop seed potatoes) were planted into each plot May 24. There was a 9-in. spacing between seed pieces and the rowspacing was 38 in. (approximately 2870 lbs/A planting rate). Plots measured 6.3 by 20 ft. Hills were re-shaped June 18, when the first potato leaves emerged. Herbicides were applied immediately following re-hilling using a tractor-mounted sprayer delivering 29.7 gpa at 15 psi. Common lambsquarters and pale smartweed were the major weed species in the plots. Weed control was evaluated June 28, July 7, and August 9; foliar injury was estimated July 7. Potato plants were killed September 15 using diquat at 0.5 lb/A + X-77 at 0.25% v/v. Tubers were dug and sacked October 4 and weighed October 8. The experimental design was a randomized complete block with four replicates. A general linear models procedure was used to analyze the data. Means were separated using Fisher's Protected LSD. Application data is listed in Table 1 and weed control, crop injury, and yield in Table 2.

Predominantly cool, moist conditions during June allowed many of the germinated weed seedlings to survive the re-hilling process. Consequently, many lambsquarters and smartweed seedlings were too large for optimal control. Still, weed control from rimsulfuron + metribuzin was excellent, and sulfentrazone ranged from good to excellent throughout the growing season. Dimethenamid and BAS 656 did not adequately control these two species in this trial. None of these treatments caused significant crop injury, and tuber yields were not significantly reduced compared to the handweeded check.

Table 1. Herbicide application data.

6:45 to 7:30 a.m., June 18, 1999
Broadcast, after re-hilling
100% cloud cover, high overcast
winds 5 to 7 mph, from S
air temp. = 58 F; soil temp (4") = 50 F
relative humidity = 77%
soil surface was damp with small clods

Table 2. Effect of herbicides on weed control, crop injury, and tuber yield of potatoes.

Treatment	Rate	Weed control 6/28	7/7	8/9	Crop injury[b]	Tuber yield
	lb/A	%			%	cwt/A
Sulfentrazone	0.125	77	81	81	1	620.6
Sulfentrazone	0.1875	92	92	88	5	664.7
Sulfentrazone	0.25	64	91	85	4	556.0
Sulfentrazone	0.375	98	99	95	6	647.2
Rimsulfuron	0.02	97	100	99	3	799.6
+ metribuzin	0.5					
Dimethenamid	1.17	51	70	51	4	583.4
BAS 656 H	0.64	46	75	45	4	762.9
Untreated check	—	0	0	0	4	601.6
Handweeded check	—	100	100	100	3	874.9
LSD	—	41	14	21	ns	ns
r^2	—	0.65	0.94	0.88	0.31	0.16
C.V.	—	40.8	11.9	20.1	94.9	44.7

[a]Crop injury evaluated 7/7/99.

Endothall performance with adjuvants on potato. Richard K. Zollinger and Scott A. Fitterer. (Department of Plant Sciences, North Dakota State University, Fargo, ND 58105) An experiment was conducted near Prosper, ND to evaluate endothall performance with adjuvants. 'Russet Burbank' potato was seeded June 1, and one hilling was performed on June 6, 1999. Each treatment consisted of split applications at beginning of natural senescence and then 7 days following. The first application was made on September 9, 1999 at 10:00 to 10:30 am with 61 F air, 65 F soil surface, 61% relative humidity, 0% clouds, 5 to 8 mph NW wind, moist soil surface, wet subsoil, and no dew present. Crop was beginning to yellow. Split treatments were applied September 17, 1999 at 2:30 to 3:00 pm with 77 F air, 68 F soil surface, 49% relative humidity, 35% clouds, 8 to 10 mph S wind, moist soil surface, wet subsoil, and no dew present. Treatments were applied to the center 6.67 feet of the 12 by 25 ft plots with a CO_2 pressurized back-pack delivering 26 gpa at 40 psi through 8003 flat fan nozzles. The experiment had a randomized complete block design with three replicates per treatment.

The two week period following applications was wet and cloudy which slowed dessication. Potato leaf tissue was 75 to 88% killed before sequential applications were made. A sequential application of endothall or diquat was needed to desicate stems. Stem dessication tended to be faster with sequential applications of endothall+AMS. Two weeks after initial application, significant differences in stem or leaf dessication were not observed from any treatment. Vines in the untreated treatment were killed just prior to harvest. This provided two weeks of extra growth which contributed to the yield increase. Treatments with endothall+AMS as the initial application had lower skin set values, which may lead to increased bruising during harvesting.

Table. Endothall performance with adjuvants on potato.

Treatment[b]	Rate	1 DAT[a]		3 DAT		5 DAT		7 DAT		9 DAT		11 DAT		13 DAT		Potato	Skin
		Stem	Leaf	Stem	Leaf	Stem	Leaf	Stem	Leaf	Stem	Leaf	Stem	Leaf	Stem	Leaf	yield	set
	lb/A	% dessication														cwt/A	oz/in
<u>BNS[c]/7 DAT</u>																	
Endothall+LI 700/diquat+Activator 90	0.75+16oz/100 gal/0.375+0.25%	0	5	10	35	17	58	35	83	77	100	82	100	93	100	123	63
Endothall+AMS/diquat+Activator 90	0.75+17lb/100 gal/0.375+0.25%	0	5	10	38	17	57	32	85	72	100	77	100	93	100	124	51
Endothall+LI 700/diquat+Activator 90	0.75+32oz/100 gal/0.375+0.25%	0	10	8	30	15	52	35	78	77	100	80	100	95	100	154	59
Endothall+LI 700+AMS/diquat+Activator 90	0.75+16 oz/100 gal+17lb/100 gal/0.375+0.25%	0	7	10	42	18	58	33	85	63	97	73	98	96	100	114	60
Endothall/diquat+Activator 90	0.75/0.375+0.25%	0	7	8	30	10	48	33	80	82	100	87	100	98	100	141	69
Endothall+AMS/endothall+AMS	0.75+17lb/100 gal/0.75+17lb/100 gal	0	5	10	48	18	68	33	88	88	100	93	100	99	100	150	55
Diquat+Activator 90/diquat+Activator 90	0.375+0.25%/0.375+0.25%	0	17	10	43	13	58	33	75	73	100	80	100	95	100	143	60
Untreated		0	0	0	0	0	0	0	0	0	0	0	0	0	0	164	60
LSD (0.05)		0	4	3	12	11	21	11	24	15	4	16	2	6	0	45	14

[a]DAT = days after final treatment.
[b]LI-700 and Activator 90 = nonionic surfactant, AMS = ammonium sulfate.
[c]BNS = beginning of natural senescence.

Potato dessication with glufosinate. Richard K. Zollinger and Scott A. Fitterer. (Department of Plant Sciences, North Dakota State University, Fargo, ND 58105) An experiment was conducted near Prosper, ND to evaluate potato vine desiccation from glufosinate. 'Red Norland' potato was seeded June 1 and one hilling was performed on June 6, 1999. Treatments were applied on August 28, 1999 at 11:00 to 11:30 am with 76 F air, 75 F soil surface, 46% relative humidity, 40% clouds, 0 to 3 mph NW wind, dry soil surface, moist subsoil, and no dew present. The crop was beginning to yellow. Treatments were applied to the center 6.67 feet of the 12 by 25 ft plots with a CO_2 pressurized backpack sprayer delivering 26 gpa at 40 psi through 8003 flat fan nozzles. The experiment had a randomized complete block design with four replicates per treatment.

Weather was wet, cloudy, and cool for six days after application. Vine dessication was more rapid from glufosinate+ AMS than from glufosinate alone. On September 8, vine dessication was similar from glufosinate with or without AMS. Glufosinate+AMS dessicated as rapidly as diquat and had greater dessication than diquat on September 8. At September 11, 14 days after treatment, no differences were found between treatments. Vines in untreated plots were killed just prior to harvest. This provided an extra three weeks of growth which contributed to increased yield.

Table. Potato dessication with glufosinate.

Treatment[a]	Rate	Vine dessication					Potato yield
		August 31	September 2	September 8	September 11	September 18	
	lb/A	%					cwt/A
Glufosinate+AMS	0.375+3	40	49	95	98	100	395
Glufosinate	0.375	15	26	94	98	100	407
Diquat	0.25	48	55	86	95	100	409
Untreated		0	0	0	0	0	504
LSD (0.05)		9	12	6	3	0	81

[a]AMS = ammonium sulfate.

Potato response to San 582H. Richard K. Zollinger and Scott A. Fitterer. (Department of Plant Sciences, North Dakota State University, Fargo, ND 58105) An experiment was conducted near Glyndon, ND to evaluate potato response to San 582H applied PRE. 'Russet Burbank' potato was seeded May 25, 1999. Plots were hilled and PRE treatments were applied on June 2, 1999 at 7:00 to 8:00 am with 68 F air, 63 F soil at a 2 to 4 inch depth, 30% relative humidity, 20% clouds, 0 to 5 mph SE wind, dry soil surface, and moist subsoil. Treatments were applied to the center 6.67 feet of 12 by 25 foot plots with a back-pack sprayer delivering 17 gpa at 40 psi through 8002 flat fan nozzles. The experiment had a randomized complete block design with three replicates per treatment.

No potato injury was found throughout the season. Common lambsquarters control ranged from 92 to 98%. All treatments gave excellent control of redroot pigweed, kochia, and common ragweed. The experiment was terminated on July 3 because of a hail storm.

Table. Potato response to San 582H.

		June 24	June 24			
Treatment	Rate	Potato injury	Rrpw[a]	Colq[a]	Kocz[a]	Corw[a]
	lb/A	%	% control			
San 582H	2.34	0	98	92	97	99
San 582H-a	0.66	0	98	95	97	99
San 582H-a	1.31	0	98	94	98	98
San 582H-a	2.63	0	96	98	99	99
Metolachlor	2.58	0	98	95	96	99
Metolachlor	5.25	0	98	98	97	99
Metribuzin	0.75	0	96	96	97	99
Untreated		0	0	0	0	0
LSD (0.05)		NS	2	4	2	1

[a]Rrpw = redroot pigweed, Colq = common lambsquarters, Kocz = kochia, Corw = common ragweed.

Weed control in potato. Richard K. Zollinger and Scott A. Fitterer. (Department of Plant Sciences, North Dakota State University, Fargo, ND 58105) An experiment was conducted near Glyndon, MN to evaluate weed control from herbicides applied PRE and POST. 'Russet Burbank' potato was seeded May 25, 1999, with imidacloprid insecticide applied in-furrow. PRE treatments were applied on June 2, 1999 at 7:00 to 8:00 am with 68 F air, 63 F soil at a 2 to 4 inch depth, 30% relative humidity, 20% clouds, 0 to 5 mph SE wind, dry soil surface, and moist subsoil. Plots were hilled on June 2, 1999. POST treatments were applied on June 14, 1999 at 1:30 to 2:00 pm with 74 F air, 90 F soil surface, 30% relative humidity, 5% clouds, 5 to 8 mph N wind, dry soil surface, moist subsoil, good crop vigor, no dew present, and 1 to 6 inch potato. Weeds present were: 1 to 3 leaf, foxtail (5 to 10/ft^2) and 1 to 2 inch, redroot pigweed (1 to 3/ft^2). Treatments were applied to the center 6.67 feet of 12 by 25 foot plots with a back-pack sprayer delivering 17 gpa at 40 psi through 8002 flat fan nozzles for PRE treatments and delivering 8.5 gpa at 40 psi through 8001 flat fan nozzles for POST applications. The experiment had a randomized complete block design with three replicates per treatment.

Growth reduction rating on June 14 reflects damage due to Colorado potato beetle feeding. An interaction occurred with imidacloprid and sulfentrazone. This interaction inhibited imidacloprid from controlling beetles. As the rate of sulfentrazone increased the effectiveness of imidacloprid decreased allowing more beetle damage to the potato plant. Clethodim showed complete safety to potato. Sulfentrazone gave poor to fair green and yellow foxtail control on June 24, but control from sulfentrazone+metribuzin was better. Control of redroot pigweed, common lambsquarters, and kochia was lower from metolachlor than other treatments on June 24. Kochia and common ragweed were completely controlled on July 13 (data not shown). Experiment was terminated after severe hail damage.

Table. Weed control in potato.

		June 14	June 24					July 13		
Treatment[a]	Rate	GR[b]	Fxtl[c]	Rrpw[c]	Colq[c]	Kocz[c]	Corw[c]	Fxtl[c]	Rrpw[c]	Colq[c]
	lb/A	%	% control							
PRE										
San 582H+metribuzin	1.17+0.5	0	98	99	99	99	99	98	99	99
San 582H-a+metribuzin	0.64+0.5	0	98	99	99	99	96	99	99	99
San 582H-a+rimsulfuron	0.64+0.016	0	95	99	99	99	99	94	99	99
Metribuzin+EPTC	0.5+3.0	0	82	98	99	92	96	90	99	99
Pendimethalin+metribuzin	1.0+0.5	0	95	99	98	98	99	98	99	99
EPTC+rimsulfuron	3.0+0.16	0	90	98	95	96	98	93	98	95
Metribuzin	0.5	0	90	94	94	82	97	93	98	99
Rimsulfuron	0.016	0	82	95	95	93	99	90	95	95
Sulfentrazone	0.125	10	60	96	96	96	98	80	96	99
Sulfentrazone	0.187	3	67	98	98	99	99	83	90	96
Sulfentrazone	0.234	8	65	98	96	98	98	83	95	96
Sulfentrazone	0.375	30	78	99	99	99	99	87	96	98
Sulfentrazone+metribuzin	0.187+0.25	5	90	96	98	98	99	92	99	99
Metolachlor	1.4	0	96	85	78	85	93	92	95	91
POST										
Clethodim+PO	0.094+1 qt	0	99	0	0	0	0	95	0	0
Clethodim+PO	0.125+1 qt	0	99	0	0	0	0	95	0	0
Clethodim+PO	0.188+1 qt	0	99	0	0	0	0	99	0	0
Clethodim+metribuzin+PO	0.125+0.375+1 qt	0	98	99	89	86	99	99	99	99
Sethoxydim+PO	0.28+1 qt	0	99	0	0	0	0	80	0	0
Untreated		0	0	0	0	0	0	0	0	0
LSD (0.05)		9	15	6	9	8	4	11	6	5

[a]PO = petroleum oil = Herbimax, San 582H-a = a-isomer of San 582H.
[b]GR = growth reduction.
[c]Fxtl = green foxtail and yellow foxtail, Rrpw = redroot pigweed, Colq = common lambsquarters, Kocz = kochia, Cocb = common cocklebur, Wimu = wild mustard.

Herbicide screening in carbon-seeded perennial ryegrass. Bradley D. Hanson, Bill D. Brewster, and Carol Mallory-Smith. (Department of Crop and Soil Science, Oregon State University, Corvallis, OR 97331-3002) Diuron has been used to control weeds and volunteer ryegrass in carbon-seeded perennial ryegrass fields in western Oregon for many years. Annual bluegrass has developed resistance to diuron through repeated use of this herbicide in new seedings and established stands. This resistance has greatly reduced the quality of seed produced in infested fields and underlines the need for alternative herbicide programs in both new seedings and established stands of perennial ryegrass. Two studies were established in carbon-seeded perennial ryegrass at the Hyslop Research Farm near Corvallis, OR to evaluate annual bluegrass tolerance to several herbicides. Experimental design in both experiments was a randomized strip plot with four replications. Individual plots were 8 by 24 ft in the fall-seeded trial (8 ft seeded without carbon and 16 ft seeded with carbon) and 8 by 32 ft in the spring-seeded trial (8 ft seeded without carbon and 24 ft seeded with carbon). 'Delaware Dwarf' perennial ryegrass was seeded at 8 lb/A in 12-inch rows in both experiments. Activated carbon was applied at 300 lb/A in a one-inch band over the seed row at planting. Herbicides were applied preemergance with a single-wheel, compressed-air, plot sprayer calibrated to deliver 20 gpa at 19 psi and 3 mph (Table 1). The spring-seeded trial was sprinkler-irrigated to simulate fall growing conditions and increase the probability of crop injury. Seed yield in the fall-seeded trial was determined by swathing a 6 by 14 ft area from the carbon-seeded rows on July 10, allowing the grass to dry in the windrow, and threshing the seed on July 22, 1999 with a small plot combine. Because more than one year of growth is required to produce perennial ryegrass seed from a spring planting, seed yield was not obtained from the spring trial.

Table 1. Application data.

Seeding date	September 30, 1998	March 15, 1999
Application date	September 30, 1998	March 16, 1999
Air temp (F)	77	38
Soil temp (F)	68	40
RH (%)	39	98
Soil texture	Silt loam	Silt loam
Organic member (%)	2.4	2.4
pH	5.3	5.2

Annual bluegrass control in the fall-carbon-seeding experiment was at least 89% with all treatments (Table 2). Perennial ryegrass injury ranged from 20 to 81% in the absence of carbon and from 0 to 25% when carbon-seeded. Seed yield of perennial ryegrass was not different among treatments. Carbon-seeded perennial ryegrass was adequately protected from injury with all treatments in this experiment.

Spring-seeded perennial ryegrass was injured 33 to 100% by all treatments in the absence of carbon and 0 to 95% when carbon-seeded (Table 3). Diuron, sulfentrazone, and norflurazon were safe to the crop when carbon-seeded; low rates of azafenidin also were marginally safe. Carbon seeding did not prevent significant perennial ryegrass injury from pendimethalin and flufenacet-metribuzin.

Table 2. Annual bluegrass control and crop injury and seed yield in fall carbon-seeded perennial ryegrass.

Treatment	Rate	Annual bluegrass Control	Perennial ryegrass injury[a] no carbon	carbon-seeded	Perennial ryegrass seed yield
	lb/A	%			lb/A
Untreated check	--	0	0	0	2094
Diuron	1.6	100	81	25	2172
Clomazone	0.25	100	30	3	2338
Norflurazon	0.25	89	20	0	2556
Sulfentrazone	0.125	97	55	3	2547
Diuron + clomazone	0.8 + 0.25	100	65	10	2520
Diuron + norflurazon	0.8 + 0.25	100	60	10	2558
Diuron + sulfentrazone	0.8 + 0.125	100	73	10	2355
$LSD_{(0.05)}$	--	3	13	4	ns

[a] February 15 rating.

Table 3. Crop injury from herbicides in spring-seeded perennial ryegrass on June 9, 1999.

Treatment	Rate	Perennial ryegrass injury	
		no carbon	carbon-seeded
	lb/A	%	
Untreated check	–	0	0
Diuron	2.4	100	9
Sulfentrazone	0.125	33	0
Sulfentrazone	0.25	58	8
Sulfentrazone	0.375	80	3
Norflurazon	0.5	70	0
Norflurazon	1.0	96	9
Norflurazon	1.5	100	13
Pendimethalin	1.5	99	60
Pendimethalin	3.0	100	90
Pendimethalin	4.5	100	95
Azafenidin	0.125	100	15
Azafenidin	0.25	100	24
Azafenidin	0.375	100	30
Flufenacet-metribuzin	0.42	100	53
Flufenacet-metribuzin	0.63	100	68
Flufenacet-metribuzin	0.84	100	85
$LSD_{(0.05)}$		17	16

Downy brome control and seedling perennial ryegrass crop tolerance with glufosinate. Devesh Singh and Daniel A. Ball. (Columbia Basin Agricultural Research Center, Oregon State University, Pendleton, 97801). Three trials were conducted to evaluate the effect of application rate and timing of glufosinate on downy brome control and crop tolerance in seedling perennial ryegrass. First (1997-98) and second (1998-99) trials were conducted under center pivot irrigation at the Hermiston Agricultural Research & Extension Center. Herbicide treatments were applied with a hand-held CO_2 backpack sprayer with 15 GPA water at 30 psi. The third trial (1998-99) was conducted on a commercial, pivot-irrigated field near Echo, OR. Herbicide treatments were applied with a hand-held CO_2 backpack sprayer with 17 GPA water at 30 psi. Soil characteristics for the experimental sites are summarized in Table 1. Application timings and climatic conditions at time of application are summarized in Table 2. No surfactant was mixed with glufosinate treatments.

Table 1. Soil characteristics of experiment sites.

	First trial (1997-98)	Second trial (1998-99)	Third trial (1998-99)
Soil Texture	Sandy loam	Loamy sand	Silt loam
Organic Matter (%)	0.79	1.09	1.04
pH	6.5	6.6	5.7
CEC (meq/100 g)	9.6	10.3	8.2

Table 2. Application description.

	Perennial ryegrass	Downy brome	Air temperature	Relative humidity	Soil temperature (2")
			F	%	F
First trial					
Feb 17, 98	4-6 tillers, 4.5" tall	-	60	-	54
Feb 27, 98	5-9 tillers, 4.5"tall	-	56	70	50
Mar 25, 98	Multiple tillers	-	54	85	52
Second trial					
Feb 23, 99	Multiple tillers, 3" tall	-	54	74	50
Mar 15, 99	Multiple tillers, 4-5" tall	-	46	70	52
Apr 2, 99	Fully tillered, 5-6" tall	-	58	48	42
Third trial					
Feb 26, 99	3-4" tall	Tillered, 2-3" tall	50	54	50
Mar 17, 99	3-4" tall	Tillered, 3" tall	54	60	56
Apr 2, 99	3-5" tall	Tillered, 6-8"tall	58	54	48

In the first trial (var. Palmer III), early spring and late spring application of glufosinate at high rate of 0.38 lb/A provided good control of downy brome (Table 3). An early/mid spring split application at 0.25 lb/A, each, also provided effective downy brome control. Glufosinate applications were not overly phytotoxic to perennial ryegrass (data not shown).

In the second trial (var. Top Hat) no crop injury on perennial ryegrass was evident from glufosinate treatments throughout the cropping season. Clean seed yields were mostly unaffected by glufosinate treatments except yields were significantly reduced by early spring glufosinate application at high rate of 0.38 lb/A (Table 4). Clean seed yields were also reduced by the early/mid spring split application of glufosinate at 0.25 lb/A. Highest seed yield was obtained in the weed-free check plots, which were hand-weeded.

In the third trial (var. Brightstar) perennial ryegrass response to mid-spring application of glufosinate was most prominent (Table 5). All treatments applied on the March 17 produced visible perennial ryegrass injury and provided the best control of downy brome. Split treatment of glufosinate at 0.38 lb/A + 0.38 lb/A in early spring and mid-spring provided effective downy brome control in this study and reduced downy brome seed contamination in the cleaned seed. The same treatment significantly increased the clean seed yield of perennial ryegrass. Due to the high downy brome pressure in the untreated check the clean seed yields were significantly reduced.

Table 3. First trial: Effect of glufosinate treatments in seedling perennial ryegrass (variety Palmer III).

Treatment	Rate	Timing	April 28, 98		Clean seed yield
			Crop injury	Downy brome control	
	lb/A		%		lb/A
Glufosinate	0.25	Feb 17, 98	0	63	997
Glufosinate	0.38	Feb 17, 98	7	97	1331
Glufosinate / Glufosinate	0.25 / 0.25	Feb 17 / Feb 28, 98	3	93	1110
Glufosinate	0.25	Feb 28, 98	0	60	1161
Glufosinate	0.38	Feb 28, 98	7	63	1151
Glufosinate / Glufosinate	0.25 / 0.25	Feb 28 / Mar 25, 98	7	63	1103
Glufosinate	0.25	Mar 25, 98	3	67	1276
Glufosinate	0.38	Mar 25, 98	7	93	1251
Untreated			0	0	1175
L.S.D (0.05)			NS	53	NS

Table 4. Second trial: Effect of glufosinate treatments in seedling perennial ryegrass (variety Top Hat).

Treatment	Rate	Timing	Clean seed yield
	lb/A		lb/A
Glufosinate	0.25	Feb 23, 99	1830
Glufosinate	0.38	Feb 23, 99	1555
Glufosinate / Glufosinate	0.25 / 0.25	Feb 23 / Mar 15, 99	1674
Glufosinate	0.25	Mar 15, 99	1807
Glufosinate	0.38	Mar 15, 99	1862
Glufosinate / Glufosinate	0.25 / 0.25	Mar 15 / Apr 2, 99	1608
Glufosinate	0.25	Apr 2, 99	1824
Glufosinate	0.38	Apr 2, 99	1896
Untreated			1897
Weed-free Check			2109
L.S.D (0.05)			253

Table 5. Third trial: Effect of glufosinate treatments in seedling perennial ryegrass (variety Brightstar).

Treatment	Rate	Timing	April 14, 99		May 13, 99		DB[c] seed yield	PRG[d] seed yield	Contamination[e]
			PRG[a]	DB[b]	PRG[a]	DB[b]			
			%				lb/ac	lb/ac	%
Glufosinate	0.25	Feb 26, 99	0	13	10	40	154	993	1.3
Glufosinate	0.38	Feb 26, 99	0	22	18	52	150	1172	0.6
Glufosinate / Glufosinate	0.25 / 0.25	Feb 26 / Mar 17, 99	23	68	8	41	171	1051	0.9
Glufosinate / Glufosinate	0.38 / 0.38	Feb 26 / Mar 17, 99	22	99	15	92	118	1465	0.4
Glufosinate	0.25	Mar 17, 99	12	57	5	60	172	1175	2.1
Glufosinate	0.38	Mar 17, 99	32	73	8	75	134	1160	0.8
Glufosinate / Glufosinate	0.25 / 0.25	Mar 17 / Apr 2, 99	22	68	10	73	129	1131	0.7
Glufosinate	0.25	Apr 2, 99	3	20	0	22	188	1011	1.6
Glufosinate	0.38	Apr 2, 99	5	23	0	7	157	759	2.3
Untreated			0	0	0	0	184	878	1.0
L.S.D (0.05)			11	19	NS	39	NS	375	NS

PRG[a]: Perennial ryegrass injury
DB[b]: Downy brome control
DB[c]: Downy brome seed separated during the clean process.
PRG[d]: Perennial ryegrass clean seed yield
Contamination[e]: Percent downy brome contamination by weight in cleaned perennial ryegrass seed.

Fluroxypyr versus dicamba for weed control in grain sorghum. Patrick W. Geier and Phillip W. Stahlman. (Kansas State University Agricultural Research Center, Hays, KS 67601). An experiment conducted near Hays, KS in 1999 compared fluroxypyr rates and timings to dicamba for weed control and crop response in dryland, no-till grain sorghum. Fluroxypyr was applied alone at 0.125, 0.187, or 0.25 lb/A and with atrazine at 0.5 lb/A. Dicamba was applied at 0.25 lb/A alone and with atrazine. Each treatment was applied early-POST, POST or late-POST. A blanket application of S-metolachlor at 0.72 lb/A was applied PRE to all plots to reduce annual grass pressure. Soil for the experiment was Crete silty clay loam with pH 6.3 and 2.2% organic matter. 'DK39Y' grain sorghum was seeded 1.5 inches deep on May 31 at 40,000 kernels/A in rows spaced 30 inches apart. The experiment was a factorial of herbicide treatment and application timing with three replicates. Plots were 10 by 32 ft. Growing-season precipitation (June through September) totaled 15.1 inches, 3.1 above normal. Details on application, environmental conditions, and plants are listed below.

Date	Jun 3	Jun 22	Jun 27	Jul 1
Treatment	PRE	EPOST	POST	LPOST
Sprayer				
gpa	12	12	12	12
psi	24	24	24	24
Temperature (C)				
air	19	24	24	31
soil (2 inch)	20	20	27	32
Soil moisture	moist	moist	moist	moist
Wind (mph)	5-10E	8-12S	3-6E	0-3SE
Sky cloudy	cloudy	cloudy	clear	clear
Relative				
humidity (%)	88	84	86	46
Grain				
sorghum	-			
leaf no.	-	5-6	6-7	6-7
height (inch)	-	4-5	8-10	12-14
Kochia				
leaf no.	-	100	150	200
height (inch)	-	4-6	8-10	8-12
infestation	-	1/m^2	1/m^2	1/m^2
Tumble				
pigweed				
leaf no.	-	4-6	6-10	6-12
height (inch)	-	1-3	2-6	2-8
infestation	-	3/m^2	3/m^2	3/m^2
Puncturevine				
leaf no.	-	3-6	4-8	4-8
diameter (inch)	-	4-12	4-24	6-36
infestation	-	2/m^2	2/m^2	2/m^2

Herbicide by application timing interactions occurred for kochia and tumble pigweed control (Table 1). These interactions generally occurred with fluroxypyr at the low rates alone or with atrazine. Averaged over application timing, dicamba or fluroxypyr alone at 0.25 lb/A or fluroxypyr at any rate with atrazine provided the best kochia control (91 to 95%). Fluroxypyr alone at 0.125 or 0.187 lb/A provided less tumble pigweed control (93% compared to 96 to 100 for other treatments). Tank mixing dicamba or fluroxypyr with atrazine either did not improve or improved efficacy only slightly. Grain sorghum was not visibly injured by herbicide treatment, nor were sorghum stands or mature plant heights. Averaged over application timings, grain sorghum yields ranged from 105 to 121 bu/A, and did not differ among treatments (Table 2). Although not significant, sorghum yields tended to be greater with late-POST applications than with early-POST applications.

Table 1. Fluroxypyr rates and timings for weed control in no-till, dryland grain sorghum.

		Kochia [b]				Tumble pigweed [b]			
Treatment [a]	Rate	EPOST	POST	LPOST	Treatment mean	EPOST	POST	LPOST	Treatment mean
	(lb/A)	(%)				(%)			
Dicamba	0.25	94	90	88	91	100	100	87	96
Fluroxypyr	0.125	95	87	83	88	97	83	100	93
Fluroxypyr	0.187	97	90	77	88	93	98	87	93
Fluroxypyr	0.25	98	91	88	92	98	99	100	99
Dicamba+atrazine	0.25+0.5	92	78	80	83	97	100	100	99
Fluroxypyr+atrazine	0.125+0.5	92	93	94	93	100	100	100	100
Fluroxypyr+atrazine	0.187+0.5	99	97	90	95	100	100	100	100
Fluroxypyr+atrazine	0.25+0.5	98	89	96	94	100	100	98	99
Atrazine&2,4-D	0.56&0.25	70	90	80	80	100	100	100	100
Atrazine&fluroxypyr	0.56&0.25	95	87	85	89	100	97	99	99
LSD (0.05)		11			7	7			5

[a] All treatments received a blanket application of S-metolachlor at 0.76 lb/A PRE.

[b] Application timings: EPOST = 4 to 5 inch sorghum; POST = 8 to 10 inch sorghum; LPOST = 12 to 14 inch sorghum.

Table 2. Grain sorghum yields following application of fluroxypyr rates and timings.

		Yield			
Treatment [a]	Rate	EPOST [b]	POST [b]	LPOST [b]	Treatment mean
	(lb/A)	(bu/A)			
Dicamba	0.25	93.0	109.8	111.8	104.9
Fluroxypyr	0.125	107.4	103.7	116.9	109.3
Fluroxypyr	0.187	108.8	119.0	113.6	113.8
Fluroxypyr	0.25	109.6	108.5	117.5	111.9
Dicamba+atrazine	0.25+0.5	117.8	120.7	115.9	118.1
Fluroxypyr+atrazine	0.125+0.5	119.6	120.2	124.2	121.3
Fluroxypyr+atrazine	0.187+0.5	117.3	113.9	112.1	114.4
Fluroxypyr+atrazine	0.25+0.5	123.1	114.5	125.1	120.9
Atrazine&2,4-D	0.56&0.25	110.3	109.7	107.1	109.0
Atrazine&fluroxypyr	0.56&0.25	107.9	116.8	113.3	112.7
LSD (0.05)		NS			NS

[a] All treatments received a blanket application of S-metolachlor at 0.76 lb/A PRE.

[b] Application timings: EPOST = 4 to 5 inch sorghum; POST = 8 to 10 inch sorghum; LPOST = 12 to 14 inch sorghum.

Control of biennial wormwood in soybean. George O. Kegode and Mark G. Ciernia. (Department of Plant Sciences, North Dakota State University, Fargo, ND 58105). Biennial wormwood is becoming a serious weed in soybean production systems in the Northern Great Plains. Field studies were conducted at Fargo, Geneseo, and Wyndmere, ND to evaluate PRE and POST applied herbicides for control of biennial wormwood in soybean. Glyphosate-resistant soybean were planted at Fargo (Asgrow AG0901) and Wyndmere (Pioneer 9093), whereas 'Wensman 3096' conventional soybean was seeded at Geneseo. Soybeans were seeded in 30 inch rows at Fargo and Wyndmere, and in 20 inch rows at Geneseo.

Fargo study: Glyphosate at 0.75 ae/A was applied as a burndown treatment on May 20, 1999, since some biennial wormwood had already emerged by April 20. Soybean was seeded on May 24. PRE treatments were applied within 24 hrs of soybean seeding and POST treatments were applied when biennial wormwood seedlings were 2 in tall. Split application of herbicides were: POSTI, applied when biennial wormwood seedlings were 1 in tall; and POSTII, applied when biennial wormwood seedlings were 3 in tall. All treatments were applied to the center 6.7 ft of the 10 by 30 ft plots with a bicycle-wheel-type sprayer equipped with a drift shield, delivering 17 gpa (PRE) and 8.5 gpa (POST) at 40 psi through 8002 flat fan nozzles. Additional herbicide application information is in Table 1. The experiment was in a randomized complete block design with four replicates per treatment. Biennial wormwood control and soybean injury were evaluated 14 and 28 days after herbicide application and soybean yield was measured at the end of the study. Biennial wormwood densities ranged from 1 to 6 plants ft^{-2} (and averaged 3 plants ft^{-2}).

Table 1: Application data for the Fargo study.

Application type:	PRE	POST	POSTI	POSTII
Date:	May 25	June 25	June 18	July 1
Time:	8:30 a.m.	8:00 a.m.	8:30 a.m.	1:00 p.m.
Cloud cover:	Clear	Partly cloudy	Mostly cloudy	Partly cloudy
Winds:	2 – 6 mph	3 – 7 mph	3 – 7 mph	2 – 5 mph
Air temperature:	15 C	26 C	18 C	21 C
Relative humidity:	44%	46%	45%	72%
Soybean stage:	-	3 Trifoliate	2 Trifoliate	3 – 4 Trifoliate
Weed stage:	-	6 – 8 leaf	4 – 6 leaf	8 – 11 leaf

Geneseo and Wyndmere studies: Soybean was seeded on May 22 at Wyndmere and May 25 at Geneseo. Glyphosate at 0.75 ae/A was applied as a burndown treatment on May 25 at Wyndmere and May 27 at Geneseo. Application of POST herbicides, experimental design, and herbicide evaluations were similar to the Fargo, ND study. Yield data, however, were not collected at either Geneseo or Wyndmere. Additional information pertinent to herbicide application are in Tables 2 and 3. Biennial wormwood population density at Geneseo ranged from 1 to 5 plants ft^{-2} (and averaged 2 plants ft^{-2}), and at Wyndmere ranged from 0 to 2 plants ft^{-2} (and averaged 1 plant ft^{-2}).

Table 2: Application data for the Geneseo study.

Application type:	POST	POSTI	POSTII
Date:	June 29	June 21	July 6
Time:	10:00 a.m.	11:30 a.m.	10:00 a.m.
Cloud cover:	Partly cloudy	Mostly cloudy	Clear
Winds:	5 – 8 mph from S	8 – 10 mph from SE	1 – 3 mph from W
Air temperature:	21 C	26 C	25 C
Relative humidity:	43%	53%	24%
Soybean stage:	2 Trifoliate	1 Trifoliate	5 Trifoliate
Weed stage:	3 – 6 leaf	1 – 4 leaf	4 – 12 leaf

Table 3: Application data for the Wyndmere study.

Application type:	POST	POSTI	POSTII
Date:	June 29	June 21	July 6
Time:	11:00 a.m.	10:30 a.m.	11:00 a.m.
Cloud cover:	Partly cloudy	Mostly cloudy	Clear
Winds:	7 – 10 mph	6 – 9 mph	6 – 8 mph
Air temperature:	22 C	27 C	27 C
Relative humidity:	45%	49%	37%
Soybean stage:	3 Trifoliate	2 Trifoliate	5 Trifoliate
Weed stage:	4 – 6 leaf	1 – 4 leaf	8 – 12 leaf

Glyphosate provided the best control of biennial wormwood at all three locations (Tables 4, 5, and 6). Bentazon split applied provided better than 90% control of biennial wormwood at Fargo (Table 4) and as a result soybean yield was similar to the glyphosate treatments. However, bentazon as split application was less effective at Wyndmere and Geneseo then at Fargo. Continuous emergence of biennial wormwood seedlings, especially following rain events, was the primary reason for poor control by a most of the herbicides used at the three sites.

Table 4. Effect of PRE and POST herbicide treatments on biennial wormwood control and soybean injury at 14 and 28 days after treatment, and soybean yields, Fargo, ND.

			Biww control[d]		Soybean injury		
Treatment[a]	Rate[b]	Timing[c]	14 d	28 d	14 d	28 d	Yield
	oz ai/A		%				lb/A
Flumioxazin	1	PRE	62	45	0	0	2450
Flumioxazin	1.5	PRE	55	28	0	0	1600
Flumioxazin	2	PRE	65	48	0	0	2400
Lactofen+COC	1.5+1%	POST	68	32	24	9	2450
Lactofen+COC	3.13+1%	POST	81	53	18	12	2400
Lact+COC/Lact+COC	1+1%/1+1%	POSTI & II	58	31	14	5	2300
Glyphosate+AMS	12+23	POST	97	98	0	0	3400
Glyphosate+AMS	9+23	POST	96	96	1	0	3250
Glyt+AMS/Glyt+AMS	6+23/6+23	POSTI & II	99	100	0	0	3250
Alachlor	32	PRE	61	30	0	0	2200
Metolachlor	31	PRE	44	23	0	0	2200
Dimethenamid	24	PRE	36	22	0	0	1700
Acifluorfen+NIS	4+0.25%	POST	32	7	5	5	2100
Acif+NIS/Acif+NIS	2+0.25/2+0.25	POSTI & II	26	11	12	3	1500
Bentazon+PO	16+0.25 gpa	POST	78	42	12	6	2800
Bent+PO/Bent+PO	8+0.25 gpa/ 8+0.25 gpa	POSTI & II	91	90	0	0	3550
Thifensulfuron	0.083+0.25%	POST	74	49	6	2	2850
Flumiclorac+Lact+PO	0.43+3.2+0.13 gpa	POST	74	46	24	8	2850
Untreated	0	-	0	0	0	0	1750
C.V.%			15	27	84	134	33
LSD 5%			13	17	7	5	1200

[a]COC = crop oil concentrate (petroleum based); AMS = ammonium sulfate; NIS = non-ionic surfactant; PO = petroleum oil
[b]gpa = gallons per acre
[c]PRE = preemergence; POST = postemergence; POSTI & II = postemergence split treatments
[d]Biww = Biennial wormwood

Table 5. Effect of POST herbicide treatments on biennial wormwood control and soybean injury 14 and 28 days after treatment, Wyndmere, ND.

Treatment[a]	Rate[b]	Timing[c]	Biww control[d]		Soybean injury	
			14 d	28 d	14 d	28 d
	oz ai/A		%			
Lactofen+COC	1.5+1%	POST	56	23	10	10
Lactofen+COC	3.13+1%	POST	56	38	16	11
Lact+COC/Lact+COC	1+1%/1+1%	POSTI & II	40	36	8	3
Glyphosate+AMS	12+23	POST	84	58	0	0
Glyphosate+AMS	9+23	POST	77	58	0	0
Glyt+AMS/Glyt+AMS	6+23.6+23	POSTI & II	94	75	0	0
Acifluorfen+NIS	4+0.25%	POST	40	23	4	2
Acif+NIS/Acif+NIS	2+0.25/2+0.25	POSTI & II	18	3	3	2
Bentazon+PO	16+0.25 gpa	POST	51	19	1	2
Bent+PO/Bent+PO	8+0.25 gpa/8+0.25 gpa	POSTI & II	44	56	2	2
Fomesafen&adju+MSO	2.82+1%	POST	54	21	1	1
Fomesafen&adju+MSO	1.88+1%	POST	48	31	1	1
Thifensulfuron	0.083+0.25%	POST	39	25	0	1
Flumiclorac+Lact+PO	0.43+3.2+0.13 gpa	POST	61	39	49	35
Imazethapyr+Quad7	0.76+1%	POST	37	26	8	1
Imazamox+Quad7	0.63+1%	POST	48	31	7	2
C.V.%			24	32	51	78
LSD 5%			18	16	5	5

[a]COC = crop oil concentrate (petroleum based); AMS = ammonium sulfate; NIS = non-ionic surfactant; PO = petroleum oil; adju = adjuvant.
[b]gpa = gallons per acre
[c]PRE = preemergence; POST = postemergence; POSTI & II = postemergence split treatments
[d]Biww = Biennial wormwood

Table 6. Effect of POST herbicide treatments on biennial wormwood control and soybean injury 14 and 28 days after treatment, Geneseo, ND.

Treatment[a]	Rate[b]	Timing[c]	Biww Control[d]		Soybean Injury	
			14 d	28 d	14 d	28 d
	oz ai/A		%			
Lactofen+COC	1.5+1%	POST	54	42	27	18
Lactofen+COC	3.13+1%	POST	74	63	19	10
Lact+COC/Lact+COC	1+1%/1+1%	POSTI & II	53	55	17	18
Glyphosate+AMS	12+23	POST	76	87	86	93
Glyphosate+AMS	9+23	POST	77	91	84	99
Glyt+AMS/Glyt+AMS	6+23/6+23	POSTI & II	92	98	100	100
Acifluorfen+NIS	4+0.25%	POST	39	10	19	12
Acif+NIS/Acif+NIS	2+0.25/2+0.25	POSTI & II	4	1	6	6
Bentazon+PO	16+0.25 gpa	POST	76	68	7	2
Bent+PO/Bent+PO	8+0.25 gpa/8+0.25 gpa	POSTI & II	63	77	4	5
Fomesafen&adju+MSO	2.82+1%	POST	45	22	7	5
Fomesafen&adju+MSO	1.88+1%	POST	26	8	6	5
Thifensulfuron	0.083+0.25%	POST	24	13	2	4
Flumiclorac+Lact+PO	0.43+3.2+0.13 gpa	POST	71	62	59	41
Imazethapyr+Quad7	0.76+1%	POST	35	15	14	6
Imazamox+Quad7	0.63+1%	POST	65	42	34	23
C.V.%			28	25	49	34
LSD 5%			22	17	21	14

[a]COC = crop oil concentrate (petroleum based); AMS = ammonium sulfate; NIS = non-ionic surfactant; PO = petroleum oil; adju = adjuvant.
[b]gpa = gallons per acre
[c]PRE = preemergence; POST = postemergence; POSTI & II = postemergence split treatments
[d]Biww = Biennial wormwood

Evaluation of preemergence and postemergence herbicide applications on sugar beets, 1998. Marvin D. Butler. (Central Oregon Agricultural Research Center, Oregon State University, 850 NW Dogwood Ln., Madras, OR 97741) Evaluation of preemergence and postemergence herbicide applications on sugar beets was conducted in two commercial fields near Prineville and Culver, Oregon. Preemergence treatments were ethofumesate and pyrazon alone and in combination. Postemergence applications were phenmedipham and desmedipham, phenmedipham and desmedipham plus triflusulfuron, phenmedipham and desmedipham and ethofumesate, phenmedipham and desmedipham and ethofumesate plus triflusulfuron, phenmedipham and desmedipham plus triflusulfuron at less than label rates with crop oil concentrate at 1.5% v/v alone and in combination with ammonium nitrate at 4% v/v. Treatments applied preemergence were made April 22 at Culver and May 1 at Prineville. The first postemergence treatments were made at the cotyledon stage May 6 at Culver and May 18 in Prineville. The second postemergence treatments were made at the two-leaf stage May 15 at Culver and May 27 at Prineville, with a third postemergence application June 5 at the Prineville location at the four-leaf stage.

Treatments were applied with a CO_2-pressurized, hand-held boom sprayer calibrated to deliver 20 gpa at 40 psi. Plots 10 ft by 22 ft were replicated four times in a randomized complete block design. Evaluation of treatments at the Prineville location were made June 19 for redroot pigweed, hairy nightshade, kochia, and common lambsquarters. Treatments at the Culver location were evaluated on June 24 for percent control of common lambsquarters, henbit, hairy nightshade, and kochia.

Similar results were obtained from the two locations. Application of ethofumesate at 1.5 lb/A followed by phenmedipham and desmedipham plus triflusulfuron provided the best result with 97 to 98% overall weed control. Pyrazon at 3.1 lb/A followed by phenmedipham and desmedipham plus triflusulfuron provided overall weed control of 87 to 91%, while 88 to 95% control was provided with a combination of ethofumesate at 0.5 lb/A plus pyrazon at 0.5 lb/A as the preemergence application. Reducing the rate of ethofumesate from 1.5 lb/A to 0.75 lb/A when followed by phenmedipham and desmedipham plus triflusulfuron reduced overall weed control to 95%. Reducing the rate of pyrazon from 3.1 lb/A to 1.3 lb/A when followed by phenmedipham and desmedipham plus triflusulfuron reduced overall weed control to 82 to 83%. Ethofumesate provided better weed control than pyrazon at both rates.

Treatments with both preemergence and postemergence applications generally provided greater weed control than postemergence treatments alone. Similar weed control was provided by postemergence only application of phenmedipham and desmedipham, or phenmedipham and desmedipham and ethofumesate whether applied alone or with triflusulfuron. Results from phenmedipham and desmedipham at 0.08 lb/A plus clopyralid at 0.03 lb/A plus triflusulfuron at either 0.011 lb/A or 0.008 lb/A were similar. Rescue treatments with the first application delayed until the two-leaf stage provided similar weed control whether or not ammonium nitrate at 4% v/v was included.

Table 1. Effect of herbicide application on sugar beets near Prineville, 1998.

	Application				Weed control[a]				
Treatments[b]	Pre	Post 1	Post 2	Post 3	Hairy nightshade	Redroot pigweed	Kochia	Common lambsquarters	Average
	(lb/A)				(%)				
Ethofumesate	0.75				99 a	99 a	90 a	94 a	95
phen & desm[c] +		0.24	0.32						
triflusulfuron		0.016	0.016						
Ethofumesate	1.5				99 a	100 a	93 a	98 a	97
phen & desm +		0.24	0.32						
triflusulfuron		0.016	0.016						
Pyrazon	1.3				99 a	94 a	55 ab	81 a	82
phen & desm +		0.24	0.32						
triflusulfuron		0.016	0.016						
Pyrazon	3.1				99 a	99 a	52 ab	99 a	87
phen & desm +		0.24	0.32						
triflusulfuron		0.016	0.016						
Ethofumesate +	0.5				99 a	100 a	58 ab	96 a	88
pyrazon	0.5								
phen & desm +		0.24	0.32						
triflusulfuron		0.016	0.016						
Phen & desm & etho[d]		0.27	0.38		98 a	97 a	73 ab	62 a	82
Phen & desm & etho +		0.27	0.38		96 a	96 a	59 ab	81 a	83
triflusulfuron		0.016	0.016						
Phen & desm		0.24	0.32		94 a	53 b	43 ab	80 a	67
Phen & desm +		0.24	0.32		94 a	93 a	55 ab	60 a	75
triflusulfuron		0.016	0.016						
Phen & desm +		0.08	0.08	0.08	94 a	85 ab	38 ab	89 a	76
triflusulfuron +		0.011	0.011	0.011					
clopyralid[e]		0.03	0.03	0.03					
Phen & desm +		0.08	0.08	0.08	93 a	80 ab	41 ab	71 a	71
triflusulfuron +		0.008	0.008	0.008					
clopyralid[e]		0.03	0.03	0.03					
Phen & desm +			0.32	0.32	98 a	95 a	46 ab	86 a	82
triflusulfuron +			0.016	0.016					
clopyralid[e]			0.09						
Phen & desm +			0.32	0.32	97 a	56 ab	71 ab	89 a	78
triflusulfuron +			0.016	0.016					
clopyralid[e,f]			0.09						
Untreated	—	—	—	—	0 b	0 c	0 b	0 b	0

[a]Visual evaluation was conducted June 19, 1998.
[b]Treatments were applied May 1, May 18, May 27, June 5, 1998.
[c]Phen & desm=phenmedipham & desmedipham commerical formulation.
[d]Phen & desm & etho = phenmedipham & desmedipham & ethofumesate commercial formulation.
[e]Methylated seed oil added at 1.5% v/v.
[f]NH_4NO_3 added at 4% v/v.

Table 2. Effect of herbicide application on sugar beets near Culver, OR, 1998.

Treatments[b]	Application			Weed control[a]								
	Pre	Post 1	Post 2	Hairy nightshade		Henbit		Kochia		Common lambsquarters		Average
	(lb/A)			(%)								
Ethofumesate	0.75			94	a	98	a	93	a	95	a	95
phen & desm[c] +		0.24	0.32									
triflusulfuron		0.016	0.016									
Ethofumesate	1.5			100	a	99	a	91	a	100	a	98
phen & desm +		0.24	0.32									
triflusulfuron		0.016	0.016									
Pyrazon	1.3			93	a	75	a	68	a	98	a	83
phen & desm +		0.24	0.32									
triflusulfuron		0.016	0.016									
Pyrazon	3.1			99	a	99	a	66	a	100	a	91
phen & desm +		0.24	0.32									
triflusulfuron		0.016	0.016									
Ethofumesate +	0.5			95	a	99	a	91	a	96	a	95
pyrazon	0.5											
phen & desm +		0.24	0.32									
triflusulfuron		0.016	0.016									
Phen & desm & etho[d] +		0.27	0.38	93	a	96	a	60	a	100	a	87
triflusulfuron		0.016	0.016									
Phen & desm +		0.24	0.32	81	a	97	a	81	a	100	a	90
triflusulfuron		0.016	0.016									
Phen & desm +		0.08	0.08	86	a	75	a	83	a	91	a	84
triflusulfuron +		0.011	0.011									
clopyralid[d]		0.03	0.03									
Phen & desm +		0.08	0.08	93	a	73	a	78	a	91	a	83
triflusulfuron +		0.008	0.008									
clopyralid[e]		0.03	0.03									
Phen & desm +			0.32	85	a	63	a	71	a	99	a	79
triflusulfuron +			0.016									
clopyralid[e]			0.09									
Phen & desm +			0.32	91	a	80	a	74	a	98	a	86
triflusulfuron +			0.016									
clopyralid[e,f]			0.09									
Untreated	—	—	—	0	b	0	b	0	b	0	b	0

[a]Visual evaluation was conducted June 24, 1998.
[b]Treatments were applied April 22, May 6, May 15, 1998.
[c]Phen & desm=phenmedipham & desmedipham commerical formulation.
[d]Phen & desm & etho = phenmedipham & desmedipham & ethofumesate commercial formulation.
[e]Methylated seed oil added at 1.5% v/v.
[f]NH_4NO_3 added at 4% v/v.

Evaluation of preemergence and postemergence herbicide applications on sugar beets, 1999. Marvin D. Butler. (Central Oregon Agricultural Research Center, Oregon State University, 850 NW Dogwood Lane, Madras, OR 97741) Evaluation of preemergence and postemergence herbicide applications on sugar beets was conducted in two commercial fields near Prineville and Culver, Oregon. Preemergence treatments were ethofumesate at 1.5 lb/A and 1 lb/A followed by phenmedipham and desmedipham plus triflusulfuron at the labeled rate and at micro-rates (one-third label rate). Postemergence only applications were phenmedipham and desmedipham plus triflusulfuron at the labeled rates and micro-rates. Micro-rate treatments were in combination with or without clopyralid, and with or without MSO. The first application of a rescue treatment of phenmedipham and desmedipham plus triflusulfuron plus clopyralid was made at the two-leaf stage. Preemergence treatments were made April 26 at Culver and April 29 at Prineville. The first postemergence applications were made at the cotyledon stage May 28 at Culver and June 4 at Prineville, and the second at the two-leaf stage June 4 at Culver and June 11 at Prineville. A third postemergence application was made June 18 at the Prineville location only.

Treatments were applied with a CO_2-pressurized hand held boom sprayer calibrated to deliver 20 gpa at 40 psi. Plots 10 ft by 20 ft were replicated four times in a randomized complete block design. Plots at the Prineville location were evaluated for number of plants of kochia, common groundsel, common lambsquarters and hairy nightshade June 30. Plots were evaluated at the Culver location for number of plants of kochia, common groundsel, redroot pigweed, common lambsquarters and hairy nightshade June 16.

Application of ethofumesate at 1.5 lb/A followed by phenmedipham and desmedipham plus triflusulfuron controlled all the weeds per plot at the Prineville location and all but 8 weeds per plot at the Culver location. When the rate of ethofumesate was reduced to 1 lb/A, 5 weeds per plot were not controlled at Prineville and 14 weeds per plot were not controlled at Culver. Ethofumesate followed by phenmedipham and desmedipham plus triflusulfuron at micro-rates left 7 weeds per plot uncontrolled at the Prineville location and 58 weeds per plot at the Culver location.

The postemergence only treatments did not provide the level of weed control provided by the combination of preemergence and postemergence treatments. Micro-rates of phenmedipham and desmedipham plus triflusulfuron plus clopyralid left 38 and 60 weeds per plot uncontrolled at Prineville and Culver. The micro-rate of phenmedipham and desmedipham plus triflusulfuron without clopyralid did not control 50 weeds per plot at Prineville and 47 weeds per plot at Culver. Without MSO, micro-rates of phenmedipham and desmedipham plus triflusulfuron plus clopyralid controlled 25 more weeds than the same treatment with MSO. Following a rescue treatment of phenmedipham and desmedipham plus triflusulfuron plus clopyralid with MSO at 2% v/v, 23 weeds per plot remained but the plants were severely stunted.

Table 1. Effect of herbicide application on sugar beets near Prineville, OR, 1999.

Treatments[b]	Application Pre	Post 1	Post 2	Post 3	Weeds[a] Kochia	Common groundsel	Common lambsquarters	Hairy nightshade	Total
	(lb/A)				(number of plants)				
Ethofumesate	1.5				0	0	0	0 b	0
phen & desm[c] +		0.24	0.32						
triflusulfuron		0.016	0.016						
Ethofumesate	1.0				2	0	2	1 b	5
phen & desm +		0.24	0.32						
triflusulfuron		0.016	0.016						
Ethofumesate	1.5				4	1	2	1 b	8
phen & desm +		0.08	0.08						
triflusulfuron[d]		0.006	0.006						
Phen & desm +		0.08	0.08	0.08	14	15	14	7 b	50
triflusulfuron[d]		0.006	0.006	0.006					
Phen & desm +		0.08	0.08	0.08	13	19	24	8 b	64
triflusulfuron +		0.006	0.006	0.006					
clopyralid		0.03	0.03	0.03					
Phen & desm +		0.08	0.08	0.08	13	8	8	9 b	38
triflusulfuron +		0.006	0.006	0.006					
clopyralid[d]		0.03	0.03	0.03					
Phen & desm +			0.32	0.32	5	5	8	6 b	24
triflusulfuron +			0.016	0.016					
clopyralid[e]			0.09	0.09					
Untreated		—	—	—	3	15	5	66 a	89
					ns	ns	ns		

[a]Visual evaluation was conducted on June 30, 1999.
[b]Treatments were applied April 29, June 4, June 11, and June 18, 1999.
[c]Phen & desm = phenmedipham and desmedipham commercial formulation.
[d]Methylated seed oil added at 1.5% v/v.
[e]Methylated seed oil added at 2.0% v/v.

Table 2. Effect of herbicide application on sugar beets near Culver, OR, 1999.

Treatments[b]	Application Pre	Post 1	Post 2	Weeds[a] Kochia	Common groundsel	Redroot pigweed	Common lambsquarters	Hairy nightshade	Total
	(lb/A)			(number of plants)					
Ethofumesate	1.5			0	1	0	3 b	4	8
phen & desm +		0.24	0.32						
triflusulfuron		0.016	0.016						
Ethofumesate	1.0			1	5	0	2 b	7	15
phen & desm +		0.24	0.32						
triflusulfuron		0.016	0.016						
Ethofumesate	1.5			0	4	1	26 a	27	58
phen & desm +		0.08	0.08						
triflusulfuron[d]		0.006	0.006						
Phen & desm +		0.08	0.08	4	6	6	28 a	4	48
triflusulfuron[d]		0.006	0.006						
Phen & desm +		0.08	0.08	1	3	14	30 a	14	62
triflusulfuron +		0.006	0.006						
clopyralid [d]		0.03	0.03						
Untreated		—	—	0	16	16	24 a	34	90
				ns	ns	ns		ns	

[a]Visual evaluation was conducted on June 16, 1999.
[b]Treatments were applied April 26, May 28, and June 4, 1999.
[c]Phen & desm = phenmedipham and desmedipham commercial formulation.
[d]Methylated seed oil added at 1.5% v/v.

Weed control in glyphosate resistant sugarbeets. Corey J. Guza, Corey V. Ransom, Joey Ishida, and Carol Mallory-Smith. (Malheur Experiment Station, Ontario, OR 97914 and Department of Crop and Soil Sciences, Oregon State University, Corvallis, OR 97331-3002). Glyphosate-resistant sugarbeets allow glyphosate to be used for postemergent weed control in sugarbeets. Studies were conducted in 1998 and 1999 in Malheur County Oregon to evaluate glyphosate rate and application timing for weed control in sugarbeets. Tank mixtures with residual herbicides or residual herbicides applied preplant incorporated with sequential postemergent applications were compared to a standard herbicide program. The standard program consisted of ethofumesate, ethofumesate + phenmedipham + desmedipham, triflusulfuron and sethoxydim (Table 1 and Table 2). The glyphosate-resistant sugarbeets were grown in a silt loam soil and furrow irrigated. Plot size was 7.33 by 27 feet and the study design was a randomized complete block with treatments replicated three times. Weed control was evaluated visually 21 days after the final application, June 28, 1998, and June 14, 1999, and at the end of the season, Sept. 3, 1998, and Sept. 7, 1999. Weeds evaluated included redroot pigweed, common lambsquarters, hairy nightshade, and barnyardgrass. Sugarbeet yield and percent sugar content were determined.

In 1998, all treatments that included glyphosate provided weed control equal to and greater than the standard (85 to 98%) for all weed species except for a single application of glyphosate to 2- to 4-leaf stage sugarbeets at a rate of 0.75/A. The single application of glyphosate provided lower redroot pigweed (68%), hairy nightshade (62%) and barnyardgrass (68%) control than the standard treatment. Sugarbeet root yield with glyphosate treatments (33.5 to 38.5 ton/A) were greater than or equal to the standard (34.7 ton/A). Sugar content also was greater than or equal to the standard for treatments containing glyphosate (Table 1).

In 1999, most treatments containing glyphosate provided weed control equal to and greater than the standard (93 to 100%) for all weed species. However, a single application of glyphosate applied once to 2- to 4-leaf sugarbeets provided less redroot pigweed (78%) and hairy nightshade (92%) control than the standard. A single application of glyphosate + ethofumesate to 2- to 4-leaf sugarbeets also provided less redroot pigweed (82%) and common lambsquarters (93%) control than the standard or some treatments with multiple applications of glyphosate. Even with slight differences in weed control, there were no differences in sugarbeet yield and sugar content between any of the glyphosate treatments and the standard treatment (Table 2).

Table 1. 1998 weed control and yield results, glyphosate-resistant sugar beets.

Treatment	Rate	Timing	Weed control: Redroot pigweed June 29	Redroot pigweed Sept. 3	Common lambsquarters June 29	Common lambsquarters Sept. 3	Hairy nightshade June 29	Hairy nightshade Sept. 3	Barnyard-grass Sept. 3	Sugarbeet yield: Root yield	Sugar content
		Leaf	---	---	---	%	---	---	---	ton/a	%
Glyphosate + AMS [a]	0.37 + 2.5	cot + 2-4 + 6-8	95	92	95	97	95	92	85	37.6	16.02
Glyphosate	0.37	cot + 2-4 + 6-8	95	83	95	97	95	98	87	35.2	16.27
Glyphosate	0.56	cot + 2-4 + 6-8	95	95	95	98	95	98	92	37.2	15.98
Glyphosate	0.75	cot +2-4 + 6-8	95	98	95	98	95	98	97	37.3	16.02
Glyphosate/ Glyphosate + ethofumesate	0.75 0.75 + 1.0	cot + 2-4 6-8	95	96	95	97	95	94	97	38.5	16.08
Glyphosate	0.75	2-4	92	68	95	98	92	62	68	33.5	15.93
Glyphosate + ethofumesate	0.75 + 1.0	2-4	95	91	95	98	95	98	90	35.2	16.16
Glyphosate + BAS 656 07 H	0.75 + 0.64	2-4	95	90	95	98	95	94	98	36.8	16.05
Ethofumesate/ Glyphosate	1.0 0.75	PPI 2-4 + 6-8	95	97	95	98	95	95	98	37.1	16.63
Ethofumesate/ Glyphosate	1.0 0.37	PPI 2-4 + 6-8	95	95	95	98	95	98	94	36.9	16.24
Ethofumesate/ Glyphosate + AMS	1.0 0.37 + 2.5	PPI 2-4 + 6-8	95	97	95	98	95	95	95	37.4	16.16
Ethofumesate/ Ethf + phen + desm [b]/ Ethf + phen + desm + trfl [c]/ Ethf + phen + desm + trfl + seth [d]	1.0 0.25 0.33 + 0.0156 0.33 + 0.0156 + 0.3	PPI cot 2-4 6-8	95	89	95	98	85	92	85	34.7	15.78
Untreated			0	0	0	0	0	0	0	11.6	15.90
$LSD_{(0.5)}$			3	12	1	1	3	20	10	2.8	0.66

[a]AMS = ammonium sulfate
[b]Ethf + phen + desm = premix of ethofumesate + phenmedipham + desmedipham
[c]trfl = triflusulfuron
[d]seth = sethoxydim

Table 2. 1999 weed control and yield results, glyphosate-resistant sugarbeets.

			Weed control							Sugarbeet yield	
			Redroot pigweed		Common lambsquarters		Hairy nightshade		Barnyard-grass		
Treatment	Rate	Timing	June 14	Sept. 7	June 14	Sept. 7	June 14	Sept. 7	Sept. 7	Root yield	Sugar content
		Leaf	----	----	----	%	----	----	----	ton/a	%
Glyphosate + AMS [a]	0.37 + 2.5	cot + 2-4 + 6-8	100	90	100	100	100	100	95	39.7	17.79
Glyphosate	0.37	cot + 2-4 + 6-8	100	92	100	100	98	100	95	37.2	17.91
Glyphosate	0.56	cot + 2-4 + 6-8	100	88	100	100	100	100	98	37.7	17.67
Glyphosate	0.75	cot +2-4 + 6-8	100	89	100	98	100	100	97	36.7	18.04
Glyphosate/	0.75	cot + 2-4	100	89	100	97	100	98	97	37.7	17.66
Glyphosate + ethofumesate	0.75 + 1.0	6-8									
Glyphosate	0.75	2-4	95	78	97	100	96	92	98	36.4	17.95
Glyphosate + ethofumesate	0.75 + 1.0	2-4	96	82	98	93	90	100	95	35.1	17.87
Glyphosate + BAS 656 07 H	0.75 + 0.64	2-4	98	89	100	97	95	97	96	38.3	17.92
Ethofumesate/	1.0	PPI	100	90	100	97	100	97	100	38.9	17.72
Glyphosate	0.75	2-4 + 6-8									
Ethofumesate/	1.0	PPI	100	91	99	100	100	97	93	38.1	17.84
Glyphosate	0.37	2-4 + 6-8									
Ethofumesate/	1.0	PPI	100	87	100	100	100	97	98	37.0	17.84
Glyphosate + AMS	0.37 + 2.5	2-4 + 6-8									
Ethofumesate/	1.0	PPI	98	95	98	100	93	100	93	38.1	17.54
Ethf + phen + desm [b]/	0.25	cot									
Ethf + phen + desm + trfl [c]/	0.33 + 0.0156	2-4									
Ethf + phen + desm + trfl + seth [d]	0.33 + 0.0156 + 0.3	6-8									
Untreated			0	0	0	0	0	0	0	12.8	18.21
$LSD_{(0.5)}$			5	10	4	4	5	8	7	5.0	0.80

[a]AMS = ammonium sulfate
[b]Ethf + phen + desm = premix of ethofumesate + phenmedipham + desmedipham
[c]trfl = triflusulfuron
[d]seth = sethoxydim

Effect of glufosinate application rate, method, and spray volume on weed control in glufosinate-resistant sugar beet. Don W. Morishita and Michael J. Wille. (Twin Falls Research and Extension Center, University of Idaho, Twin Falls, ID 83303-1827). Because glufosinate does not readily translocate in plants, spray coverage may be an important factor contributing to its efficacy. Studies were initiated in 1998 to evaluate glufosinate application rate, method, and spray volume for weed control in glufosinate-resistant sugar beet. This report represents the second year of this study. The experiment was located at the University of Idaho Research and Extension Center near Kimberly, Idaho. Sugar beet ('8757 LL') was planted 0.75 inch deep April 15, 1999, at a rate of 47,520 seed/A on 22-inch row spacing and grown under sprinkler irrigation. Soil type was a silt loam with 1.45% organic matter, 8.3 pH, and CEC of 17.5 meq/100 g soil. Herbicides were applied with a CO_2-pressurized bicycle-wheel sprayer. Application methods compared were broadcast, even fan band, and band with air induction (AI) nozzles. Broadcast applications were applied with flat fan nozzles at 10 and 20 gpa and both band applications were applied at 20 gpa. All band applications were 10-inches wide. Additional application information and weed densities are in Table 1. The experimental design was a randomized complete block with four replications. Individual plots were 4-rows by 30-feet. Crop injury and weed control evaluations were taken 7 and 28 days after last treatment applied (DAT). The two center rows of each plot were harvested with a mechanical harvester September 22.

Table 1. Application information and weed species densities.

Application date	5/6	5/17	5/24	6/4	6/14
Application timing	cotyledon	+ 7 days	+ 7 days and 1-inch weeds	1-inch weeds	1-inch weeds
Air temperature (F)	58	63	80	56	80
Soil temperature (F)	60	63	92	56	85
Relative humidity (%)	62	46	56	62	34
Wind velocity (mph)	3	6	5	4	0
Cloud cover (%)	10	100	50	100	-
Weed species/ft^2					
Common lambsquarters	4	8	9	-	-
Kochia	4	5	6	-	-
Volunteer wheat	-	-	-	-	-

None of the herbicide treatments injured the crop at either evaluation date (Table 2). Common lambsquarters control ranged from 88 to 100% for all herbicide treatments 7 and 28 DAT. Kochia control with all glufosinate treatments ranged from 86 to 100% 7 and 28 DAT. The herbicide treatments consisting of ethofumesate & desmedipham & phenmedipham + triflusulfuron applied in a band or broadcast did not satisfactorily control kochia. Volunteer wheat control with glufosinate was similar to that observed for kochia. Glufosinate at 0.268 lb/A applied with AI band nozzles controlled volunteer wheat 73% 28 DAT, however there was no statistical difference among any of the treatments. All of the herbicide treatments had higher sugar beet root yields and more extractable sugar than the check. Glufosinate applied broadcast or with even fan band nozzles had yields ranging from 16 to 24 ton/A. Both glufosinate rates applied with AI nozzles had root yields equal to the ethofumesate & desmedipham & phenmedipham + triflusulfuron treatments. Weed control, root yield, and extractable sugar yield does not appear to be affected by application volume or broadcast versus even fan band application methods. Root and extractable sugar yield appear to be reduced with AI band nozzles.

Table 2. Crop injury, weed control, sugar beet root yield, and extractable sugar yield response to glufosinate application rate, method, and spray volume.

Treatment[b]	Rate	Application method	Application volume	Application date	Crop injury 6/25	Crop injury 7/15	Weed control[a] CHEAL 6/25	CHEAL 7/15	KCHSC 6/25	KCHSC 7/15	TRZAS 6/25	TRZAS 7/15	Root yield	Extractable sugar
	lb/A		gpa		------	------	------	------	%	------	------	------	ton/A	lb/A
Check					-	-	-	-	-	-	-	-	1	700
Glufosinate /	0.268 /	broadcast	10	5/24	0	0	100	100	99	100	100	100	20	6700
glufosinate /	0.268 /			6/4										
glufosinate	0.268			6/14										
Glufosinate /	0.357 /	broadcast	10	5/24	0	0	100	100	100	98	100	100	20	6200
glufosinate /	0.357 /			6/4										
glufosinate	0.357			6/14										
Glufosinate /	0.268 /	broadcast	20	5/24	0	0	99	98	98	97	96	99	21	6500
glufosinate /	0.268 /			6/4										
glufosinate	0.268			6/14										
Glufosinate /	0.357 /	broadcast	20	5/24	0	0	100	100	100	99	98	98	18	6200
glufosinate /	0.357 /			6/4										
glufosinate	0.357			6/14										
Glufosinate /	0.268 /	even band	20	5/24	0	0	99	99	99	89	99	85	16	4800
glufosinate /	0.268 /			6/4										
glufosinate	0.268			6/14										
Glufosinate /	0.357 /	even band	20	5/24	0	0	100	100	100	100	99	93	24	7600
glufosinate /	0.357 /			6/4										
glufosinate	0.357			6/14										
Glufosinate /	0.268 /	AI[c] band	20	5/24	0	0	96	96	94	96	85	73	10	3500
glufosinate /	0.268 /			6/4										
glufosinate	0.268			6/14										
Glufosinate /	0.357 /	AI band	20	5/24	0	0	96	88	99	86	94	97	13	4100
glufosinate /	0.357 /			6/4										
glufosinate	0.357			6/14										
Efs&dmp&pmp +	0.25 +	even band	20	5/6	0	0	100	100	53	43	99	100	7	2500
triflusulfuron /	0.016 /													
efs&dmp&pmp +	0.25 +			5/17										
triflusulfuron /	0.016 /													
efs&dmp&pmp +	0.25 +			5/24										
triflusulfuron +	0.016 +													
sethoxydim	0.25													
Efs&dmp&pmp +	0.083 +	broadcast	10	5/6	0	0	96	96	58	48	69	94	6	4800
triflusulfuron /	0.005 /													
efs&dmp&pmp +	0.083 +			5/17										
triflusulfuron /	0.005 /													
efs&dmp&pmp +	0.083 +			5/24										
triflusulfuron +	0.005 +													
sethoxydim	0.125													
LSD (0.05)					ns	ns	ns	ns	29	32	ns	ns	8	2900

[a]Weed species evaluated were common lambsquarters (CHEAL), kochia (KCHSC) and volunteer wheat (TRZAS).

[b]Ammonium sulfate was added to all glufosinate treatments and methylated seed oil was added to efs&dmp&pmp + triflusulfuron at 0.083 + 0.005 lb/A broadcast treatment. Efs&dmp&pmp is a 1:1:1 commercial formulation of ethofumesate, desmedipham and phenmedipham.

[c]AI band = Teejet Spraying Systems air induction nozzle.

'Micro herbicide rates' for broadleaf weed control in sugar beet. Don W. Morishita and Michael J. Wille. (Twin Falls Research and Extension Center, University of Idaho, Twin Falls 83303-1827). A study was initiated at the University of Idaho Research and Extension Center near Kimberly, ID to determine the effectiveness of below-label herbicide rates for broadleaf weed control in sugar beet. Most postemergence herbicides used in sugar beet are applied in a 7-inch band. Micro-rates typcially are applied broadcast using the same amount of active ingredient used in a 7-inch band. Methylated seed oil (MSO) or Placement® was added to all micro-rate applications. Sugar beet ('WS PM9') was planted at a density of 47,520 seed/A in rows 22-inches apart April 15, 1999, and grown under sprinkler irrigation. The first herbicide applications for all treatments began at the sugar beet cotyledon stage followed by two sequential applications 6 and 9 days later. A standard herbicide rate was band-applied for comparison to broadcast and band applications of the micro-rates. Broadcast applications were made at 10 gpa with 11001 flat fan nozzles and band applications were made at 20 gpa with 8001 even fan nozzles. All treatments were applied using a CO_2-pressurized bicycle-wheel sprayer. Additional application information and weed species densities are given in Table 1. Kochia, redroot pigweed, common lambsquarters, and hairy nightshade were the major weed species present. The experimental design was a randomized complete block with four replications. Individual plots were four rows by 25 ft. Soil type was a Portneuf silt loam with an 8.3 pH, 1.6% organic matter, and CEC of 20 meq/100 g soil. Crop injury and weed control were evaluated June 24. On July 1, all plots except the check were handweeded and the times recorded. Sugar beet was harvested from the middle two rows of each plot September 29.

Table 1. Application information and weed species densities.

Application date	5/12	5/18	5/28
Application timing	cotyledon	+ 7 days	+ 13 days
Air temperature (F)	60	60	75
Soil temperature (F)	50	60	60
Relative humidity (%)	30	70	34
Wind velocity (mph)	6	3	4
Weed species/ft^2			
Common lambsquarters	6	9	8
Kochia	41	42	37

Sugar beet was not injured by any herbicide treatment (Table 2). Common lambsquarters control ranged from 98 to 100% with all herbicide treatments. Kochia control was generally poor with all herbicide treatments except the standard rate of ethofumesate & desmedipham & phenmedipham + triflusulfuron applied twice followed by the same combination plus clopyralid at the third application. Due to poor kochia control, all herbicide treatments were handweeded. However, hoeing time for each treatment was variable and no differences were observed among treatments. All herbicide treatments yielded higher than the untreated check, which yielded only 1 ton/A, but there were no differences among herbicide treatments. Sugar beet yields among herbicide treatments ranged from10 to 17 ton/A.

Table 2. Crop injury, broadleaf weed control, hoeing time, and sugar beet yield with micro herbicide rates in sugar beet.

		Application			Crop	Weed control[a]		Hoeing	
Treatment[b]	Rate	placement	volume	timing	injury	CHEAL	KCHSC	time	Yield
	lb/A				——%——			hr/A	ton/A
Check					-	-	-		1
Efs&dmp&pmp +	0.25 +	band	20	cotyledon	0	99	78	61	17
triflusulfuron	0.01562 +								
efs&dmp&pmp +	0.25 +			6 & 9 days later					
triflusulfuron +	0.0156 +								
clopyralid	0.094								
Efs&dmp&pmpn +	0.125 +	band	20	cotyledon	0	99	50	85	14
triflusulfuron +	0.00781 +								
MSO	1.5% v/v								
efs&dmp&pmp +	0.125 +			6 & 9 days later					
triflusulfuron +	0.00781 +								
clopyralid +	0.047 +								
MSO	1.5% v/v								
Efs&dmp&pmp +	0.083 +	band	20	cotyledon	0	100	20	131	13
triflusulfuron +	0.00519 +								
clopyralid +	0.031 +								
MSO	1.5% v/v								
efs&dmp&pmp +	0.083 +			6 & 9 days later					
triflusulfuron +	0.00519 +								
clopyralid +	0.031 +								
MSO	1.5% v/v								
Efs&dmp&pmp +	0.083 +	band	20	cotyledon	0	98	30	91	15
triflusulfuron +	0.00519 +								
clopyralid +	0.031 +								
Placement	6.0 fl oz/A								
efs&dmp&pmp +	0.083 +			6 & 9 days later					
triflusulfuron +	0.00519 +								
clopyralid +	0.031 +								
Placement	6.0 fl oz/A								
Efs&dmp&pmp +	0.083 +	broadcast	10	cotyledon	0	98	60	53	12
triflusulfuron +	0.00519 +								
clopyralid +	0.031 +								
MSO	1.5% v/v								
efs&dmp&pmp +	0.083 +			6 & 9 days later					
triflusulfuron +	0.00519 +								
clopyralid +	0.031 +								
MSO	1.5% v/v								
Efs&dmp&pmp +	0.083 +	broadcast	20	cotyledon	0	100	23	121	10
triflusulfuron +	0.00519 +								
clopyralid +	0.031 +								
MSO	1.5% v/v								
efs&dmp&pmp +	0.083 +			6 & 9 days later					
triflusulfuron +	0.00519 +								
clopyralid +	0.031 +								
MSO	1.5% v/v								
Efs&dmp&pmp +	0.083 +	broadcast	10	cotyledon	0	100	28	91	17
triflusulfuron +	0.00519 +								
clopyralid +	0.031 +								
Placement	6.0 fl oz/A								
efs&dmp&pmp +	0.083 +			6 & 9 days later					
triflusulfuron +	0.00519 +								
clopyralid +	0.031 +								
Placement	6.0 fl oz/A								
LSD (0.05)					ns	3	24	ns	8

[a]Weed species evaluated were common lambsquarters (CHEAL) and kochia (KCHSC).
[b]Efs&dmp&pmp is a 1:1:1 commercial formulation of ethofumesate, desmedipham and phenmedipham, MSO = methylated seed oil, and Placement is a proprietary adjuvant.

Sugar beet tolerance to *S*-dimethenamid. Don W. Morishita and Michael J. Wille. (Twin Falls Research and Extension Center, University of Idaho, Twin Falls, ID 83303-1827). Dimethenamid has been evaluated for weed control in sugar beet for several years. A formulation of dimethenamid has been developed with a higher proportion of the active isomer than the original formulation. Thus, a study was conducted to evaluate the tolerance of sugar beet to *S*-dimethenamid. The study was established at the University of Idaho Research and Extension Center near Kimberly, ID. Sugar beet ('Pillar RR') was planted April 27, 1999, at a rate of 47,520 seed/A on 22-inch beds and grown under sprinkler irrigation. The experimental design was a randomized complete block with four replications. Plots were 4 rows by 30 ft. Soil type at this site was a silt loam with a 7.9 pH, 1.45% organic matter, and CEC of 17.5 meq/100 g soil. All herbicides were applied in a 10-inch band with a CO_2-pressurized bicycle-wheel sprayer calibrated to deliver 20 gpa using 8001 even fan nozzles. Additional application information is shown in Table 1. Crop injury was evaluated visually 6 and 28 days after the last treatment was applied. Sugar beet was harvested September 22 with a 2-row mechanical harvester.

Table 1. Additional application information.

Application date	5/27	6/2	6/17
Application timing	cotyledon	2 leaf	4 leaf
Air temperature (F)	89	50	74
Soil temperature (F)	70	54	85
Relative humidity (%)	25	90	64
Wind speed (mph)	0	0	3
Cloud cover (%)	5	60	0

No crop injury was observed with any of the treatments (Table 2). There were no differences in sugar beet root yield or extractable sugar yield among the treatments. The new *S*-dimethenamid formulation appears to be as safe to use on sugar beet as the original formulation.

Table 2. Crop injury, weed control and sugar beet yield response to *S*-dimethenamid.

Treatment	Rate	Application timing[a]	Crop injury 6/23	Crop injury 7/15	Yield
	lb/A		%		ton/A
Handweeded check			-	-	18
Desmedipham & phenmedipham[b] /	0.33 /	cotyledon	0	0	19
desmedipham & phenmedipham /	0.33 /	2 leaf			
dimethenamid	2.34	4 leaf			
Desmedipham & phenmedipham /	0.33 /	cotyledon	0	0	23
desmedipham & phenmedipham /	0.33 /	2 leaf			
S-dimethenamid	0.64	4 leaf			
Desmedipham & phenmedipham /	0.33 /	cotyledon	0	0	18
desmedipham & phenmedipham /	0.33 /	2 leaf			
S-dimethenamid	1.28	4 leaf			
Desmedipham & phenmedipham /	0.33 /	cotyledon	0	0	26
desmedipham & phenmedipham /	0.33 /	2 leaf			
S-dimethenamid	2.56	4 leaf			
Desmedipham & phenmedipham /	0.33 /	cotyledon	0	0	22
desmedipham & phenmedipham /	0.33 /	2 leaf			
S-dimethenamid +	0.64 +	4 leaf			
desmedipham & phenmedipham	0.33				
Desmedipham & phenmedipham /	0.33 /	cotyledon	0	0	25
desmedipham & phenmedipham /	0.33 /	2 leaf			
S-dimethenamid +	0.64 +	4 leaf			
desmedipham & phenmedipham +	0.33 +				
triflusulfuron	0.0156				
LSD (0.05)			0	0	9

[a]Application date for cotyledon timing was 5/25; 2 leaf was 6/2; and 4 leaf was 6/17.
[b]Efs&dmp&pmp is a 1:1:1 commercial formulation of ethofumesate, desmedipham.

Tank mix combinations with glyphosate for weed control in glyphosate resistant sugar beet. Don W. Morishita and Michael J. Wille. (Twin Falls Research and Extension Center, University of Idaho, Twin Falls, ID 83303-1827). Currently, sugar beet growers typically make three or more postemergence herbicide applications for weed control. A study was conducted to evaluate glyphosate tank mixtures with soil-active herbicides for weed control in glyphosate resistant sugar beet. Sugar beet ('Pillar RR') was planted April 15, 1999, on 22-inch rows at a seeding rate of 47,520 seed/A and grown under sprinkler irrigation. Soil type was a Portneuf silt loam with a soil pH of 7.9, 1.45% organic matter, and CEC of 17.5 meq/100 g soil. The experimental design was a randomized complete block with four replications. Individual plots were 4 rows by 30 ft. All herbicides were applied with a CO_2-pressurized bicycle-wheel sprayer calibrated to deliver 10 gpa using 11001 flat fan nozzles spaced 16 inches apart. Additional application information and weed species densities are shown in Table 1. Weed control was evaluated visually June 28 and July 12, 7 and 21 days after last treatment (DAT), respectively. Sugar beet was harvested September 22 with a mechanical harvester.

Table 1. Application data and weed species densities.

Application date	5/24	6/7	6/24
Air temperature (F)	80	70	74
Soil temperature (F)	80	80	63
Relative humidity (%)	68	46	50
Wind speed (mph)	5	5	4
Cloud cover (%)	50	20	30
Weed species/ft^2			
Common lambsquarters	9	9	-
Kochia	6	5	-
Volunteer wheat	-	-	-

None of the herbicide treatments injured the crop (Table 2). All single applications of glyphosate applied in combination with ethofumesate, *S*-dimethenamid, or *S*-metolachlor controlled common lambsquarters, kochia, or volunteer wheat 93 to 100%. These treatments were as effective controlling weeds in this study as the sequential glyphosate applications. All herbicide treatments had root and extractable sugar yields greater than the check. There were no differences among herbicide treatments in root yield. However, glyphosate applied three times beginning at the 1 to 2 leaf stage had a higher extractable sugar yield than three of the glyphosate tank mixtures with soil-applied herbicides. Based on data from 1998 (see 1999 WSWS Research Progress Report) and 1999, it appears that weeds in sugar beet can be controlled with a single glyphosate plus soil-applied herbicide tank mix application.

Table 2. Effect of glyphosate tank mix combinations on crop injury, weed control, and yield in glyphosate resistant sugar beet.

Treatment	Rate	Application timing	Crop injury 6/28	Crop injury 7/12	Weed control[a] CHEAL 6/28	CHEAL 7/12	KCHSC 6/28	KCHSC 7/12	TRZAS 6/28	TRZAS 7/12	Yield	Extractable sugar
	lb/A		%								ton/A	lb/A
Check			-	-	-	-	-	-	-	-	7	2400
Glyphosate +	0.75 +	4-6 leaf	0	0	98	97	99	96	95	96	19	5700
ethofumesate	1.0											
Glyphosate +	0.75 +	4-6 leaf	0	0	98	96	98	97	97	97	15	4900
S-dimethenamid	0.64											
Glyphosate +	0.75 +	4-6 leaf	0	0	100	100	98	99	98	99	23	7100
S-dimethenamid	1.28											
Glyphosate +	0.75 +	4-6 leaf	0	0	95	95	100	93	97	93	19	5700
S-metolachlor	1.3											
Glyphosate +	0.75 +	4-6 leaf	0	0	96	98	100	100	98	100	25	7400
S-metolachlor	2.6											
Glyphosate +	0.75 +	1-2 leaf	0	0	100	96	100	97	100	97	25	7300
S-metolachlor /	1.6											
glyphosate	0.75	4-6 leaf										
Glyphosate +	0.75 +	1-2 leaf	0	0	97	96	100	97	93	93	25	7900
glyphosate /	0.75	4-6 leaf										
S-metolachor	1.6											
Glyphosate /	0.75 /	1-2 leaf	0	0	100	100	100	100	100	100	23	6900
glyphosate /	0.75 /	4-6 leaf										
glyphosate +	0.75 +	8-10 leaf										
S-metolachor	1.6											
Glyphosate /	0.75 /	1-2 leaf	0	0	100	100	100	100	100	100	26	8100
glyphosate /	0.75 /	4-6 leaf										
glyphosate	0.75	8-10 leaf										
LSD (0.05)			ns	ns	ns	ns	ns	ns	ns	ns	7	2200

[a]Weed species evaluated were common lambsquarters (CHEAL), kochia (KCHSC) and volunteer wheat (TRZAS).

Effect of cultivation on yield and quality of glyphosate resistant sugar beet. M. Ann Pool, Don W. Morishita, and Michael J. Wille. (Twin Falls Research and Extension Center, University of Idaho, Twin Falls, ID 83303-1827). A study was conducted to determine the effects of cultivation on the yield and quality of glyphosate resistant sugar beet ('Pillar RR')'. Sugar beet was seeded April 29, 1999, and grown under sprinkler irrigation at the University of Idaho Research and Extension Center near Kimberly, ID. Glyphosate was applied three times at 0.75 lb/A to all plots (Table 1). Cultivation treatments were zero, one or two cultivation. The experimental design was a randomized complete block with four replications and individual plots were 11 by 30 feet. Soil type was a Portneuf silt loam (20% sand, 71% silt, and 9% clay), with a pH of 8.0, 1.5% organic matter, and a CEC of 17 meq/100 g soil. A CO_2-pressurized bicycle-wheel sprayer calibrated to deliver 10 GPA with 110001 flat fan nozzles was used for all applications Sugar beet was harvested from the middle two rows September 24, using a two-row mechanical beet harvester.

Table 1. Application information

Application date	6/2	6/17	7/12
Application timing	2 to 4 leaf	8 leaf	12 to 14 leaf
Air temperature (F)	50	65	80
Soil temperature (F)	54	60	100
Relative humidity (%)	90	76	40
Wind speed (mph)	0	0	4

There were no differences in sugar beet root yield or extractable sugar yield among the cultivation treatments. Root yields ranged from 25 to 27 ton/A and extractable sugar yields ranged from 8100 to 9000 lb/A (Table 2). Eliminating the cultivation costs from the no cultivation treatment, provided a higher net return by not cultivating the beets.

Table 2. Herbicide application rates, root yield, and extractable sugars in glyphosate resistant sugar beets.

Treatment	Rate	Application date	Yield	Extractable sugars
	lb/A		ton/A	lb/A
No cultivation			25	8100
glyphosate	0.75	2 leaf		
glyphosate	0.75	10d later		
glyphosate	0.75	10d later		
One cultivation			27	9000
glyphosate	0.75	2 leaf		
glyphosate	0.75	10d later		
glyphosate	0.75	10d later		
Two cultivation			26	8400
glyphosate	0.75	2 leaf		
glyphosate	0.75	10d later		
glyphosate	0.75	10d later		
LSD (0.05)			19	1500

Evaluating the potential antagonism of tank mixing chlorpyrifos with glyphosate for weed control in sugar beet. M. Ann Pool, Don W. Morishita, and Michael J. Wille. (Twin Falls Research and Extension Center, University of Idaho, Twin Falls, Idaho 83303-1827). A study was established at the University of Idaho Research and Extension Center near Kimberly, Idaho, to determine the potential antagonistic effects of tank mixing chlorpyrifos with glyphosate used on glyphosate resistant sugar beet. 'Pillar RR' sugar beet was seeded May 6, 1999, in rows 22-inches apart. Soil type was a Portneuf silt loam (8.8% sand, 54% silt, and 32.2% clay), with a pH of 7.9, 1.45% organic matter, and a CEC of 17.5 meq/100 g soil. Seedlings were thinned to a spacing of 6-inches. The experimental design was a randomized complete block with four replications and individual plots were 4 rows by 30 feet. Glyphosate was applied June 7 alone or in combination with chlorpyrifos. A sequential glyphosate application was made June 17.

A CO_2-pressurized bicycle-wheel sprayer calibrated to deliver 10 gpa with flat fan nozzles was used for all applications. Plants appear to have emerged at different times so that each plot had mixed populations at different growth stages. Some plots had thin stands. Common lambsquarters populations on June 7 were 10 plants per/ft^2. Environmental conditions are listed in Table 1. Sugar beet was harvested from the middle two rows September 21, using a mechanical beet harvester.

Table 1. Application information

Application date	6/7	6/17
Application timing	4 leaf	10 d later
Air temperature (F)	68	75
Soil temperature (F)	80	80
Relative humidity (%)	44	50
Wind speed (mph)	0	2

Sugar beet injury 16 days after the last treatment was observed with all chlorpyrifos + glyphosate treatments, except the dry flowable chlorpyrifos formulation applied at 1 lb/A (Table 2). However, the injury was highly variable and was not significantly different among treatments. By the second evaluation, no sugar beet injury was observed. All glyphosate plus chlorpyrifos treatments had yields higher than a single glyphosate alone application. Additionally, glyphosate applied in combination with both rates of the chlorpyrifos dry flowable formulation, had higher yields than ghyphosate tank mixed with chlorpyrifos emulsifiable concentrate formulation. The same was observed with extractable sugar.

Table 2. Crop injury, weed control, and yields with chlorpyrifos tank mixed with glyphosate.

Treatment	Rate	Application timing	Crop injury 7/2	Crop injury 7/15	CHEAL[a] control	Yield	Extractable sugar
	lb/A		%	%	%	ton/A	lb/A
Glyphosate	0.75	4 leaf	0	0	0	8	2200
Glyphosate + chlorpryifos 4 EC/ glyphosate	0.75 + 1.0 / 0.75	4 leaf 10 d later	8	0	100	15	4400
Glyphosate + chlorpryifos 4 EC/ glyphosate	0.75 + 2.0 / 0.75	4 leaf 10 d later	12	0	100	15	4400
Glyphosate + chlorpryifos 75 DF/ glyphosate	0.75 + 1.0 / 0.75	4 leaf 10 d later	0	0	100	24	6900
Glyphosate + chlorpryifos 75 DF/ glyphosate	0.75 + 2.0 / 0.75	4 leaf 10 d later	8	0	100	23	6600
LSD (0.05)			21	ns	ns	5	1400

[a]Weed species evaluated was common lambsquarters (CHEAL).

Application timing effects on weed control in glyphosate-resistant sugar beet. Michael J. Wille and Don W. Morishita. (Twin Falls Research and Extension Center, University of Idaho, Twin Falls, ID 83303-1827). A study was established at the University of Idaho Research and Extension Center near Kimberly to determine the optimum start time of the first glyphosate application and timing of sequential applications in glyphosate-resistant sugar beet. 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 (9% sand, 54% silt, 37% clay, pH 7.9, 1.5% organic matter, 18-meq/100 g soil CEC). Sugar beet ('Pillar RR') was seeded in rows 22-inches apart April 15, 1999, and thinned to a density of 47,520 seed/A on May 28. Glyphosate was applied beginning with 2-leaf, 4-leaf, or 6-leaf sugar beet. Following initial herbicide application to 2- or 4-leaf sugar beet, plots were treated either twice more at 10 d intervals, or once more at 20 or 30 day intervals. Plots initially treated at the 6-leaf stage were treated again at 20 or 30 d intervals. Glyphosate rate was 0.75 lb/A for all applications. Ethofumesate & desmedipham & phenmedipham (Efs&dmp&pmp) was included as a standard herbicide treatment, and applied at the sugar beet cotyledon stage and 7 and 14 d later. All herbicide treatments were broadcast-applied with a CO_2-pressurized bicycle-wheel sprayer calibrated to deliver 10 gpa using 11001 flat-fan nozzles, except efs&dmp&pmp which was applied in a 10-inch band calibrated to deliver 20 gpa using 8001 even-fan nozzles. Kochia, common lambsquarters, and volunteer wheat were the major weed species. Application information and weed species densities are given in Table 1. Crop injury and weed control were evaluated visually 7 and 21 days after the last herbicide application (DAT) on July 23 and August 9. Sugar beet was harvested from the middle two rows of each plot September 22.

Table 1. Application information and weed species densities.

Application date	May 6	May 16	May 24	June 3	June 7	June 14	June 17	June 24	July 2	July 9	July 15
Application timing[a]											
Efs&dmp&pmp[b]											
Cotyl	X										
Cotyl +7 d		X									
Cotyl + 14 d			X								
Glyphosate											
Two-leaf											
2-leaf + 10 d			X	X							
2-leaf + 10 d + 10 d			X	X		X					
2-leaf + 20 d			X			X					
2-leaf + 30 d			X					X			
Four leaf											
4-leaf + 10 d + 10 d					X		X		X		
4-leaf + 20 d					X				X		
4-leaf + 30 d					X					X	
Six-leaf											
6-leaf + 20 d						X			X		
6-leaf + 30 d						X					X
Air temperature (F)	55	63	80	50	60	82	70	74	70	72	80
Soil temperature (F)	60	63	80	60	58	90	68	63	64	70	100
Relative humidity (%)	64	46	68	80	64	32	80	50	41	46	28
Wind velocity (mph)	0	4 to 7	2 to 5	0	4 to 7	2 to 4	0	2 to 5	4 to 6	3	5
Weed Species (plants/ft^2)											
Kochia	4	–	6	–	7	7	–	–	–	–	–
Common lambsqsuarters	0	–	9	–	9	6	–	–	–	–	–
Volunteer wheat	5	–	7	–	6	6	–	–	–	–	–

[a]X-mark indicates the application date of the various herbicide application timings.

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

None of the herbicide treatments injured sugar beet. Efs&dmp&pmp controlled common lambsquarters 93 and 98%, kochia 44 and 28%, and volunteer wheat 74 and 35% 7 and 21 DAT, respectively. All glyphosate treatments controlled common lambsquarters, kochia, and volunteer wheat 100% regardless of application timing. All herbicide-treatments yielded more than the check. Yields from glyphosate-treatments ranged from 23 to 29 ton/A and did not differ from each other. Yield from plots treated with efs&dmp&pmp averaged 17 ton/A, which was significantly less than plots treated with glyphosate at the two-leaf stage and again 20 d later, but did not differ from other glyphosate-treated plots.

Table 2. Crop injury, weed control, and sugarbeet root yield in glyphosate-resistant sugarbeet.

					Weed control[a]						
		Application	Crop injury		CHEAL		KCHSC		TRZAS		
Treatment[b]	Rate	timing	7/23	8/9	7/23	8/9	7/23	8/9	7/23	8/9	Yield
	lb/A		%								ton/A
Check			—	—	—	—	—	—	—	—	11
Efs&dmp&pmp +	0.25 +	cotyledon	0	0	93	98	44	28	74	35	17
triflusulfuron	0.0156										
efs&dmp&pmp +	0.25 +	7 d later									
triflusulfuron	0.0156										
efs&dmp&pmp +	0.25 +	7 d later									
triflusulfuron	0.0156										
Glyphosate	0.75	2 leaf	0	0	100	100	100	100	99	100	26
glyphosate	0.75	10 d later									
glyphosate	0.75	10d later									
Glyphosate	0.75	2 leaf	0	0	100	100	100	100	100	100	29
glyphosate	0.75	20 d later									
Glyphosate	0.75	2 leaf	0	0	100	100	100	100	100	100	27
glyphosate	0.75	30 d later									
Glyphosate	0.75	4 leaf	0	0	100	100	100	100	100	100	26
glyphosate	0.75	10 d later									
glyphosate	0.75	10 d later									
Glyphosate	0.75	4 leaf	0	0	100	100	100	100	100	100	26
glyphosate	0.75	20 d later									
Glyphosate	0.75	4 leaf	0	0	100	100	100	100	100	100	26
glyphosate	0.75	30 d later									
Glyphosate	0.75	6 leaf	0	0	100	100	100	100	100	100	23
glyphosate	0.75	20 d later									
Glyphosate	0.75	6 leaf	0	0	100	100	100	100	100	100	24
glyphosate	0.75	30 d later									
LSD (0.05)			NS	NS	1	2	25	18	11	21	6

[a]Weed species evaluated were common lambsquarters (CHEAL), kochia (KCHSC) and volunteer wheat (TRZAS).
[b]Efs&dmp&pmp is a 1:1:1 commercial formulation of ethofumesate, desmedipham and phenmedipham.

Comparison of glufosinate rates for grass and broadleaf weed control in sugar beet. Michael J. Wille and Don W. Morishita. (Twin Falls Research and Extension Center, University of Idaho, Twin Falls, ID 83303-1827). A study was established at the University of Idaho Research and Extension Center near Kimberly to evaluate weed control in glufosinate-resistant sugar beet with glufosinate applied at different rates, and combined with broadleaf and grass herbicides at two different application timings. 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 (9% sand, 54% silt, 37% clay, pH 7.9, 1.5% organic matter, 18-meq/100 g soil CEC). Sugar beet ('8757 LL') was seeded in rows 22-inches apart April 15, 1999, and thinned to a density of 47,520 seed/A on May 28. Kochia, common lambsquarters, and volunteer wheat were the major weed species present. At the early timing (1-inch weeds), glufosinate was applied two or three times at 0.268, 0.312 or 0.357 lb/A, whenever weeds were 1-inch tall. In treatments receiving only two glufosinate applications, ethofumesate was applied either preemergence to the crop or with the second glufosinate application. At the late timing (2-inch weeds), glufosinate at 0.268 lb/A was applied alone whenever weeds were 2-inches tall. Clethodim was applied at 0.094 or 0.125 lb/A alone or combined with glufosinate at 0.268 lb/A when weeds were again two inches tall. Two sequential applications of ethofumesate & desmedipham & phenmedipham (efs&dmp&pmp) applied alone followed by efs&dmp&pmp + sethoxydim were applied as a standard herbicide treatment to sugar beet cotyledon stage, and at two 7-d intervals thereafter. All herbicide treatments were broadcast-applied with a CO_2-pressurized bicycle-wheel sprayer calibrated to deliver 10 gpa using 11001 flat-fan nozzles, except efs&dmp&pmp alone or with sethoxydim which was applied in a 10-inch band calibrated to deliver 20 gpa using 8001 even-band nozzles. Additional application information and weed species densities are given in Table 1. Crop injury and weed control were evaluated 7 and 28 days after the last herbicide application (DAT) on June 22 and July 12. Sugar beet was harvested from the middle two rows of each plot September 23.

Table 1. Application information and weed species densities.

	Standard treatment			1-inch weeds				2-inch weeds	
Application date	5/11	5/17	5/27	5/06	5/20	6/03	6/14	6/03	6/14
Application timing	Cotyledon	+7 d	+7 d	PRE	1 inch	1 inch	1 inch	2 inch	2 inch
Air temperature (F)	65	63	75	69	68	60	72	60	72
Soil temperature (F)	70	63	60	62	68	60	80	60	80
Relative humidity (%)	40	46	34	36	56	60	64	60	64
Wind velocity (mph)	3 to 6	4 to 7	2 to 4	2	0 to 6	3 to 6	0	3 to 6	0
Weed Species (plants/ft^2)									
Kochia (KCHSC)	6	7	2	0	6	1	<1	9	3
Common lambsqsuarters (CHEAL)	7	9	1	0	9	1	0	14	0
Volunteer wheat (TRZAS)	4	3	0	0	6	0	0	8	0

No herbicide treatment injured the crop (Table 2). Efs&dmp&pmp controlled kochia 69 to 71% on both evaluation dates. One-inch kochia was controlled better than 96% at both evaluation dates by three applications of glufosinate alone at any rate. Two glufosinate applications at 0.357 lb/A either preceded by ethofumesate applied preemergence, or tank-mixed with glufosinate at the second application controlled kochia 95 to 100% on both evaluation dates. Two-inch kochia was controlled 13 to 27% 7 DAT and 27 to 30% 28 DAT by a single glufosinate application of 0.268 lb/A followed by clethodim alone at 0.094 or 0.125 lb/A, respectively. Two applications of glufosinate combined with 0.094 or 0.125 lb/A clethodim at the second application controlled kochia 78 to 81% 7 DAT and 75 to 90% 28 DAT, respectively. Common lambsquarters was controlled 94% or greater at both evaluation dates with efs&dmp&pmp. One-inch common lambsquarters was controlled 100% on both evaluation dates by three glufosinate applications regardless of rate. Ethofumesate applied preemergence followed by 0.357 lb/A glufosinate, or glufosinate alone followed by 0.357 lb/A glufosinate plus ethofumesate at the second application controlled common lambsquarters 94 to 100% at both evaluation dates. Two-inch common lambsquarters was controlled 25 and 57% 7 DAT and 20 to 35% 28 DAT by a single 0.268 lb/A glufosinate application followed by clethodim alone at 0.094 or 0.125 lb/A, respectively. One application of glufosinate alone plus a second application of glufosinate tank-mixed with clethodim at the above rates controlled two-inch common lambsquarters 70 and 86% 7 DAT and 53 and 91% 28 DAT, respectively.

Efs&dmp&pmp controlled volunteer wheat 89% or more at both evaluation dates. Three glufosinate applications at any rate controlled 1-inch volunteer wheat 100% on both evaluation dates. Ethofumesate applied preemergence followed by two 0.357 lb/A glufosinate applications, or 0.357 lb/A glufosinate alone and combined with ethofumesate at the second application controlled 1-inch volunteer wheat 95 to 100%. A single 0.268 lb/A glufosinate application followed by clethodim alone at 0.094 and 0.125 lb/A controlled volunteer wheat 47 and 82% 7 DAT and 66 and 96% 28 DAT, respectively. Glufosinate applied alone followed by a glufosinate + clethodim at the preceding rates controlled volunteer wheat 70% 7 DAT and 100% 28 DAT.

Glufosinate at all three rates applied three times had equal yields ranging from 25 to 27 ton/A compared to the untreated check which yielded 7 ton/A. Ethofumesate applied preemergence in combination with glufosinate had yields of 25 and 23 ton/A, respectively. All other treatments did not yield any better than the check.

Table 2. Crop injury, weed control and sugarbeet root yield response to glufosinate rate and tank-mix combinations.

					Weed control[a]						
		Application	Crop injury		CHEAL		KCHSC		TRZAS		
Treatment[b]	Rate	timing	6/22	7/12	6/22	7/12	6/22	7/12	6/22	7/12	Yield
	lb/A		%								ton/A
Check			–	–	–	–	–	–	–	–	7
Glufosinate +	0.268 +	1" weeds	0	0	100	100	100	100	100	100	25
AMS	3.0										
glufosinate +	0.268 +	1" weeds									
AMS	3.0										
glufosinate +	0.268 +	1" weeds									
AMS	3.0										
Glufosinate +	0.312 +	1" weeds	0	0	100	100	100	96	100	100	27
AMS	3.0										
glufosinate +	0.312 +	1" weeds									
AMS	3.0										
glufosinate +	0.312 +	1" weeds									
AMS	3.0										
Glufosinate +	0.357 +	1" weeds	0	0	100	100	100	100	100	100	26
AMS	3.0										
glufosinate +	0.357 +	1" weeds									
AMS	3.0										
Glufosinate +	0.357 +	1" weeds									
AMS	3.0										
Efs&dmp&pmp	0.33	cotyledon	0	0	99	94	71	69	95	89	14
Eefs&dmp&pmp	0.33	7 d later									
Efs&dmp&pmp +	0.33 +	7 d later									
sethoxydim	0.30										
Ethofumesate	1.0	PRE	0	0	100	100	100	100	99	99	25
glufosinate +	0.357 +	1" weeds									
AMS	3.0										
glufosinate +	0.357 +	1" weeds									
AMS	3.0										
Glufosinate +	0.357 +	1" weeds	0	0	95	94	95	95	95	96	23
AMS	3.0										
glugosinate +	0.357 +	1" weeds									
ethofumesate +	1.0 +										
AMS	3.0										
Glufosinate +	0.268 +	2" weeds	0	0	25	20	13	28	47	66	5
AMS	3.0										
Clethodim +	0.0.94 +	2" grass									
COC	1.0 qt/A										
Glufosinate +	0.268 +	2" weeds	0	0	57	35	27	30	82	96	4
AMS	3.0										
Clethodim +	0.125 +	2" grass									
COC	1.0 qt/A										
Glufosinate +	0.268 +	2" weeds	0	0	70	53	78	90	70	100	13
AMS	3.0										
glufosinate +	0.268 +	2" grass									
clethodim +	0.094 +										
AMS +	3.0 +										
COC	1.0 qt/A										
Glufosinate	0.268 +	2" weeds	0	0	86	91	81	75	70	100	10
AMS	3.0										
glufosinate +	0.268 +	2" grass									
clethodim +	0.125 +										
AMS +	3.0 +										
COC	1.0 qt/A										
LSD (0.05)			NS	NS	19	26	28	31	13	NS	11

[a]Weed species evaluated were common lambsquarters (CHEAL), kochia (KCHSC) and volunteer wheat (TRZAS).
[b]Efs&dmp&pmp is a 1:1:1commercial formulation of ethofumesate, desmedipham and phenmedipham; COC = crop oil concentrate; AMS = ammonium sulfate

Tank-mix combinations of *S*-dimethenamid with registered sugar beet herbicides. Michael J. Wille and Don W. Morishita. (Twin Falls Research and Extension Center, University of Idaho, Twin Falls, ID 83303-1827). A study was established at the University of Idaho Research and Extension Center near Kimberly to evaluate combinations of *S*-dimethenamid with desmedipham & phenmedipham (dmp&pmp) and triflusulfuron. 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 (9% sand, 54% silt, 37% clay, pH 7.9, 1.5% organic matter, 18-meq/100 g soil CEC). Sugar beet ('WS PM9') was seeded in rows 22- inches apart at a seeding rate of 47,520 seeds/A on April 15, 1999. Kochia and common lambsquarters were the major weed species present. All plots were treated with 0.25 lb/A dmp&pmp at the sugarbeet cotyledon stage. Seven days later, plots were treated with 0.25 lb/A dmp&pmp alone, 1.17 lb/A dimethenamid, 0.64 lb/A *S*-dimethenamid, 0.25 lb/A dmp&pmp + 0.64 lb/A *S*-dimethenamid, 0.25 lb/A dmp&pmp + 0.0156 lb/A triflusulfuron + 0.64 lb/A *S*-dimethenamid, or 0.25 lb/A dmp&pmp + 0.0156 lb/A triflusulfuron. Some plots also received a third application of 0.25 lb/A dmp&pmp alone, or 0.64 lb/A *S*-dimethenamid + 0.19 lb/A sethoxydim. All herbicide treatments were applied in a 10-inch band with a CO_2-pressurized bicycle-wheel sprayer using 8001 even-band nozzles calibrated to deliver 20 gpa. Additional application information and weed species densities are given in Table 1. Crop injury and weed control were evaluated visually 7 and 28 days after the last herbicide application (DAT) on June 10 and June 25. All plots were hand-weeded and timed on July 1. Sugar beet was harvested from the middle two rows of each plot September 25.

Table 1. Application information and weed species densities.

Application date	May 6	May 16	May 24
Application timing (BEAVU)	cotyledon	+ 7 d	+ 14 d
Air temperature (F)	60	76	75
Soil temperature (F)	70	68	60
Relative humidity (%)	34	46	34
Wind velocity (mph)	6	5	4
Weed species (plants/ft^2)			
Kochia	29	38	5
Common lambsqsuarters	6	9	9

Sugar beet was not injured by any herbicide treatment. Kochia control ranged from 59 to 95% 7 DAT and 52 to 87% 28 DAT and did not differ among herbicide treatments. All herbicide treatments controlled common lambsquarters better than 97% 7 DAT except one application of dmp&pmp followed by either dimethenamid or *S*-dimethenamid which controlled common lambsquarters less than 52%. Herbicide treatments controlled common lambsquarters 31 to 77% 28 DAT. Sugar beet yield ranged from 16 to 20 ton/A for all herbicide treatments compared to 1 ton/A for the check. Yields from all herbicide-treated plots were greater than the check but did not differ from each other.

Table 2. Effect of *S*-dimethenamid on crop injury, weed control, and sugar beet root yield.

Treatment[b]	Rate	Application timing	Crop injury 6/10	Crop injury 6/25	Weed control[a] KCHSC 6/10	KCHSC 6/25	CHEAL 6/10	CHEAL 6/25	Yield
	lb/A		%						ton/A
Check			–	–	–	–	–	–	1
Dmp&pmp	0.25	cotyledon	0	0	59	53	51	63	16
dimethenamid	1.17	7 d later							
Dmp&pmp	0.25	cotyledon	0	0	66	60	50	31	17
S-dimethenamid	0.64	7 d later							
Dmp&pmp	0.25	cotyledon	0	0	89	83	100	60	20
dmp&pmp +	0.25 +	7d later							
S-dimethenamid	0.64								
Dmp&pmp	0.25	cotyledon	0	0	90	83	97	69	20
dmp&pmp	0.25	7 d later							
dmp&pmp	0.25	7 d later							
Dmp&pmp	0.25	cotyledon	0	0	95	88	100	78	20
dmp&pmp +	0.25 +	7 d later							
triflusulfuron +	0.0156 +								
S-dimethenamid	0.64								
Dmp&pmp	0.25	cotyledon	0	0	95	80	98	74	20
dmp&pmp +	0.25 +	7d later							
triflusulfuron	0.0156								
Dmp&pmp	0.25	cotyledon	0	0	95	83	100	65	18
dmp&pmp	0.25	7d later							
S-dimethenamid +	0.64 +	7 d later							
sethoxydim +	0.19 +								
COC	1.0% v/v								
LSD (0.05)			NS	NS	NS	NS	26	NS	8

[a]Weed species evaluated were kochia (KCHSC) and common lambsquarters (CHEAL).
[b]Dmp&pmp is a 1:1 commercial formulation of desmedipham and phenmedipham; COC is crop oil concentrate.

Weed control in sunflower. Brian Jenks, Kent McKay, and Gary Willoughby. (NDSU, North Central Research Extension Center, Minot, ND 58701). We evaluated several registered and experimental herbicides for weed control in sunflower. Sunflower (CL803) was seeded May 20 into 30-inch rows at 20,000 seeds/A. Herbicide treatments were applied preplant incorporated (May 19) or preemergence (May 21). Only metolachlor, flumioxazin, and sulfentrazone were applied PRE. Individual plots were 10 x 30 ft arranged in a RCBD with three replications. PPI and PRE treatments were applied with a CO_2 pressurized bicycle sprayer delivering 20 gpa at 30 psi using XR80015 flat fan nozzles. The crop was not harvested due to hail and wind damage.

Flumioxazin caused initial crop stunting and slight stand reduction. By mid-season the crop appeared to catch up with the sunflower in the other treatments. Flumioxazin provided good control of mustard species, kochia, lambsquarters, and pigweed; but was weak on wild buckwheat and foxtails. Sulfentrazone and flumioxazin were active on the same weeds, but control with flumioxazin was generally equal to or slightly higher than sulfentrazone. Based on this and other studies, it appears that a postemergence grass herbicide will be needed in combination with flumioxazin or sulfentrazone.

Table. Weed control in sunflower.

		June 16						September 20					
Treatment	Rate	Must[a]	KCHSC	POLCO	CHEAL	AMARE	SET[b]	Must[a]	KCHSC	POLCO	CHEAL	AMARE	SET[b]
	lb/A	Control (%)						Control (%)					
Pendimethalin	1.5	25	93	80	98	93	92	20	80	47	93	89	94
Trifluralin	1.0	17	97	68	100	92	93	17	87	47	96	91	96
Ethalfluralin	1.125	30	100	82	100	93	100	18	95	70	98	92	97
Ethalfluralin+ EPTC	0.56 + 1.3	42	92	73	98	93	93	27	83	53	96	92	97
Metolachlor	1.9	90	27	0	73	78	96	86	17	0	70	70	88
Flumioxazin	0.094	99	97	82	97	100	75	96	91	53	90	93	40
Sulfentrazone	0.125	90	97	27	77	63	43	87	82	30	67	63	30
Sulfentrazone	0.188	90	97	57	92	77	50	87	88	33	73	70	35
Sulfentrazone	0.25	94	98	57	95	88	57	92	92	37	75	77	33
Untreated		0	0	0	0	0	0	0	0	0	0	0	0
LSD		15	7	15	16	10	11	6	8	17	11	9	13
CV		17	6	18	12	9	10	8	7	29	9	8	14

[a] Must=Mustard species field pennycress and shepherdspurse

[b] SET=Green and yellow foxtail

Sulfentrazone for weed control in no-till sunflower. Curtis R. Thompson and Alan J. Schlegel. (Southwest Research Extension Center, Kansas State University, Garden City, KS 67846). The objective of this experiment was to evaluate sulfentrazone for broadleaf and grass weed control in sunflowers planted no-till into soybean stubble. The experiment was conducted at the Southwest Research Extension Center - Tribune Unit near Tribune, KS. on a Richfield silt loam soil with 1.4% organic matter and pH of 7.9. Early pre-plant (EPP) and postplant preemergence (PRE) treatments were applied to the soil surface on May 7 and May 20, 1999, respectively. All treatments were applied with a backpack sprayer delivering 20 gpa at 30 psi. 'Pioneer 64M01' sunflower was planted at 20,000 seeds/a on May 20. The experimental units were 10 by 35 feet and the experimental design was a randomized complete block. A 5 by 32 foot area of each plot was harvested for seed yield on September 23. Due to a soil gradient across the experiment, an analysis of covariance was conducted. Visual evaluations of weed control and sunflower injury were made on June 15 and August 11.

All treatments containing sulfentrazone injured sunflowers (Table 1). Sunflowers were injured more with postplant preemergence treatments than early preplant treatments, however, the increased injury from the postplant preemergence treatments did not reduce sunflower yield when compared to yields from the early preplant treatments. Sunflower yields were reduced with sulfentrazone applied at 0.25 lb/a or at 0.2 lb/a tank mixed with pendimethalin at 1.0 lb/a. Injury and yield reductions from sulfentrazone was greater during 1999 than has been previously observed (data note shown). It is possible that the high pH and high $CaCO_3$ concentration, > 5000 ppm, of the soil, increases the risk of sulfentrazone injury to sunflower.

Sunflower stand was not reduced by any herbicide treatment (Table 2). Sulfentrazone alone applied at 0.188 lb/a or more or all rates when tank mixed with pendimethalin tended to reduce sunflower test weight compared to the untreated sunflowers.

Sulfentrazone at all rates applied alone or tank mixed with pendimethalin controlled kochia, Russian thistle, and pigweed species, redroot and tumble pigweed, 94% or more (Tables 3 and 4). Sulfentrazone had good activity on puncturevine, however, control was more variable than with the other broadleaf weeds evaluated. Pendimethalin generally gave inadequate control of broadleaf weeds regardless of rate or application timing. A low infestation of large crabgrass was controlled with sulfentrazone or pendimethalin at all rates and combinations (Table 5).

Table 1. Sunflower response to sulfentrazone and pendimethalin, Tribune, KS 1999.

		Yield at 10% H_2O			Injury 6-15-99			Injury 8-11-99		
Treatment[1]	Rate	EPP[2]	PRE[2]	Mean	EPP[2]	PRE[2]	Mean	EPP[2]	PRE[2]	Mean
	(lb/a)	(lb/a)			(%)					
Untreated		1391	1592	1491						
Sulfentrazone	0.125	1247	1405	1326	23	23	23	13	1	7
Sulfentrazone	0.15	1100	1054	1078	14	28	21	6	5	5
Sulfentrazone	0.188	1115	1030	1072	33	43	38	13	13	13
Sulfentrazone	0.2	1050	1106	1078	35	40	38	9	12	10
Suen + pend	0.125+1.0	1124	826	975	30	24	27	4	12	8
Suen + pend	0.15+1.0	1165	1058	1112	33	52	42	14	14	14
Suen + pend	0.188+1.0	843	1025	934	33	44	38	10	22	16
Suen + pend	0.2+1.0	749	855	802	40	54	47	8	25	17
Sulfentrazone	0.25	940	682	811	49	57	53	21	36	28
Pendimethalin	1.0	1041	1196	1118	0	6	3	0	1	1
Pendimethalin	1.5	1182	1576	1379	1	0	0	1	0	0
	Mean	1079	1117		26	34		9	13	
LSD (0.05)	Timing		NS			7			NS	
	Herbicide		436			16			13	
	Timing x Herbicide		NS			NS			NS	

[1] Suen = sulfentrazone pend = pendimethalin
[2] application timing EPP = early pre-plant PRE = post plant pre-emergence

Table 2. Sunflower response to sulfentrazone and pendimethalin, Tribune, KS 1999.

Treatment[1]	Rate	Test weight EPP[2]	Test weight PRE[2]	Test weight Mean	Seed moisture EPP[2]	Seed moisture PRE[2]	Seed moisture Mean	Stand EPP[2]	Stand PRE[2]	Stand Mean
	-- (lb/a) --	(lb/bu)			(%)			(/1000 plants/a)		
Sulfentrazone	0.125	25.8	25.4	25.6	7.9	5.7	6.8	12.9	18.0	15.4
Sulfentrazone	0.15	25.0	25.5	25.2	6.5	7.2	6.8	19.0	15.7	17.4
Sulfentrazone	0.188	23.3	24.2	23.8	9.0	7.6	8.3	17.6	15.9	16.7
Sulfentrazone	0.2	23.3	24.2	23.7	7.1	8.6	7.9	16.2	16.3	16.3
Suen + pend	0.125+1.0	24.3	23.5	23.9	7.2	5.2	6.2	17.4	17.4	17.4
Suen + pend	0.15+1.0	25.7	24.2	24.9	6.5	9.0	7.7	18.5	15.9	17.1
Suen + pend	0.188+1.0	24.3	24.5	24.4	8.1	6.6	7.4	16.4	15.8	16.1
Suen + pend	0.2+1.0	24.9	23.3	24.1	7.4	8.5	8.0	17.2	16.1	16.6
Sulfentrazone	0.25	24.2	24.8	24.5	8.8	7.7	8.2	16.1	14.8	15.4
Pendimethalin	1.0	25.9	26.7	26.3	6.7	7.4	7.1	17.5	17.8	17.7
Pendimethalin	1.5	25.7	25.6	25.7	5.6	7.1	6.3	15.8	19.0	17.4
	Mean	24.9	24.8		7.3	7.4		16.9	16.7	
LSD (0.05)	Timing		NS			NS			NS	
	Herbicide		1.5			NS			NS	
	Timing x Herbicide		NS			NS			NS	

[1] Suen = sulfentrazone pend = pendimethalin

[2] application timing EPP = early pre-plant PRE = post plant pre-emergence

Table 3. Kochia and Russian thistle control in no-till sunflower, Tribune, KS 1999.

Treatment[1]	Rate	Kochia 6-15-99 EPP[2]	Kochia 6-15-99 PRE[2]	Kochia 6-15-99 Mean	Kochia 8-11-99 EPP[2]	Kochia 8-11-99 PRE[2]	Kochia 8-11-99 Mean	Russian thistle 6-15-99 EPP[2]	Russian thistle 6-15-99 PRE[2]	Russian thistle 6-15-99 Mean	Russian thistle 8-11-99 EPP[2]	Russian thistle 8-11-99 PRE[2]	Russian thistle 8-11-99 Mean
	-- (lb/a) --	(%)											
Sulfentrazone	0.125	100	100	100	98	98	98	100	100	100	100	100	100
Sulfentrazone	0.15	100	100	100	99	98	98	100	100	100	100	100	100
Sulfentrazone	0.188	100	98	99	95	100	98	100	97	99	95	99	97
Sulfentrazone	0.2	100	100	100	99	100	99	100	99	100	100	100	100
Suen + pend	0.125+1.0	100	100	100	98	100	99	100	100	100	100	100	100
Suen + pend	0.15+1.0	96	97	97	100	100	100	93	95	94	98	99	98
Suen + pend	0.188+1.0	100	100	100	99	99	99	100	100	100	100	100	100
Suen + pend	0.2+1.0	96	100	98	100	100	100	92	100	96	97	100	99
Sulfentrazone	0.25	98	97	97	100	100	100	96	94	95	99	98	99
Pendimethalin	1.0	56	65	61	50	85	67	39	52	45	30	58	44
Pendimethalin	1.5	61	70	66	57	89	73	42	52	48	28	61	44
	Mean	92	93		90	97		87	90		86	92	
LSD (0.05)	Timing		NS			NS			NS			NS	
	Herbicide		10			14			16			9	
	Timing x Herbicide		NS			NS			NS			NS	

[1] Suen = sulfentrazone pend = pendimethalin

[2] application timing EPP = early pre-plant PRE = post plant pre-emergence

Table 4. Pigweed and puncturevine control in no-till sunflower, Tribune, KS 1999.

		Pigweed species control[3]						Puncturevine control					
		6-15-99			8-11-99			6-15-99			8-11-99		
Treatment[1]	Rate	EPP[2]	PRE[2]	Mean	EPP[2]	PRE[2]	Mean	EPP[2]	PRE[2]	Mean	EPP[2]	PRE[2]	Mean
	-- (lb/a) --	(%)											
Sulfentrazone	0.125	100	100	100	99	100	99	95	93	94	80	97	89
Sulfentrazone	0.15	100	100	100	100	99	99	89	88	88	82	69	76
Sulfentrazone	0.188	100	100	100	100	100	100	100	90	95	90	84	87
Sulfentrazone	0.2	100	100	100	100	100	100	98	97	97	88	84	86
Suen + pend	0.125+1.0	100	100	100	100	100	100	100	75	87	92	62	77
Suen + pend	0.15+1.0	98	97	97	100	100	100	96	100	98	93	100	97
Suen + pend	0.188+1.0	99	100	100	100	100	100	99	98	98	100	91	90
Suen + pend	0.2+1.0	98	99	98	100	100	100	90	100	96	96	100	98
Sulfentrazone	0.25	97	98	97	100	100	100	100	100	100	94	94	94
Pendimethalin	1.0	71	81	76	74	85	79	13	46	29	44	46	45
Pendimethalin	1.5	77	92	85	84	93	88	62	84	73	73	73	73
	Mean	95	97		96	98		85	88		85	81	
LSD (0.05)	Timing		NS			NS			NS			NS	
	Herbicide		8			7			15			19	
	Timing x Herbicide		NS			NS			NS			NS	

[1] Suen = sulfentrazone pend = pendimethalin

[2] application timing EPP = early pre-plant PRE = post plant pre-emergence

[3] Redroot pigweed and tumble pigweed

Table 5. Large crabgrass control in no-till sunflower, Tribune, KS 1999.

		Large crabgrass control					
		6-15-99			8-11-99		
Treatment[1]	Rate	EPP[2]	PRE[2]	Mean	EPP[2]	PRE[2]	Mean
	-- (lb/a) --	(%)					
Sulfentrazone	0.125	100	99	100	92	97	95
Sulfentrazone	0.15	100	100	100	97	82	90
Sulfentrazone	0.188	100	100	100	94	100	97
Sulfentrazone	0.2	100	100	100	98	100	99
Suen + pend	0.125+1.0	100	100	100	100	100	100
Suen + pend	0.15+1.0	98	98	98	100	100	100
Suen + pend	0.188+1.0	100	100	100	100	100	100
Suen + pend	0.2+1.0	99	99	99	100	100	100
Sulfentrazone	0.25	98	99	98	96	100	98
Pendimethalin	1.0	77	93	85	95	100	97
Pendimethalin	1.5	92	96	94	100	99	99
	Mean	97	99		98	98	
LSD (0.05)	Timing		NS			NS	
	Herbicide		7			NS	
	Timing x Herbicide		NS			NS	

[1] Suen = sulfentrazone pend = pendimethalin

[2] application timing EPP = early pre-plant PRE = post plant pre-emergence

Weed control in no-till sunflower with preemergence and postemergence herbicides. Curtis R. Thompson and Alan J. Schlegel. (Southwest Research Extension Center, Kansas State University, Garden City, KS 67846). The objective of this experiment was to evaluate broadleaf and grass weed control in sunflowers planted no-till into pea and bean stubble. The experiment was conducted at the Southwest Research Extension Center - Tribune Unit near Tribune, KS. on a Richfield silt loam soil with 1.4% organic matter and pH of 7.9. Early pre-plant (EPP)and postplant preemergence (PRE) treatments were applied to the soil surface on May 7 and May 20, 1999, respectively. Soil applied treatments were applied with a backpack sprayer delivering 20 gpa at 30 psi. 'Pioneer 64M01' sunflower was planted at 20,000 seeds/a on May 20. Postemergence treatments were applied to 4 to 5-leaf sunflower and 0.5 to 1 inch large crabgrass on June 18, 1999. Postemergence treatments were applied with a backpack sprayer delivering 10 gpa at 40 psi. The experimental units were 10 by 35 feet and the experimental design was a randomized complete block. A 5 by 32 foot area of each plot was harvested for seed yield on September 23. Due to a soil gradient across the experiment, an analysis of covariance was conducted. Visual evaluations of weed control and sunflower injury were made on June 15 and August 11.

Flumioxazin when applied early preplant reduced sunflower stand by 6000 to 11000 plants/acre compared to the untreated checks (Table 1). This stand reduction would be unacceptable in a commercial field. The 54 to 72% injury ratings from flumioxazin reflect the loss in sunflower plant stand. Flumioxazin applied preemergence after planting did not reduce sunflower stand and the injury ratings were much lower. Sulfentrazone applied preemergence after planting or tank mixed with S-metolachlor and applied early preplant or preemergence injured sunflower 19 to 26% at the June evaluation. Little or no injury was observed in August. Sunflower yields were quite variable and no significant yield differences were observed among the treatments despite the significant differences in plant stand and sunflower injury.

Pendimethalin applied early preplant did not control redroot and tumble pigweed, or any other weed species (Table 2). Flumioxazin applied early preplant had 14 to 31% lower weed control rating at the August rating compared to the June rating primarily because of the severe thinning of the sunflower stand. All other treatments, except the postemergence grass herbicides, gave acceptable pigweed and large crabgrass control. Kochia was controlled by all treatments accept pendimethalin early preplant or the grass herbicides applied postemergence. Puncturevine was the most difficult broadleaf weed to control. Sulfentrazone and flumioxazin applied postplant preemergence controlled puncturevine 86% or more, while S-metolachlor, pendimethalin, or flumioxazin applied early preplant had inadequate activity on puncturevine.

Table 1. Sunflower response to soil applied and postemergence herbicide, Tribune, KS 1999.

Treatment[1]	Rate	Timing[2]	Yield @ 10% H_2O	Moisture	Test weight	Plant stand	Injury 6-15	Injury 8-11
	(lb/a)		(lb/a)	(%)	(lb/bu)	(\1000)	(%)	
Untreated	0	—	1208	6.3	26.2	14.8	—	—
S-metolachlor	1.27	EPP	1727	6.9	25.5	12.6	5	4
S-metolachlor	1.59	EPP	1310	6.8	26.0	11.3	1	0
S-meto + suen	1.27+0.125	EPP	1610	5.7	26.0	12.4	19	3
Sulfentrazone	0.125	EPP	1311	5.4	25.4	14.0	3	0
Flumioxazin	0.078	EPP	1334	8.5	24.9	5.2	59	54
Flumioxazin + clethodim + COC + AMS	0.078 + 0.109 + 2 pt + 2.5 lb	EPP + POST	1117	8.9	23.8	3.9	69	72
Pendimethalin	1.5	EPP	1448	7.4	26.2	12.8	0	0
S-metolachlor	1.27	PRE	1862	6.3	26.6	14.6	3	0
S-metolachlor	1.59	PRE	1820	7.8	26.3	12.4	8	0
S-meto + suen	1.27 + 0.125	PRE	1579	7.8	24.4	13.3	26	1
Sulfentrazone	0.125	PRE	1832	6.6	25.6	12.9	24	0
Flumioxazin	0.078	PRE	1225	9.4	26.0	12.0	7	0
Flumioxazin + clethodim + COC + AMS	0.078 + 0.109 + 2 pt + 2.5 lb	PRE + POST	2068	6.9	26.4	12.1	10	0
Pendimethalin	1.5	PRE	1419	8.1	25.3	11.5	7	0
Clethodim + COC + AMS	0.109 +2 pt + 2.5 lb	POST	1514	6.5	25.2	12.7	—	0
Sethoxydim + COC + AMS	0.188 + 2 pt + 2.5 lb	POST	1476	9.3	26.2	12.1	—	0
Untreated			912	5.0	24.7	11.6	—	—
LSD (0.05)			NS	4.2	NS	3.5	17	8

[1] S-meto = S-metolachlor Suen = sulfentrazone COC = crop oil concentrate AMS = ammonium sulfate
[2] EPP = early preplant PRE = post plant pre-emergence POST = postemergence

Table 2. Weed control in no-till sunflower, Tribune, KS 1999.

Treatment[1]	Rate	Timing[2]	Pigweed species[3] 6-15	Pigweed species[3] 8-11	Kochia 8-11	Puncturevine 8-11	Large crabgrass 6-15	Large crabgrass 8-11
	(lb/a)		(% control)					
S-metolachlor	1.27	EPP	100	97	98	53	100	100
S-metolachlor	1.59	EPP	100	96	95	60	99	98
S-meto + suen	1.27+0.125	EPP	100	100	100	91	100	100
Sulfentrazone	0.125	EPP	99	100	100	79	89	89
Flumioxazin	0.078	EPP	93	79	97	56	95	63
Flumioxazin + clethodim + COC + AMS	0.078 + 0.109 + 2 pt + 2.5 lb	EPP + POST	100	79	96	42	96	96
Pendimethalin	1.5	EPP	9	8	10	0	31	20
S-metolachlor	1.27	PRE	76	99	93	50	76	99
S-metolachlor	1.59	PRE	100	100	95	45	100	98
S-meto + suen	1.27 + 0.125	PRE	100	100	100	85	99	97
Sulfentrazone	0.125	PRE	99	100	100	92	98	77
Flumioxazin	0.078	PRE	94	98	99	93	88	90
Flumioxazin + clethodim + COC + AMS	0.078 + 0.109 + 2 pt + 2.5 lb	PRE + POST	94	97	99	86	95	96
Pendimethalin	1.5	PRE	95	88	96	69	97	98
Clethodim + COC + AMS	0.109 +2 pt + 2.5 lb	POST	—	0	0	0	—	99
Sethoxydim + COC + AMS	0.188 + 2 pt + 2.5 lb	POST	—	0	0	0	—	98
LSD (0.05)			19	12	6	36	21	17

[1] S-meto = S-metolachlor Suen = sulfentrazone COC = crop oil concentrate AMS = ammonium sulfate
[2] EPP = early preplant PRE = post plant pre-emergence POST = postemergence
[3] Redroot pigweed and tumble pigweed

Weed control and crop response to herbicides in timothy. Joseph P. Yenish and Pete Schneider. (Washington State University, Pullman, WA 99164-6420) Timothy hay is a valuable export commodity for the state of Washington. In order to be of high-value export grade, timothy hay must be free of weeds including ryegrass and other forage grass species. Herbicides labeled for use in grass hay are legal for use on timothy. However, few of these products provide selective grass weed control. The purpose of this research was to evaluate herbicides for control of ryegrass spp. and injury to timothy.

Field experiments were established in the fall of 1998 in Kittitas County, WA to determine grass weed control and crop safety of herbicides in timothy. Two sites were established, one with an existing infestation of perennial and annual ryegrass, and the other with a known history of downy brome infestation. A weed infestation did not development at the site selected for downy brome, so only herbicide injury information from that location was collected (Table 1). Herbicides were applied 1) early fall to actively growing timothy and established perennial ryegrass, but preemergence to Italian ryegrass, 2) late fall to semi-dormant timothy and actively growing ryegrass, and 3) in the spring to actively growing timothy and ryegrass. Applications of nicosulfuron, diclofop, and paraquat injured timothy, excessively. Paraquat was applied to semi-dormant timothy with the idea that actively growing weeds would be killed and the timothy protected by dormancy. Primisulfuron provided the greatest control of ryegrass without excessive timothy injury (Table 2).

Table 1. Timothy response to fall and spring herbicide applications - site 1.

Treatment	Rate	Appl. Timing	Timothy injury 4/15/99	Timothy injury 5/7/99	Timothy injury 5/29/99
	lb/A		%		
Dimethenamid	0.5	Early Fall	0	1	1
Flufenacet + metribuzin	0.32 +0.08	Early Fall	3	0	4
Flufenacet + metribuzin + triasulfuron	0.22 + 0.05 + 0.016	Early Fall	0	0	1
Flufenacet + metribuzin	0.22 + 0.14	Early Fall	0	0	0
Pendimethalin	0.5	Early Fall	0	0	0
Nicosulfuron[a]	0.031	Late Fall	75	45	38
Primisulfuron[a]	0.031	Late Fall	0	0	0
Paraquat[a]	0.5	Late Fall	94	90	87
Paraquat + pendimethalin[a]	0.5 + 0.75	Late Fall	95	94	92
Tralkoxydim[b]	0.18	Spring	NA	0	0
Diclofop	0.75	Spring	NA	4	24
LSD (p=0.05)			4	3	11

[a]Applied with nonionic surfactant at 0.25% v/v.
[b]Applied with Supercharge surfactant at 0.5% v/v.

Table 2. Timothy and *Lolium* spp. response to fall and spring herbicide applications - site 2.

Treatment	Rate	Appl. Timing	Timothy injury 4/15/99	Timothy injury 5/7/99	Timothy injury 6/9/99	Ryegrass control 6/9/99	Ryegrass control 7/7/99
			%				
Flufenacet + metribuzin	0.22 + 0.05	Early Fall	1	0	1	44	25
Flufenacet + metribuzin	0.32 + 0.08	Early Fall	0	6	0	41	26
Flufenacet + metribuzin + triasulfuron	0.22 + 0.05 + 0.016	Early Fall	2	1	0	31	34
Flufenacet + metribuzin	0.22 + 0.14	Early Fall	0	1	0	33	21
Metribuzin + metsulfuron	0.15 + 0.01	Early Fall	0	0	0	59	44
Metribuzin	0.15	Early Fall	1	0	4	38	17
Nicosulfuron[a]	0.031	Late Fall	68	59	76	63	34
Primisulfuron[a]	0.031	Late Fall	2	4	1	75	82
Paraquat[a]	0.5	Late Fall	90	92	71	73	5
Tralkoxydim[b]	0.18	Spring	NA	3	0	59	35
Diclofop	0.75	Spring	NA	7	39	75	47
LSD (p=0.05)			21	19	12	31	32

[a]Applied with nonionic surfactant at 0.25% v/v.
[b]Applied with Supercharge surfactant at 0.5% v/v.

Foxtail control in spring wheat with clodinafop. Brian Jenks and Gary Willoughby. (NDSU, North Central Research Extension Center, Minot, ND 58701). We evaluated clodinafop for foxtail control compared to other products. Grandin hard red spring wheat was seeded May 20. Seedbed preparation was conventional with 6-inch row spacing and wheat seeded at 1 million pls/A. Individual plots were 10 x 30 ft arranged in a RCBD with three replications. All treatments were applied June 7 with XR8001 flat fan nozzles delivering 10 gpa at 40 psi. The crop was not harvested due to hail damage.

Clodinafop alone provided excellent control of foxtails, but control was reduced 10-20% when combined with broadleaf herbicides. Tralkoxydim caused moderate wheat stunting soon after application, but appeared to recover as the season progressed. Soil moisture and relative humidity were high at the time of application. We received one-half inch of rain the day before application.

Application date	June 7
Application timing	POST
Temperature (°F)	
Air	75
Soil	70
Relative humidity (%)	53
Wheat stage	4 to 5-leaf
Foxtail	1" tall / 60 per sq ft
AMARE	1" tall / 43 per sq ft
POLCO	1" tall / 1-2 per sq ft
CHEAL	1-2" tall / 1-2 per sq ft

Table. Foxtail control in spring wheat with clodinafop.

		June 18					August 18				
Treatment[a]	Rate	Injury	SET[b]	POLCO	AMARE	CHEAL	Injury	SET[b]	POLCO	AMARE	CHEAL
	lb/A	%	Control (%)				%	Control (%)			
Untreated		0	0	0	0	0	0	0	0	0	0
Clodinafop +	0.063	0	95	0	0	0	0	94	0	0	0
Score	1%										
Clodinafop +	0.063	0	90	100	98	100	0	85	88	98	98
Bromoxynil + MCPA +	0.50										
Score	1%										
Thif + trib[c] +	0.014	0	83	100	100	100	0	70	94	100	98
Clodinafop +	0.063										
MCPA ester +	0.38										
Score	1%										
Clodinafop +	0.063	0	94	97	97	100	0	87	87	92	95
Prosulfuron +	0.009										
Score	1%										
Tralkoxydim +	0.18	16	96	100	99	100	2	78	85	93	93
Supercharge+	0.5%										
AMS +	1.8%										
Bromoxynil + MCPA	0.50										
Fenoxaprop +	0.042	1	95	100	97	100	0	79	90	98	98
Bromoxynil + MCPA	0.50										
LSD		5	6	2	5	0	2	11	6	6	6
CV		69	4	1	4	0	154	8	5	4	5

[a] Thif + trib and bromoxynil + MCPA applied as commercial premixes.
[b] SET=green and yellow foxtail
[c] Thif + trib = thifensulfuron + tribenuron

Broadleaf weed control with reduced fluroxypyr rates and sulfonylurea herbicides. Michael J. Wille and Don W. Morishita. (Twin Falls Research and Extension Center, University of Idaho, Twin Falls, ID 83303-1827). A study was established at the University of Idaho Research center near Kimberly Idaho, to compare below-label rates of fluroxypyr in combination with thifensulfuron, tribenuron, and thifensulfuron + tribenuron for broadleaf weed control in spring wheat. The experimental design was a randomized complete block with four replications. Individual plots were 8 by 25 ft. Spring wheat ('Whitebird')was planted on April 17, 1999, in a Rad silt loam (26% sand, 64% silt, 10% clay, pH 8.1, 1.6% organic matter, 16-meq/100 g soil CEC). Common lambsquarters was the only weed species present. Herbicides were broadcast-applied postemergence with a CO_2-pressurized bicycle-wheel sprayer calibrated to deliver 10 gpa at 40 psi on June 1, when wheat had 6-8 leaves 2-3 tillers. Common lambsquarters was 2-6 inches tall with a density of 38 plants/ft^2. Environmental conditions were as follows: air temperature 71 F, soil temperature 62 F, relative humidity 54%, wind velocity 6 mph, and 100% cloud cover. Crop injury and weed control were visually evaluated 14 and 28 days after treatment on June 14 and June 29, respectively. Grain was harvested at maturity with a small-plot combine on September 9.

Wheat was not injured by any herbicide treatment. Fluroxypyr alone at any rate did not control common lambsquarters at either evaluation date. Fluroxypyr at either 0.75 or 1.0 oz./A tank-mixed with 0.25 oz./A thifensulfuron controlled common lambsquarters 50% on June 14, and 63 to 73% on June 29. Fluroxypyr at either 0.75 or 1.0 oz./A tank-mixed with either tribenuron, tribenuron + thifensulfuron or 0.375 oz./A thifensulfuron, controlled common lambsquarters 73 to 80% on June 14, and 83 to 93% on June 29. Tribenuron + thifensulfuron tank-mixed with bromoxynil + MCPA controlled common lambsquarters 93% on June 14, and 98% on June 29. Grain yield in herbicide-treated plots ranged from 88 to 105 bu/A and did not differ from each other or from the control. Test weights ranged from 40 to 56 lb/bu.

Table. Effect of reduced fluroxypyr rates and sulfonylurea herbicides on common lambsquarters control.

Treatment[a]	Application Rate	Crop injury 6/14	Crop injury 6/29	Common lambsquarters control 6/14	Common lambsquarters control 6/29	Yield
	lb/A	%				bu/A
Check		0	0	0	0	88
Fluroxypyr + NIS	0.75 + 0.25% v/v	0	0	0	0	79
Fluroxypyr + thifensulfuron + NIS	0.75 + 0.25 + 0.25% v/v	0	0	50	73	105
Fluroxypyr + thifensulfuron NIS	0.75 + 0.375 + 0.25% v/v	0	0	73	83	95
Fluroxypyr + thifensulfuron & tribenuron + NIS	0.75 + 0.3 + 0.25% v/v	0	0	78	93	102
Fluroxypyr + tribenuron + NIS	0.75 + 0.187 + 0.25% v/v	0	0	80	91	98
Fluroxypyr + NIS	1.0 + 0.25% v/v	0	0	0	0	75
Fluroxypyr + thifensulfuron + NIS	1.0 + 0.25 + 0.25% v/v	0	0	50	63	88
Fluroxypyr + thifensulfuron + NIS	1.0 + 0.375 + 0.25% v/v	0	0	73	85	104
Fluroxypyr + thifensulfuron & tribenuron + NIS	1.0 + 0.3 + 0.25% v/v	0	0	78	93	105
Fluroxypyr + tribenuron + NIS	1.0 + 0.187 + 0.25% v/v	0	0	80	90	89
Thifensulfuron & tribenuron + bromoxynil & MCPA + NIS	0.3 + 8.0 + 0.25% v/v	0	0	93	98	99
Fluroxypyr + NIS	2.0 + 0.25% v/v	0	0	0	0	105
LSD (0.05)		ns	ns	4	5	19

[a]NIS = nonionic surfactant, thifensulfuron & tribenuron is a 2:1 commercial formulation of thifensulfuron and tribenuron, and bromoxynil & MCPA is a 1:1 commercial formulation of bromoxynil and MCPA.

Common lambsquarters control in spring wheat with carfentrazone tank mixed with other broadleaf herbicides. Don W. Morishita and Michael J. Wille. (Twin Falls Research and Extension Center, University of Idaho, Twin Falls, ID 83303-1827) A field experiment was conducted to compare combinations of broadleaf herbicides applied with carfentrazone for weed control in irrigated spring wheat ('Whitebird'). Wheat was planted April 17, 1999, at a seeding rate of 100 lb/A at the University of Idaho Research and Extension Center near Kimberly, Idaho. Soil type was a Rad silt loam with an 8.1 pH, 1.6% organic matter, and CEC of 16 meq/100 g soil. Treatments were arranged in a randomized complete block design with four replications. Individual plots were 8 by 25 ft. All herbicide treatments were applied June 1 during the following environmental conditions: air temperature 70 F, soil temperature 74 F, relative humidity 52%, and wind speed 0 to 6 mph. All herbicides were applied with a CO_2-pressurized bicycle-wheel sprayer calibrated to deliver 10 gpa using 11001 flat fan nozzles. Grain was in the 5 to 8-leaf stage and common lambsquarters was 1 to 6-inches tall and averaged 75 plants/ft^2. Herbicide treatments were evaluated visually for crop injury and weed control June 4, 18, and July 2, which was 3, 17, and 30 days after treatment (DAT), respectively. Grain was harvested September 7 with a small-plot combine.

Crop injury, in the form of leaf burn, 3 DAT ranged from 4 to 19% for all herbicide treatments (Table). Treatments with the highest level of injury were carfentrazone + MCPA LVE and carfentrazone + bromoxynil & MCPA + 28% N, which injured the crop 19 and 18%, respectively. Carfentrazone + bromoxynil & MCPA without 28% N injured the crop 10% which was less than when 28% N was included. By 30 DAT, crop injury was not visible in any of the treatments. Overall, common lambsquarters control improved with all herbicide treatments from 3 to 30 DAT. By the last evaluation, all herbicide treatments controlled common lambsquarters better than 90% except carfentrazone + fluroxypyr at 0.132 + 0.0625 lb/A. Increasing the fluroxypyr rate to 0.125 lb/A in combination with carfentrazone improved weed control to 91%. Even though initial common lambsquarters populations averaged 75 plants/ft^2, there were no differences in yield among the treatments. Cool growing conditions in 1999 may have favored wheat growth giving it a competitive advantage over the common lambsquarters.

Table. Crop injury, weed control, and spring wheat yield with carfentrazone tank mixed with other broadleaf herbicides.

		Crop injury			Common lambsquarters control			
Treatment	Rate	6/4	6/18	7/2	6/4	6/18	7/2	Yield
	lb/A				%			bu/A
Check		-	-	-	-	-	-	93
Carfentrazone +	0.132 +	4	5	0	61	89	93	89
2,4-D amine +	0.25 +							
nonionic surfactant	0.25% v/v							
Carfentrazone +	0.132 +	13	6	0	70	93	99	93
2,4-D LVE +	0.25 +							
nonionic surfactant	0.25% v/v							
Carfentrazone +	0.132 +	10	4	0	70	71	98	97
MCPA amine +	0.375 +							
nonionic surfactant	0.25% v/v							
Carfentrazone +	0.132 +	19	8	0	80	97	98	93
MCPA LVE +	0.375 +							
nonionic surfactant	0.25% v/v							
Carfentrazone +	0.132 +	13	5	0	80	95	97	94
bromoxynil & MCPA[a] +	0.5 +							
nonionic surfactant	0.25% v/v							
Carfentrazone +	0.132 +	18	5	0	83	97	99	94
bromoxynil & MCPA +	0.5 +							
28% N	0.4% v/v							
Carfentrazone +	0.132 +	10	5	0	80	95	99	86
bromoxynil & MCPA	0.5							
Carfentrazone +	0.132 +	14	5	0	75	80	91	83
fluroxypyr +	0.125 +							
nonionic surfactant	0.25% v/v							
Carfentrazone +	0.132 +	13	5	0	58	63	77	77
fluroxypyr +	0.0625 +							
nonionic surfactant	0.25% v/v							
Carfentrazone +	0.132 +	5	5	0	58	91	98	101
dicamba +	0.094 +							
nonionic surfactant	0.25% v/v							
LSD (0.05)		5	2	0	18	25	8	24

[a]Bromoxynil & MCPA is a 1:1 commercial formulation.

Comparison of postemergence wild oat herbicides in spring wheat. Don W. Morishita and Michael J. Wille. (Twin Falls Research and Extension Center, University of Idaho, Twin Falls, ID 83303-1827). A study was conducted in sprinkler irrigated spring wheat ('Westbred 936') to compare several wild oat herbicides and herbicide combinations for wild oat control. The experiment site was located near Paul, ID in wheat planted May 1, 1999, at a seeding rate of 100 lb/A. Soil type at this location was a Portneuf silt loam with a 7.8 pH, 1.5% organic matter, and CEC of 15 meq/100 g soil. All herbicides were applied with a CO_2-pressurized bicycle-wheel sprayer calibrated to deliver 10 gpa using 11001 flat fan nozzles. Application dates and environmental conditions are shown in Table 1. The experimental design was a randomized complete block with four replications and individual plots were 8 by 25 ft. Crop injury and wild oat control was evaluated visually July 21. Wheat was harvested September 8 with a small-plot combine.

Table 1. Application information and wild oat density.

Application date	5/28	6/4
Application timing	1 to 3 leaf	3 to 5 leaf
Air temperature (F)	85	56
Soil temperature (F)	85	54
Relative humidity (%)	56	92
Wind speed (mph)	3	6
Wild oat density/ft^2	29	29

Crop injury with difenzoquat + nonionic surfactant and difenzoquat + pinolene at 6 fl oz/A averaged 4 to 5% (Table 2). All other treatments did not injure the crop or averaged only 1%. Difenzoquat + nonionic surfactant or pinolene controlled wild oat 83 to 92%. Fenoxaprop at 0.083 lb/A and clodinafop at 0.05 lb/A controlled wild oat 88 and 90%, respectively. All of these treatments were among the best wild oat control treatments in this study. All herbicide treatments had grain yields higher than the check. Highest yielding treatments included clodinafop, fenoxaprop, and imazamethabenz + fenoxaprop at 0.235 + 0.0415 lb/A.

Table 2. Effect of wild oat herbicides on spring wheat injury, wild oat control, and grain yield.

Treatment[a]	Rate	Application timing	Crop injury	Wild oat control	Yield
	lb/A		------- % -------		bu/A
Check			-	-	15
Tralkoxydim +	0.24 +	1-3 leaf	0	48	73
Supercharge +	0.5% v/v +				
ammonium sulfate	2.0				
Fenoxaprop	0.083	1-3 leaf	0	88	85
Diclofop +	1.0 +	1-3 leaf	0	50	67
crop oil concentrate	1.0				
Clodinafop +	0.05 +	1-3 leaf	0	90	89
Score	0.8% v/v				
Imazamethabenz +	0.47 +	1-3 leaf	1	84	78
nonionic surfactant	0.25% v/v				
Imazamethabenz +	0.235 +	1-3 leaf	1	74	80
fenoxaprop +	0.0415 +				
nonionic surfactant	0.25% v/v				
Imazamethabenz +	0.235 +	1-3 leaf	0	56	77
difenzoquat +	0.5 +				
nonionic surfactant	0.25% v/v				
Imazamethabenz +	0.235 +	1-3 leaf	1	68	78
difenzoquat +	0.5 +				
bromoxynil & MCPA +	0.375 +				
thifensulfuron +	0.0234 +				
nonionic surfactant	0.25% v/v				
Imazamethabenz +	0.235 +	1-3 leaf	0	40	73
difenzoquat +	0.5 +				
bromoxynil +	0.375 +				
thifensulfuron +	0.0234 +				
nonionic surfactant	0.25% v/v				
Difenzoquat +	1.0 +	3-5 leaf	5	83	65
nonionic surfactant	0.25% v/v				
Difenzoquat +	1.0 +	3-5 leaf	1	92	64
Nu Film	4 fl oz/A				
Difenzoquat +	1.0 +	3-5 leaf	4	86	62
Nu Film	6 fl oz/A				
LSD (0.05)			3	18	11

[a]Supercharge, Score and Nu Film are proprietary adjuvants; bromoxynil & MCPA is a 1:1 commercial formulation.

Effect of fluroxypyr and MCPA tank mixed with fenoxaprop or tralkoxydim on wild oat control. M. Ann Pool, Don W. Morishita, and Michael J. Wille. (Twin Falls Research and Extension Center, University of Idaho, Twin Falls, ID, 83303-1827) A study was established near Rupert, Idaho to evaluate the compatibility of fluroxypyr and MCPA when tank mixed with fenoxaprop and tralkoxydim for wild oat control. 'Westbred 936' spring wheat was seeded into a sprinkler irrigated Portneuf silt loam soil (19% sand, 71% silt, and 10% clay, pH 7.8, 1.5% organic matter, and a CEC of 15 meq/100 g soil). The experimental design was a randomized complete block with four replications, and individual plots were 8 by 25 ft. Herbicides were applied postemergence May 28, 1999, with a CO_2-pressurized bicycle-wheel sprayer calibrated to deliver 10 gpa. Wild oat was in the 2 to 4-leaf stage with a density of 18 plants/ft^2. Environmental conditions at application were as follows: air temperature 85 F, soil temperature 100 F, relative humidity 56%, wind 4 mph, and 0% cloud cover. Crop injury was evaluated visually June 11 and July 21. Wheat was harvested with a small-plot combine September 8.

No crop injury was observed at either evaluation date (Table). All herbicide treatments controlled wild oat 83 to 91%. Grain yields ranged from 96 to 109 bu/A for all treatments except the untreated check which yielded 26 bu/A. Test weights ranged from 60 to 62 lb/bu (data not shown). There was no apparent effect of tank mixing fluroxypyr with fenoxaprop or tralkoxydim on wild oat control or grain yield.

Table. Effect of fluroxypyr + MCPA LVE tank mixed with fenoxaprop and tralkoxydim on crop injury, wild oat control and grain yield.

Treatment	Rate	Crop injury 6/11	Crop injury 7/21	Wild oat Control	Yield
	lb/A	%			bu/A
Check		—	—	—	26
Fluroxypyr & MCPA[a] +	0.625 +	0	0	83	96
fenoxaprop	0.083				
Fluroxypyr +	0.125 +	0	0	84	100
MCPA amine +	0.375 +				
fenoxaprop	0.083				
Fluroxypyr & MCPA +	0.625 +	0	0	91	109
tralkoxydim +	0.24 +				
ammonium sulfate +	1.7 +				
Supercharge	0.5% v/v				
Fluroxypyr & MCPA +	0.469 +	0	0	89	101
thifensulfuron +	0.0155 +				
tralkoxydim +	0.24 +				
ammonium sulfate +	1.7 +				
Supercharge	0.5% v/v				
LSD (0.05)		NS	NS	NS	19

[a]Fluroxypyr and MCPA is a 1:4.33 commercial formulation.

The effect of carfentrazone in combination with wild oat herbicides on wild oat control in spring wheat. Curtis R. Rainbolt and Donald C. Thill (Plant science Division, University of Idaho, Moscow, ID 83844-2339). A study was established near Bonners Ferry, ID in 'Westbred 926' hard red spring wheat to determine the effect of carfentrazone combined with wild oat herbicides on wild oat control. Plots were 8 by 30 ft arranged in a randomized complete block with four replications. All herbicide treatments were applied on May 24, 1999 with a CO_2 pressurized backpack sprayer calibrated to deliver 10 gpa at 30 psi and 3 mph (Table 1). Crop injury was evaluated visually on June 11, 1999 and wild oat control was evaluated on June 11 and July 20, 1999. Spring wheat grain was not harvested, because wild oat control with most treatments was poor.

Table 1. Application data.

Wheat growth stage	3-4 leaf
Wild oat growth stage	1-2 leaf
Air temperature (F)	85
Relative humidity (%)	40
Wind (mph)	2
Soil temperature at 2 in (F)	75
pH	7.4
OM (%)	12.9
CEC (meq/100g)	38
Texture	loam

Spring wheat was not visibly injured by herbicide treatments 14 days after spraying (data not shown). Wild oat plants were chlorotic and stunted, but not dead on June 11 (Table 2). Control was poor ($\leq$ 55%) with all treatments. Imazamethabenz treatments tended to control wild oat better than fenoxaprop.

Table 2. Wild oat control with carfentrazone and wild oat herbicide tank mixes.

		Wild oat	
Treatments[a]	Rate	June 11, 1999	July 20, 1999
	lb/A	----------% control----------	
carfentrazone + AMS	0.008 + 4.0	21	0
carfentrazone + MCPA amine + AMS	0.008 + 0.375 + 4.0	25	0
carfentrazone + fenoxaprop/safeners + MCPA amine + AMS	0.008 + 0.104 + 0.375 + 4.0	44	8
carfentrazone + fenoxaprop/safeners + AMS	0.008 + 0.104 + 4.0	51	48
carfentrazone + imazamethabenz + AMS	0.008 + 0.469 + 4.0	51	54
carfentrazone + imazamethabenz + MCPA ester + AMS	0.008 + 0.469 + 0.375 + 4.0	56	64
carfentrazone + imazamethabenz	0.008 + 0.469	51	61
carfentrazone + imazamethabenz + MCPA ester	0.008 + 0.469 + 0.375	55	68
carfentrazone + fenoxaprop/safeners	0.008 + 0.104	51	41
untreated control	--		
average wild oat density	--	22 plts/ft^2	--
LSD (0.05)		6	8

[a]All treatments contained NIS at 0.25% v/v.

Wild oat control in spring wheat with fenoxaprop/safener in combination with broadleaf herbicides. Curtis R. Rainbolt and Donald C. Thill. (Plant Science Division, University of Idaho, Moscow, ID 83844-2339) A study was established in spring 1999, near Bonner's Ferry, Idaho to evaluate wild oat control in 'Westbred 926' hard red spring wheat with fenoxaprop/safener alone and in combination with broadleaf herbicides. The experimental design was a randomized complete block with four replications, and individual plot size was 8 by 30 ft. Herbicide treatments were applied on May 24, 1999 with a CO_2 pressurized backpack sprayer calibrated to deliver 10 gpa at 32 psi and 3 mph (Table 1). Wheat injury was evaluated visually on June 11, 1999, and weed control was evaluated on June 11 and July 20, 1999. Spring wheat grain was not harvested, because wild oat control with most treatments was poor.

Table 1. Application data.

Wheat growth stage	3-4 leaf
Wild oat growth stage	1-2 leaf
Air temperature (F)	85
Relative humidity (%)	40
Wind (mph)	2
Soil temperature at 2 in (F)	75
pH	7.4
OM (%)	12.9
CEC (meq/100g)	38
Texture	loam

Imazamethabenz + difenzoquat stunted wheat 19% and controlled wild oat 70% on June 11, 1999 (Table 2). Wheat injury was expected, because 'Westbred 926' is sensitive to difenzoquat. In most other treatments, wild oat plants were stunted and chlorotic, but not dead. Fenoxaprop alone controlled wild oat 48%, while fenoxaprop plus MCPA ester controlled wild oat only 31% (June 11). By July 20, wild oat control was less than 26% in all treatments.

Table 2. Wild oat control and spring wheat yield.

Treatment[a]	Rate	Wheat injury	Wild oat control June 11	Wild oat control July 20
	lb/A	%		
Fenoxaprop/safener	0.104	0	48	24
Fenoxaprop/safener + thifen/triben	0.104 + 0.019	0	44	3
Fenoxaprop/safener + thifensulfuron	0.104 + 0.023	0	40	18
Fenoxaprop/safener +thifen/triben + bromoxynil/MCPA	0.104 + 0.019 + 0.5	0	40	0
Fenoxaprop/safener +thifensulfuron + bromoxynil/MCPA	0.104 + 0.023 + 0.5	0	38	0
Fenoxaprop/safener +thifensulfuron + bromoxynil	0.104 + 0.023 + 0.25	0	38	8
Fenoxaprop/safener + MCPA ester	0.104 + 0.375	0	31	23
Fenoxaprop/safener + fluroxypyr	0.104 + 0.125	0	55	23
Fenoxaprop/safener + fluroxypyr + MCPA ester	0.104 + 0.125 + 0.375	0	49	20
Fenoxaprop/safener + fluroxypyr + thifen/triben	0.104 + 0.125 + 0.009	0	45	9
Fenoxaprop/safener + thifensulfuron + MCPA ester	0.104 + 0.019 + 0.375	0	38	5
Fenoxaprop/safener + bromoxynil/MCPA + prosulfuron	0.104 + 0.5 + 0.018	0	44	0
Fenoxaprop/safener + prosulfuron + MCPA ester	0.104 +0.018 + 0.375	0	43	13
Imazamethabenz + difenzoquat[b]	0.235 + 0.5	19	70	25
Untreated control	--	--	--	--
Average wild oat density	--	--	21 plts/ft^2	--
LSD(0.05)		1	16	11

[a]Thifen/triben is the commercial formulation of thifensulfuron/tribenuron, bromoxynil/MCPA was applied as the commercial formulation.
[b]Applied with 90% NIS at 0.25% v/v.

Wild oat control and crop response with imazamox in imidazolinone-resistant winter wheat. Traci A. Rauch, Donald C. Thill, and Lori Crumley. (Plant Science Division, University of Idaho, Moscow, ID 83844-2339) A study was established near Moscow, Idaho in 'Fidel' winter wheat to evaluate wild oat control and winter wheat tolerance with imazamox. Plots were 8 by 30 ft arranged in a randomized complete block with four replications. All herbicide treatments were applied with a CO_2 pressurized backpack sprayer calibrated to deliver 10 gpa at 30 psi and 3 mph (Table 1). Wheat injury was evaluated visually on May 17 and June 14, 1999. Wild oat (AVEFA) control was evaluated on July 16, 1999. Winter wheat was not harvested due to a poor stand from winter-kill.

Table 1. Application data

Application date	May 10, 1999		June 6, 1999
Application timing	Post		Post
Wheat growth stage	2 to 3 tiller		Jointing
Wild oat growth stage	2 to 3 leaf		4 to 6 leaf
Air temp (F)	56		50
Relative humidity (%)	40		90
Wind (mph, direction)	0		3, NE
Cloud cover (%)	90		10
Soil temperature at 2 in (F)	55		45
Soil moisture	medium		high
Dew presence (Y/N)	N		Y
pH		4.7	
OM (%)		4.6	
CEC (cmol +/Kg)		27	
Texture		silt loam	

No treatment visually injured winter wheat (data not shown). Imazamox treatments controlled wild oat 71 to 90% at the 2 to 3 leaf stage and 94 to 99% at the 4 to 6 leaf stage. At the earlier timing, fenoxaprop/safener (standard treatment) controlled wild oat better than imazamox at 0.032 and 0.04 lb/A. However, there was no difference among treatments at the later timing. Wild oat control at the 4 to 6 leaf stage was equal to or better than compared at the 2 to 3 leaf stage.

Table 2. Wild oat control with imazamox.

Treatment[a]	Rate	Application timing	Weed control AVEFA
	lb/A		%
Imazamox	0.032	2 to 3 leaf	71
Imazamox	0.04	2 to 3 leaf	78
Imazamox	0.048	2 to 3 leaf	90
Fenoxaprop/safener	0.105	2 to 3 leaf	94
Flucarbazone-sodium[b]	0.027	2 to 3 leaf	81
Imazamox	0.032	4 to 6 leaf	94
Imazamox	0.04	4 to 6 leaf	99
Imazamox	0.048	4 to 6 leaf	99
Fenoxaprop/safener	0.105	4 to 6 leaf	96
Flucarbazone-sodium	0.027	4 to 6 leaf	96
LSD (0.05)			11
Plants/ft²			21

[a] All treatments except fenoxaprop/safener contained a 90% nonionic surfactant at 0.25% v/v and 32% UAN (urea ammonium nitrate) was mixed with the imazamox treatments at 1qt/A.
[b] Proposed common name for MKH-6562

Wild oat control in spring wheat with clodinafop and broadleaf herbicide combinations. Traci A. Rauch and Donald C. Thill. (Plant Science Division, University of Idaho, Moscow, ID 83844-2339) A study was established near Bonners Ferry, Idaho in 'Westbred 926' hard red spring wheat to evaluate wild oat control and spring wheat yield with clodinafop and broadleaf herbicide combinations. Plots were 8 by 30 ft arranged in a randomized complete block with four replications. All herbicide treatments were applied with a CO_2 pressurized backpack sprayer calibrated to deliver 10 gpa at 30 psi and 3 mph (Table 1). Spring wheat injury and wild oat control were evaluated visually on June 10 and July 27, 1999. Wheat was not harvested due to a high population of wild oat and poor control.

Table 1. Application data.

Application date	May 24, 1999
Wheat growth stage	3 to 4 leaf
Wild oat growth stage	1 to 2 leaf
Air temperature (F)	73
Relative humidity (%)	40
Wind (mph, direction)	2 to 4, SW
Cloud cover (%)	0
Soil temperature at 2 in (F)	75
pH	7.4
OM (%)	12.9
CEC (meq/100g)	38
Texture	loam

Clodinafop + MCPA injured wheat 20% on June 10, but no injury was visible by July 20, 1999 (Table 2). All sulfonylurea herbicides combined with clodinafop did not injure wheat with or without MCPA. Clodinafop alone andcombined with prosulfuron, MCPA, and MCPA + thifensulfuron controlled wild oat 82 to 89% on June 10. By July 20, clodinafop + prosulfuron only suppressed wild oat (29%) while clodinafop alone and with MCPA and MCPA + thifensulfuron controlled wild oat 58 to 72%. All other treatments did not control wild oat.

Table 2. Spring wheat injury and wild oat control with clodinafop and broadleaf herbicide combinations.

Treatment[a]	Rate	Wheat injury	Wild oat control June 10	Wild oat control July 20
	lb/A	%		
Clodinafop	0.05	0	86	58
Clodinafop + prosulfuron	0.05 + 0.018	0	82	29
Clodinafop + MCPA	0.05 + 0.25	20	89	72
Clodinafop + MCPA + thifen/triben	0.05 + 0.25 + 0.014	0	24	14
Clodinafop + MCPA + thifen/triben	0.05 + 0.25 + 0.019	0	25	10
Clodinafop + MCPA + thifensulfuron	0.05 + 0.25 + 0.023	0	86	69
Clodinafop + MCPA + tribenuron	0.05 + 0.25 + 0.008	0	15	8
Clodinafop + MCPA + tribenuron	0.05 + 0.25 + 0.016	0	14	5
Clodinafop + MCPA + metsulfuron	0.05 + 0.25 + 0.002	0	11	9
Clodinafop + MCPA + metsulfuron	0.05 + 0.25 + 0.004	0	10	5
Clodinafop + MCPA + thifen/triben + metsulfuron	0.05 + 0.25 + 0.007 + 0.002	0	16	6
Clodinafop + MCPA + thifen/triben + metsulfuron	0.05 + 0.25 + 0.014 + 0.004	0	11	6
Untreated check	--	--	--	--
LSD (0.05)		2	9	16
plants/ft^2			28	

[a]MCPA was applied using the ester formulation. Thifen/triben is the commercial formulation of thifensulfuron/tribenuron. All treatments applied with crop oil concentrate (Score) at 0.8% v/v.

Comparison of bromoxynil formulations for common lambsquarters control in spring wheat. Michael J. Wille and Don W. Morishita. (Twin Falls Research and Extension Center, University of Idaho, Twin Falls, ID 83303-1827) A study was established at the University of Idaho Research and Extension Center near Kimberly, Idaho, to compare the effectiveness of new EC and solventless formulations of bromoxynil and bromoxynil & MCPA. The experimental design was a randomized complete block with four replications. Individual plots were 8 by 25 ft. Spring wheat ('Whitebird') was planted April 17, 1999, in a Rad silt loam (26% sand, 64% silt, 10% clay, pH 8.1, 1.6% organic matter, 16-meq/100 g soil CEC). Common lambsquarters was the only weed species present. Herbicides were broadcast-applied June 7 with a CO_2-pressurized bicycle-wheel sprayer calibrated to deliver 10 gpa with 11001 flat fan nozzles. Wheat had 6 to 8 leaves, and common lambsquarters was 4 to 6 inches tall with a density of 16 plants/ft^2. Environmental conditions were as follows: air temperature 70 F, soil temperature 80 F, relative humidity 42%, wind velocity 5 mph, and 0% cloud cover. Crop injury and weed control were evaluated visually 7 and 25 days after treatment (DAT) on June 14 and July 2, respectively. Grain was harvested September 7 with a small-plot combine.

None of the herbicide treatments injured the wheat on either evaluation date (Table). At 7 DAT, all herbicide treatments controlled common lambsquarters 84 to 95% except bromoxynil 2 EW alone or with crop oil concentrate (COC), and bromoxynil 4 EW + COC which controlled common lambsquarters 60 to 68%. At 25 DAT, all herbicide treatments controlled common lambsquarters 89 to 99%. Grain yields ranged from 86 to 102 bu/A and test weights ranged from 49 to 60 lb/bu (data not shown). Grain yields and test weights did not differ from each other including the untreated check.

Table. Crop injury, common lambsquarters control, and wheat yield response to bromoxynil formulations.

Treatment[a]	Rate	Crop injury 6/14	Crop injury 7/2	Common lambsquarters control 6/18	Common lambsquarters control 7/2	Yield
	lb/A	%				bu/A
Check		–	–	–	–	86
Bromoxynil 2 EC	0.25	0	0	89	99	96
Bromoxynil 4 EC	0.25	0	0	91	99	89
Bromoxynil & MCPA 4 EC	0.5	0	0	95	99	95
Bromoxynil & MCPA 5 EC	0.5	0	0	91	99	97
Bromoxynil & 2,4-D 4 EC	0.5	0	0	84	99	91
Bromoxynil 2 EW	0.25	0	0	60	91	102
Bromoxynil 4 EW	0.25	0	0	83	96	87
Bromoxynil & MCPA 4 EW	0.5	0	0	91	99	98
Bromoxynil 2 EW + COC	0.25 + 1% v/v	0	0	65	89	105
Bromoxynil 4EW + COC	0.25 + 1% v/v	0	0	68	95	94
Bromoxynil & MCPA 4 EW + COC	0.5 + 1% v/v	0	0	89	98	93
LSD (0.05)		NS	NS	9	5	NS

[a]Bromoxynil & MCPA and bromoxynil & 2,4-D are commercial or experimental formulations of bromoxynil and MCPA, and bromoxynil and 2,4-D, respectively. COC = crop oil concentrate

Harvest aid in wheat with paraquat, glyphosate and sulfosate. Joan Campbell and Donn Thill. (Plant Science Division, University of Idaho, Moscow, Idaho 83844-2339) An experiment was established in winter wheat to evaluate paraquat, glyphosate, and sulfosate as harvest aids. The experiment was located near Potlatch, Idaho and the design was a randomized complete block with four replications. Plots were 8 by 30 ft. Herbicides were applied with a CO_2 pressurized backpack sprayer calibrated to deliver 10 gal/A at 32 psi (Table 1). Quackgrass (AGRRE), Palouse tarweed (AMSRE), prickly lettuce (LACSE), and mayweed chamomile (ANTCO) control was evaluated visually prior to wheat grain harvest on August 27, 1999. Grain moisture was recorded in the field with a portable grain moisture tester.

Table 1. Application data.

Application date	August 16, 1999	August 23, 1999
Growth stage / density (plants/ft^2)		
quackgrass	headed	headed
Palouse tarweed	flower	flower
prickly lettuce	bud	bud
mayweed chamomile	flower	flower
Air temperature (F)	76	72
Soil temperature at 2 inch (F)	68	66
Relative humidity (%)	59	48
Wind (mph) / direction	0 to 3 / W	4 / NE
Cloud cover (%)	10	0
Soil moisture	dry	moderate

Table 2. Weed control and wheat yield from paraquat, glyphosate and sulfosate treatments.

		Weed control				Wheat
Treatment[a]	Rate	AGRRE	AMSRE	LACSE	ANTCO	grain yield
	lb/A	%	%	%	%	lb/A
Paraquat	0.25	88	98	98	100	4385
Paraquat	0.375	94	95	75	100	3809
Paraquat	0.5	100	97	100	100	4314
Glyphosate	1	94	100	97	100	4796
Sulfosate	1	92	100	83	100	4518
Untreated control	--	--	--	--	--	4580
LSD (0.05)		NS	NS	NS	NS	NS

[a] Paraquat treatments applied with 90% nonionic surfactant at 0.25% v/v.

Wheat grain moisture from all treatments was below 12.5% (data not shown) and there were no differences among treatments. Weed control and grain yield did not differ among herbicide treatments (Table 2).

Mayweed chamomile control with sulfonylurea herbicides and fluroxypyr in winter wheat. Joan Campbell and Donn Thill. (Plant Science Division, University of Idaho, Moscow, Idaho 83844-2339) An experiment was established in 'Madsen' winter wheat east of Moscow, Idaho to evaluate weed control with sulfonylurea herbicides applied with and without fluroxypyr. Herbicides were applied with a CO_2 pressurized backpack sprayer calibrated to deliver 10 gal/A at 32 psi on May 14, 1999. The wheat had 3 tillers and mayweed chamomile was 1 to 2 in. diameter with 22 plants/ft^2. Air and soil temperature and relative humidity were 43 F, 45 F, and 66%, respectively. Mayweed chamomile control was evaluated on July 8 and wheat grain was harvested at maturity on August 24.

Table. Mayweed chamomile and wheat grain yield.

Treatment[a]	Rate	Mayweed chamomile	Wheat grain yield
	lb ai/A	%	lb/A
Untreated control	--	--	5212 abcd[b]
Prosulfuron	0.0134	96 a[b]	5858 abcd
Triasulfuron	0.013	31 c	4741 cd
Triasulfuron/dicamba	0.159	86 a	5535 abcd
Tribenuron	0.012	76 ab	5164 bcd
Thifensulfuron/tribenuron	0.019	86 a	4477 d
Metsulfuron	0.004	94 a	5922 abcd
Chlorsulfuron/metsulfuron	0.014	98 a	6010 abcd
Prosulfuron + fluroxypyr	0.0134 + 0.094	99 a	6829 a
Triasulfuron + fluroxypyr	0.013 + 0.094	58 b	5927 abcd
Triasulfuron/dicamba fluroxypyr	0.159 + 0.094	92 a	5808 abcd
Tribenuron + fluroxypyr	0.012 + 0.094	95 a	6285 abc
Thifensulfuron/tribenuron + fluroxypyr	0.019 + 0.094	95 a	5677 abcd
Metsulfuron + fluroxypyr	0.004 + 0.094	96 a	6577 ab
Chlorsulfuron/metsulfuron fluroxypyr	0.014 + 0.094	100 a	6256 abc

[a] All treatments were applied with a non-ionic surfactant at 0.25% v/v.
[b] Means within a column followed by the same letter are not significantly different ($P>0.05$)

Mayweed chamomile control was 90% or better with all treatments containing fluroxypyr except triasulfuron + fluroxypyr (Table). Mayweed chamomile control was higher when fluroxypyr was applied with a sulfonylurea herbicide compared to each sulfonylurea herbicide alone, although these differences were not statistically significant. Averaged over treatments, mayweed chamomile control and grain yield were 81% and 5387 lb/A without fluroxypyr and 91% and 6194 lbA with fluroxypyr, respectively.

Weed control with dicamba tank mixes in winter wheat. Joan Campbell and Donn Thill. (Plant Science Division, University of Idaho, Moscow, Idaho 83844-2339) An experiment was established in 'Madsen' winter wheat to evaluate weed control with dicamba applied with other broadleaf weed herbicides. The experiment was located near Moscow, Idaho and the design was a randomized complete block with four replications. Plots were 8 by 30 ft. Herbicides were applied on April 30, 1999 with a CO_2 pressurized backpack sprayer calibrated to deliver 10 gal/A at 32 psi. Air and soil temperatures and relative humidity were 62 F, 58 F, and 55%, respectively. Wheat was 4 inches and had 3 tillers. Mayweed chamomile (ANTCO), lowland cudweed (GNAPA), narrowleaf navaretia (NLNA), toad rush (IUNBU), Scouleri's plagiobothrys (SCPL), and red sandspurry (SPBRU) control was evaluated visually on July 15, 1999. Wheat was harvested at maturity on August 17, 1999.

Table. Weed control and wheat grain yield.

Treatment[a]	Rate	Weed control ANTCO	GNAPA	NLNA	IUNBU	SCPL	SPBRU	Wheat grain yield
	lb/A	%	%	%	%	%	%	lb/A
Untreated control	--	--	--	--	--	--	--	5548
Dicamba + thifen/triben + NIS	0.094 + 0.016 0.25	98	95	95	84	95	95	5701
Fluroxypyr + thifen/triben + NIS	0.094 + 0.016 0.25	96	98	96	79	90	95	5405
Triasulfuron/dicamba + NIS	0.159 + 0.25	91	100	96	85	100	65	5415
Carfentrazone + 2,4-D + UAN	0.031 + 0.38 + 2	96	96	99	97	84	90	5120
Dicamba + carfentrazone + UAN	0.094 + 0.031 + 2	92	95	92	96	85	100	5317
Quinclorac + dicamba + thifen/triben + NIS	0.125 + 0.094 + 0.016 + 0.25	95	98	95	86	96	70	4539
Thifen/triben + NIS	0.016	95	96	96	84	85	80	5598
Thifen/triben + bromoxynil + NIS	0.016 + 0.25 + 0.25	100	100	100	86	98	98	5461
LSD (0.05)		NS	NS	NS	NS	NS	NS	NS
Plant density (number/ft^2)		1	1	1	10	1	1	

[a] Thifen/triben is the commercial formulation of thifensulfuron/tribenuron, NIS is 90% nonionic surfactant applied at 0.25%v/v, UAN is urea ammonium nitrate applied at 2% v/v.

Wheat in the carfentrazone treated plots was yellow with some necrosis 7 days after treatment, but injury was not visible 3 weeks after application (data not shown). Mayweed chamomile, lowland cudweed, and narrowleaf navaretia were controlled 91% or better with all treatments although there were no statistical differences between treatments for weed control of any of the species in the study (Table). Grain yield ranged from 4539 to 5598 lb/A, but there were no differences among treatments.

Wheat yield following pea with various tillage regimes and herbicide treatments. Joan Campbell and Donn Thill. (Plant Science Division, University of Idaho, Moscow, Idaho 83844-2339) Imazethapyr and imazethapyr/pendimethalin were applied pre-emergence and imazamox was applied post emergence to spring pea at Nezperce, Genesee, and Winchester, Idaho in spring 1998. The experiment was a split block design with four replications. The main plot tillage regimes were fall moldboard plow/spring cultivate, fall disc, spring burn, and direct seed at Nezperce; fall moldboard plow/spring cultivate, fall chisel, fall paratill, and direct seed at Genesee; and burn, flail, disc, and direct seed at Winchester. The herbicide plots were 15 ft wide by the width of the tillage strip which varied from 20 to 46 ft depending on the tillage operation. Winter wheat was planted in September 1998 to determine herbicide carry-over effects on wheat injury and grain yield. Wheat was harvested at maturity in late summer 1999. See 1998 report for herbicide application data, pea injury, and pea yield (Western Soc. Weed Sci. Progress Report, ISSN. 0090-8142, Pg 152).

Wheat was not visibly injured by any herbicide treatment and there were no herbicide treatment by tillage regime interactions. Herbicide treatment did not reduce grain yield or test weight compared to the untreated control when averaged over tillage regime (Table 1). Test weight at Nezperce was lowest in the control plot when averaged over tillage regime, and test weight was not affected by herbicide treatment at the other locations. Grain yield, averaged over herbicide treatment, was higher in direct seed and burn plots than disc or moldboard plow plots at Nezperce; was higher in paratill and chisel plots at Genesee; and was highest in burn plots and lowest in flail plots at Winchester (Table 2). Lower yield in the direct seed plots compared to paratill and chisel at Genesee likely was a result of high rodent activity due to high residue. High yield in burn plots at Winchester also is likely a result of low residue. Test weight was highest at Winchester in the direct seed plots, and test weight was not affected by tillage regime at other locations.

Table 1. Wheat grain yield and test weight averaged over tillage.

		Nezperce		Genesee		Winchester	
Herbicide treatment	Rate	Grain yield	Test weight	Grain yield	Test weight	Grain yield	Test weight
	lb/A	lb/A	lb/bu	lb/A	lb/bu	lb/A	lb/bu
control	0	4767 a	48.4 b	4855 c	56.5 a	1488 d	57.7 a
imazamox[a]	0.032	5084 a	53.4 ab	5055 bc	56.4 a	1694 bcd	57.7 a
imazamox[a]	0.064	4717 a	56.3 a	5626 a	56.4 a	1568 cd	57.8 a
imazethapyr	0.047	4679 a	56.1 a	4836 c	56.3 a	1951 a	57.7 a
imazethapyr	0.094	4982 a	55.1 a	5253 abc	56.4 a	1630 cd	57.8 a
imazethapyr/pendimethalin	0.68	5021 a	56.5 a	5499 ab	57.0 a	1770 abc	57.7 a
imazethapyr/pendimethalin	1.35	5045 a	56.8 a	5092 bc	56.8 a	1892 ab	57.7 a

[a] Applied with R-11 nonionic surfactant (0.25% v/v) at Nezperce and Winchester, and applied with R-11 nonionic surfactant (0.25%v/v) + UAN 32-0-0 (1qt/A) at Genesee
[b] Means within a column followed by the same letter are not significantly different from one another (P=0.05)

Table 2. Wheat grain yield and test weight averaged over herbicide treatment.

Nezperce			Genesee			Winchester		
Tillage	Grain yield	Test wt.	Tillage	Grain yield	Test wt.	Tillage	Grain yield	Test wt.
	lb/A	lb/bu		lb/A	lb/bu		lb/A	lb/bu
Direct seed	5273 a[a]	55.7 a	Paratill	5498 a	56.6 a	Burn	1951 a	57.7 b
Burn	5093 a	56.3 a	Direct seed	5009 b	56.5 a	Direct seed	1739 b	58.0 a
Disc	4635 b	55.7 a	Chisel	5437 a	56.4 a	Disc	1683 b	57.6 b
Moldboard plow	4620 b	56.3 a	Moldboard plow	4751 b	56.6 a	Flail	1434 c	57.6 b

[a] Means within a column followed by the same letter are not significantly different from one another (P=0.05)

Windgrass control in winter wheat with clodinofop. Joan Campbell and Donn Thill. (Plant Science Division, University of Idaho, Moscow, Idaho 83844-2339) An experiment was established to evaluate interrupted windgrass control with clodinofop in winter wheat east of Moscow, Idaho. Plots were 8 by 30 ft arranged in a randomized complete block design with four replications. Herbicides were applied with a CO_2 pressurized backpack sprayer calibrated to deliver 10 gal/A at 32 psi. Air and soil temperature and relative humidity were 45 F, 46 F, and 62%, respectively, on May 13, 1999. Interrupted windgrass was 2 inches tall with 3 to 5 tillers and wheat was 8 to 10 inches tall with 5 tillers. All plots were sprayed with clopyralid at 0.11 lb ai/A on May 19 to control broadleaf weeds. Interrupted windgrass control was evaluated visually July 17 and wheat grain was harvested at maturity on August 10.

Table. Interrupted windgrass control and wheat grain yield.

Treatment[a]	Rate	Interrupted windgrass control	Wheat yield
	lb/A	%	lb/A
Untreated control	--	--	6521
Clodinofop	0.051	83	6636
Clodinofop	0.064	80	6717
Clodinofop + bromoxynil/MCPA	0.051 + 0.514	85	6583
Clodinofop + bromoxynil/ MCPA	0.064 + 0.514	80	6409
Clodinofop + thifen/triben	0.051 + 0.015	72	6567
Clodinofop + thifen/triben	0.064 + 0.015	75	6606
Clodinofop + MCPA ester	0.051 + 0.514	83	6727
Clodinofop + MCPA ester	0.064 + 0.514	77	6740
Clodinofop + thifen/triben + MCPA ester	0.051 + 0.015 + 0.386	70	6645
Clodinofop + thifen/triben + MCPA ester	0.064 + 0.015 + 0.386	62	6780
Metribuzin	0.25	82	6255
Fenoxyprop	0.083	88	6588
Prob. F > 0.05	NS	NS	NS

[a] All clodinofop treatments were applied with a crop oil concentrate at 0.8% v/v.

Interrupted windgrass can be competitive and top the wheat crop at heading. The interupted windgrass in this field did not reach the top of the canopy even in the untreated check. Interrupted windgrass control tended to be highest (88%) with fenoxyprop and lowest (62%) with clodinofop + thifen/triben + MCPA ester at 0.064 + 0.015 + 0.386 lb ai/A, but these data were not statistically significant (Table). Wheat grain yield ranged from 6255 to 6727 lb/A and there were no differences between treatments.

Evaluation of MKH 6561 and MON 37503 for grass control in winter wheat. John O. Evans, Brent Beutler, and R. William Mace. (Department of Plants, Soils and Biometeorology, Utah State University, Logan, Utah 84322-4820). Promontory winter wheat was planted September 2, 1998 on the Clair Allen farm in Cove, Utah to evaluate the effectiveness of controlling Japanese brome (BROJA) and black mustard (BRANI) with MKH 6561 and MON 37503. Individual treatments were applied to 12 by 100 foot plots with an ATV sprayer using flatfan 8002 nozzles providing a 12 foot spray width calibrated to deliver 11 gpa at 30 psi. The soil was a Collett silty clay loam with 7.6 pH and O.M. content of less than 2%. Treatments were applied postemergence in the fall (11-23-98), and early spring (4-13-99) in a randomized block design, with three replications. Wheat ranged in size from 5 inches tall at fall application to 7 inches in the spring. Japanese brome was 1 to 3 inches in the fall and 2 to 3 inches in the spring. Visual evaluations for crop injury and weed control were completed May 13, June 8 and July 13, 1999. Plots were harvested August 16,1999.

Treatments did not cause any visible signs of injury to the wheat at either evaluation date. Evaluations of Japanese brome control were based on above canopy presence of brome. Japanese brome plants were green beneath the wheat, but not growing. Wheat yields were not measurably different among the treatments and the untreated check, but increased yield trends were noticeable in the field and revealed the benefit of controlling brome competition. The last evaluation in July showed excellent Japanese brome control for all treatments. Spring treatments resulted in improved black mustard control compared with late fall applications. (Utah Agricultural Experiment Station, Logan, UT. 84322-4820)

Table. Evaluation of MKH 6561 and MON 37503 for grass control in winter wheat

Treatment[a]			Wheat			Weed control			
			Injury		Yield	BRANI	BROJA		
	Rate	Growth stage	5/13	6/8	8/16	5/13	5/13	6/8	7/13
	lb ai/A				bu/A		%		
check			0	0	43.5	0	0	0	0
MON 37503	0.031	late fall	0	0	64.4	87	85	85	87
MKH6561	0.04	late fall	0	0	72.9	70	77	78	95
MON 37503+	0.031+	late fall	0	0	74.6	93	88	73	95
metribuzin	0.188								
MKH6561+	0.04+	late fall	0	0	67.5	90	83	70	95
metribuzin	0.188								
MON 37503	0.031	spring	0	0	64.4	98	98	77	92
MKH6561	0.04	spring	0	0	45.3	95	90	83	92
MON 37503+	0.031+	spring	0	0	68.5	100	97	82	92
metribuzin	0.188								
MKH6561+	0.04+	spring	0	0	70.6	98	93	75	95
metribuzin	0.188								
MKH6561+	0.027+	late fall	0	0	60.4	100	95	70	93
MKH6561	0.022	spring							
MKH6561+	0.031+	late fall	0	0	67.9	100	95	85	90
MKH6561	0.04	spring							
$LSD_{(0.05)}$			0	0	19.8	14.3	11	24.4	8.6

[a] Nonionic surfactant applied at 0.25% v/v all treatments.

Jointed goatgrass control with selected herbicides in Clearfield winter wheat. John O. Evans, Brent Beutler, and R. William Mace. (Department of Plants, Soils and Biometeorology, Utah State University, Logan, Utah 84322-4820). Clearfield winter wheat, an imidazolinone resistant crop, was planted September 5, 1998 at the USU Blue Creek farm near Howell, UT to evaluate selective control of jointed goatgrass (AEGCY) with imazamox. Individual treatments were applied to 10 by 30 foot plots with a CO_2 backpack sprayer using flatfan 8002 nozzles providing a 10 foot spray width calibrated to deliver 25 gpa at 39 psi. The soil was a Timpanogos silt loam with 7.7 pH and O.M. content of less than 2%. Treatments were applied postemergence in the fall (11-3-98), late fall (12-3-98), early spring (4-7-99), and spring (5-6-99) to a randomized block design, with three replications. Wheat ranged in size from 4 to 10 inches and jointed goatgrass 3 to 5 inches in height over this period. Visual evaluations of crop injury and weed control were completed May 24 and July 7, 1999. Plots were harvested August 12,1999.

Treatments of imazamox did not cause visual injury symptoms to this wheat at either evaluation date. Jointed goatgrass control was evaluated visually for total population reduction as well as developed seed heads of remaining plants. There were excellent results for all timings and treatment rates with the exception of low rates of imazamox (0.032 lb ai/A) applied in early spring. Jointed goatgrass control decreased from 92% in May to 80% in July perhaps due to additional tillering of jointed goatgrass plants. Imazamox was most effective in controlling Jim Hill mustard (SISAL) in the spring at all application rates. Wheat yields were not significantly different among treatments including the untreated check, probably a result of an extraordinary wet spring. (Utah Agricultural Experiment Station, Logan, UT. 84322-4820)

Table. Jointed goatgrass control with selected herbicides in IMI winter wheat.

Treatment[a]			Wheat			Weed control			
			Injury		Yield	AEGCY		SISAL	
	Rate	Growth stage	5/24	7/2	8/12	5/24	7/2	5/24	7/2
	lb ai/A		%		bu/A	%			
check			0	0	46	0	0	0	0
Imazamox	0.032	Fall	0	0	60	94	94	62	57
Imazamox	0.048	Fall	0	0	63	99	98	100	97
Imazamox	0.032	Late fall	0	0	59	98	92	99	90
Imazamox	0.032	Early spring	0	0	59	92	80	98	73
Imazamox	0.040	Early spring	0	0	57	95	92	97	73
Imazamox	0.048	Early spring	0	0	48	97	93	98	83
Imazamox	0.032	Spring	0	0	56	90	96	96	100
Imazamox	0.040	Spring	0	0	61	92	96	98	100
Imazamox	0.048	Spring	0	0	59	92	97	96	100
$LSD_{(0.05)}$			0	0	15.3	4.4	5.4	29	21

[a] Nonionic surfactant applied at 0.25% v/v and N at 1qt/A with all treatments.

Rye control with imazamox in Clearfield spring and winter wheat. John O. Evans, Kevin Kelley, William S. Rigby and R. William Mace. (Department of Plants, Soils and Biometeorology, Utah State University, Logan, Utah 84322-4820). Clearfield crops are a result of some advanced breeding technologies to produce imidazolinone tolerant crops such as corn, canola, spring and winter wheat etc. A Clearfield spring wheat experimental cultivar SWP 965001 and a Clearfield winter wheat experimental cultivar CV 9804 were planted September 16 and 17, 1998 respectively, at the USU Nephi farm near Nephi, UT to evaluate the selective control of rye (SECCE) and black mustard (BRANI) with imazamox. Individual treatments were applied to 10 by 30 foot plots with a CO_2 backpack sprayer using flatfan 8002 nozzles providing a 10 foot spray width calibrated to deliver 25 gpa at 39 psi. The soil was a Nephi silt loam with 8 pH and O.M. content of less than 2%. Treatments were applied postemergence in the late fall, early spring, and spring to a randomized block design, with three replications. Wheat ranged in height from 3 to 18 inches and rye 3 to 25 inches in height over this period. Visual evaluations for crop injury and weed control were completed May 20 and June 8, 1999. Plots were harvested August 3.

In spring wheat (Table 1), imazamox gave excellent control of black mustard using early spring treatments, but failed with late spring applications. Rye control was acceptable with early spring treatments of imazamox at the highest dosage and also with spring applications of 0.04 lb ai/A. However, it's effectiveness fell by 33% when 0.048 lb ai/A applied in the early spring was compared with the same dosage applied in the late spring. Spring wheat yields were also lowered by treating this wheat cultivar with imazamox later in the spring season. Late spring applications lowered wheat yields but early spring treatments of comparable dosages did not reduce yields.

In winter wheat (Table 2), imazamox provided exceptional control of black mustard at all timings and dosages. Rye control was best with both rates of imazamox at the late fall application timing. Spring treatment rye control was 10 to 40% less than fall treatments. Yields were not significantly different for any timing or imazamox application rate in winter wheat. (Utah Agricultural Experiment Station, Logan, UT. 84322-4820)

Table 1. Rye control with imazamox in Clearfield spring wheat

			Wheat		Weed control	
			Injury	Yield	SECCE	BRANI
Treatment[a]	Rate	Growth stage	6/8	8/3	6/8	6/8
	lb ai/A		--%--	bu/A	--%--	
check			0	39	0	0
Imazamox	0.032	Early spring	0	40	53	95
Imazamox	0.040	Early spring	0	35	73	93
Imazamox	0.048	Early spring	0	37	85	100
Imazamox	0.040	Spring	0	30	87	67
Imazamox	0.048	Spring	0	30	57	67
$LSD_{(0.05)}$			0	3.7	19.4	12.6

[a] Nonionic surfactant applied at 0.25% v/v and N at 1qt/A with all treatments.

Table 2. Rye control with imazamox herbicide in winter wheat

			Wheat			Weed control			
Treatment[a]			Injury		Yield	SECCE		BRANI	
	Rate	Growth stage	5/20	6/8	8/3	5/20	6/8	5/20	6/8
	lb ai/A		--%--		bu/A	--%--			
check			0	0	36	0	0	0	0
Imazamox	0.032	Late fall	0	0	51	98	90	100	100
Imazamox	0.04	Late fall	0	0	45	99	95	100	100
Imazamox	0.032	Early spring	0	0	51	66	55	100	100
Imazamox	0.040	Early spring	0	0	42	92	78	100	100
Imazamox	0.048	Early spring	0	0	45	68	43	100	100
Imazamox	0.032	Spring	0	0	48	82	72	100	100
Imazamox	0.040	Spring	0	0	54	76	80	100	100
Imazamox	0.048	Spring	0	0	48	93	77	100	100
$LSD_{(0.05)}$			0	0	12.2	24.6	24.8	0	0

[a] Nonionic surfactant applied at 0.25% v/v and N at 1qt/A with all treatments.

Downy brome control in winter wheat with imazamox. Bradley D. Hanson, Bill D. Brewster, and Carol Mallory-Smith. (Department of Crop and Soil Science, Oregon State University, Corvallis, OR 97331-3002) Development of imidazolinone-tolerant wheat varieties will allow the application of imazamox for downy brome control; therefore, a study was established at the Hyslop Research Farm near Corvallis, OR to determine the effects of imazamox on downy brome and winter wheat. Downy brome seed was spread over the trial area prior to wheat seeding. An imidazolinone-resistant winter wheat variety, 'Fidel', was seeded on October 19, 1998. Individual plots were 8 by 35 ft arranged in a randomized complete block with four replications. Herbicide treatments were applied with a single-wheel, compressed-air, plot sprayer calibrated to deliver 20 gpa at 19 psi and 3 mph (Table 1). Downy brome stand densities were determined on March 25, 1999, by counting the plants in sq yd quadrats at both ends of each plot. Grain was harvested on July 28, 1999 with a small-plot combine.

Table 1. Application data.

Application timing	Early POST	POST
Date	November 17, 1998	February 9, 1999
Wheat growth stage	2 leaf	3 to 4 tiller
Downy brome growth stage	2 leaf	2 to 5 tiller
Air temp (F)	50	41
Soil temp (F)	49	38
RH (%)	81	82
Cloud cover (%)	10	100
Soil texture	Silt loam	
Organic matter (%)	2.4	
PH	5.3	

Downy brome control was 94% or greater with imazamox applied at the 2 leaf stage at rates of 0.024 lb/A or higher (Table 2). Lower rates and later applications did not provide adequate control of downy brome. Split-applications of imazamox and sulfosulfuron controlled downy brome at least 99%. Early applications of imazamox at 0.032 lb/A or higher and the combination treatments caused temporary stunting of the crop. Although downy brome control varied greatly among treatments, wheat yield ranged from 103 to 117 bu/A for all treatments.

Table 2. Downy brome control and winter wheat injury and yield following applications of imazamox.

			Downy brome		Wheat	
Treatment[a]	Rate	Timing	control[b]	population	injury[b]	yield
	lb / A		%	plants / 2 sq yd	%	bu / A
Untreated check 1	--	--	0	118	0	103
Untreated check 2	--	--	0	129	0	106
Brome-free check 1	--	--	100	0	0	109
Brome-free check 2	--	--	100	0	0	112
Imazamox	0.008	E. POST	73	30	3	106
Imazamox	0.016	E. POST	89	19	0	113
Imazamox	0.024	E. POST	94	3	3	111
Imazamox	0.032	E. POST	100	2	5	117
Imazamox	0.04	E. POST	100	0	9	112
Imazamox	0.048	E. POST	100	1	11	112
Imazamox	0.008	POST	5	126	0	107
Imazamox	0.016	POST	18	99	0	106
Imazamox	0.024	POST	40	81	0	111
Imazamox	0.032	POST	45	74	3	108
Imazamox	0.04	POST	65	51	0	113
Imazamox	0.048	POST	68	41	0	112
Sulfosulfuron	0.023	POST	45	60	0	106
Imazamox / imazamox	0.024 / 0.024	E. POST / POST	99	0	5	117
Sulfosulfuron / sulfosulfuron	0.023 / 0.023	E. POST / POST	100	2	10	112
Imazamox / sulfosulfuron	0.024 / 0.023	E. POST / POST	100	1	11	106
LSD $_{(0.05)}$			20	29	4	7

[a] R-11, a nonionic surfactant, were added to all imazamox and sulfosulfuron treatments at 0.25 and 0.5 % v/v, respectively. All treatments also received 1 qt/A 32% urea-ammonium nitrate solution.

[b] March 17, 1999, visual rating.

Italian ryegrass control in winter wheat with flufenacet-metribuzin. Bradley D. Hanson, Bill D. Brewster, and Carol Mallory-Smith. (Department of Crop and Soil Science, Oregon State University, Corvallis, OR 97331-3002) Four studies were established in grower's fields in Polk County, OR to evaluate control of Italian ryegrass in 'Madsen' winter wheat with flufenacet-metribuzin. Flufenacet-metribuzin was applied preemergence alone and followed postemergence by four herbicide treatments. Individual plots were 8 by 25 ft arranged in a randomized complete block with four replications. Herbicide treatments were applied with a single-wheel, compressed-air, plot sprayer calibrated to deliver 20 gpa at 19 psi and 3 mph (Table 1). Grain was harvested at maturity with a small-plot combine.

Table 1. Seeding and harvest dates and herbicide application data.

Location	Ballston		Sheridan		Perrydale		Zena	
Planting date	October 20, 1998		October 20, 1998		October 23, 1998		October 27, 1998	
Timing	PRE	POST	PRE	POST	PRE	POST	PRE	POST
Application date	Oct. 22, 98	Feb. 11, 99	Oct. 22, 98	Feb. 11, 99	Oct. 27, 98	Feb. 11, 99	Oct. 27, 98	Feb. 11, 99
Wheat growth stage	preemerge	2 lf	preemerge	2-3 tiller	preemerge	3 tiller	preemerge	1-2 tiller
Italian ryegrass stage	preemerge	1-2 lf	preemerge	0-2 tiller	preemerge	1 tiller	preemerge	0-2 tiller
Air temp (F)	70	50	56	37	55	36	55	34
Soil temp (F)	55	48	55	36	54	34	55	33
RH (%)	60	77	36	85	75	85	78	82
Cloud cover (%)	0	100	0	100	100	100	100	100
Soil texture	Silt loam		Silt loam		Silt loam		Silt loam	
Harvest date	August 10, 1999		August 26, 1999		August 17, 1999		August 26, 1999	

Although Italian ryegrass density was much greater at Ballston and Sheridan than at Perrydale and Zena, flufenacet-metribuzin controlled Italian ryegrass at least 96% at all four locations (Table 2 and 3). Wheat was not visibly injured by flufenacet-metribuzin applied alone at any location, but was injured up to 15% by the combination treatments. Wheat yield was much greater in the treated plots than in the untreated check at the Ballston, Sheridan, and Perrydale locations. Yield was not significantly different among treatments at the Zena location due to high variability; however the untreated plots tended to have the lowest yield.

Table 2. Italian ryegrass control and wheat injury on March 19, 1999, and grain yield at Ballston and Sheridan, OR following applications of flufenacet-metribuzin.

Treatment	Rate	Ballston			Sheridan		
		Italian ryegrass control	Wheat injury	Wheat yield	Italian ryegrass control	Wheat injury	Wheat yield
PRE/POST	lb/a	%	%	lb/a	%	%	lb/a
Untreated check	–	0	0	12	0	0	26
Flufenacet-metribuzin[a]	0.42	98	5	144	96	3	125
Flufenacet-metribuzin / procarbazone sodium	0.42 / 0.027	99	5	154	97	8	126
Flufenacet-metribuzin / sulfosulfuron	0.42 / 0.031	99	0	156	98	5	128
Flufenacet-metribuzin / diuron	0.42 / 1.6	98	10	152	97	6	120
Flufenacet-metribuzin / chlorsulf-metsulf[b] + metribuzin	0.42 / 0.023 + 0.141	100	15	150	99	11	126
LSD $_{(0.05)}$		2	5	8	4	ns	11

[a] Flufenacet-metribuzin is a 68% df premix in a 4:1 ratio.
[b] Chlorsulf-metsulf is a 75 df premix of chlorsulfuron + metsulfuron in a 5:1 ratio.

Table 3. Italian ryegrass control and wheat injury on March 19, 1999, and grain yield at Perrydale and Zena, OR following applications of flufenacet-metribuzin.

Treatment	Rate	Perrydale			Zena		
		Italian ryegrass control	Wheat injury	Wheat yield	Italian ryegrass control	Wheat injury	Wheat yield
PRE/POST	lb/a	%	%	lb/a	%	%	lb/a
Untreated check	–	0	0	110	0	0	66
Flufenacet-metribuzin[a]	0.42	100	0	138	100	8	88
Flufenacet-metribuzin / procarbazone sodium	0.42 / 0.027	100	0	140	100	11	88
Flufenacet-metribuzin / sulfosulfuron	0.42 / 0.031	100	0	143	100	4	90
Flufenacet-metribuzin / diuron	0.42 / 1.6	100	3	145	100	3	91
Flufenacet-metribuzin / chlorsulf-metsulf[b] + metribuzin	0.42 / 0.023 + 0.141	100	3	144	100	11	91
LSD $_{(0.05)}$		–	ns	11	–	7	ns

[a] Flufenacet-metribuzin is a 68% df premix in a 4:1 ratio.
[b] Chlorsulf-metsulf is a 75 df premix of chlorsulfuron + metsulfuron in a 5:1 ratio.

Italian ryegrass control in winter wheat with imazamox. Bradley D. Hanson, Bill D. Brewster, and Carol Mallory-Smith. (Department of Crop and Soil Science, Oregon State University, Corvallis, OR 97331-3002) Diuron followed by diclofop-methyl was the primary treatment for Italian ryegrass control prior to the development of widespread diclofop-resistance in western Oregon. The use of imidazolinone-tolerant wheat would allow the application of imazamox for Italian ryegrass control; therefore, a study was established at the Hyslop Research Farm near Corvallis, OR to determine the effects of imazamox on Italian ryegrass and winter wheat. Italian ryegrass seed was spread over the trial area prior to wheat seeding. An imidazolinone-resistant winter wheat variety, 'Fidel', was seeded on October 19, 1998. Individual plots were 8 by 35 ft arranged in a randomized complete block with five replications. Herbicide treatments were applied with a single-wheel, compressed-air, plot sprayer calibrated to deliver 20 gpa at 19 psi and 3 mph (Table 1). Grain was harvested at maturity with a small plot combine.

Table 1. Application data.

Application timing	PRE	Early POST	POST
Date	October 22, 1998	November 9, 1998	February 11, 1999
Wheat growth stage	preemergance	1 leaf	4 to 5 tiller
Italian ryegrass growth stage	preemergance	1.5 to 2 leaf	2 to 3 tiller
Air temp (F)	45	55	46
Soil temp (F)	45	53	45
RH (%)	68	70	73
Cloud cover (%)	0	50	100
Soil texture	Silt loam		
Organic matter (%)	2.5		
pH	5.8		

Early postemergence treatments of imazamox caused slight stunting and yellowing of the wheat in early spring (Table 2), but symptoms were not visible by late spring. Italian ryegrass control was best with the standard treatments of triallate followed by chlorsulfuron, metsulfuron, and metribuzin or diuron followed by diclofop-methyl. Imazamox controlled Italian ryegrass 86 to 96%; best control was achieved when a nonionic surfactant was added to the spray solution. Yield from all herbicide treatments was better than the control, but plots treated with late postemergence applications of imazamox at 0.032 lb/A yielded less than with higher rates or earlier applications of imazamox.

Table 2. Italian ryegrass control and wheat injury and yield following applications of imazamox.

Treatment	Rate	Timing	Winter wheat injury		Italian ryegrass control	Winter wheat
			March 17, 1999	June 9, 1999	June 9, 1999	yield
	lb/A		%			bu/A
Untreated check	--	--	0	0	0	48
Triallate /	1.25 /	PRE /	13	0	100	123
chlorsulf-metsulf[a] +	0.023 +	E.POST				
metribuzin	0.141					
Imazamox[b]	0.032	E.POST	8	0	95	123
Imazamox[b]	0.040	E.POST	9	0	91	125
Imazamox[b]	0.048	E.POST	10	0	96	125
Imazamox[c]	0.032	E.POST	7	0	89	121
Diuron /	1.2 /	E.POST /	13	0	100	124
diclofop methyl	1.0	POST				
Imazamox[b]	0.032	POST	0	0	90	116
Imazamox[b]	0.040	POST	0	0	95	122
Imazamox[b]	0.048	POST	0	0	96	119
Imazamox[c]	0.032	POST	0	0	86	109
$LSD_{(0.05)}$			6	-	3	7

[a] Chlorsulf-metsulf is a 75 df premix of chlorsulfuron and metsulfuron in a 5:1 ratio.
[b] R-11, a nonionic surfactant, and 32% urea-ammonium nitrate solution, were added at 0.25% v/v and 1 qt/A, respectively.
[c] SunIt II, a methylated seed oil, and 32% urea-ammonium nitrate solution were each added at 1 qt/A.

Broadleaf weed control in winter wheat with carfentrazone in combination with other broadleaf herbicides. Curtis R. Rainbolt and Donald C. Thill. (Plant science Division, University of Idaho, Moscow, ID 83844-2339) A study was established near Genessee, ID in 'Madsen' winter wheat to evaluate broadleaf weed control and crop injury with carfentrazone in combination with other broadleaf herbicides. Plots were 8 by 30 ft arranged in a randomized complete block with four replications. All herbicide treatments were applied with a CO_2 pressurized backpack sprayer calibrated to deliver 10 gpa at 30 psi and 3 mph (Table 1). Wheat injury was evaluated visually on May 13 and 21, 1999, and weed control was evaluated on May 21, 1999. Wheat seed was harvested with a small plot combine from a 4 by 27 ft area of each plot on August 20, 1999.

Table 1. Application data.

Application date	May 5, 1999
Wheat growth stage	3-4 tiller
Broadleaf growth stage	2-4 inches
Air temperature (F)	60
Relative humidity (%)	38
Wind (mph)	1-2
Cloud cover (%)	0
Soil temperature at 2 in (F)	60
pH	6
OM (%)	4.6
CEC (meq/100g)	26
Texture	silt loam

Wheat injury was most severe in the treatments containing bromoxynil/MCPA, ranging from 28 to 34% (Table 2). By May 21, 1999, wheat in all treatments showed less than 5% injury, with the exception of bromoxynil/MCPA treatments, which ranged from 5 to 14% (data not shown). All treatments, with the exception of carfentrazone with thifensulfuron/tribenuron and thifensulfuron/tribenuron + bromoxynil/MCPA, controlled tumble mustard (SSYAL) 90% or more. All treatments containing carfentrazone, with the exception of carfentrazone + NIS + UAN, controlled Canada thistle (CIRAR) 90% or more. All treatments controlled mayweed chamomile (ANTCO) and catchweed bedstraw (GALAP) 93% or more. Grain yield ranged from 84 to 99 bu/A and was significantly better than the untreated control with carfentrazone + MCPA amine or 2, 4-D amine + NIS.

Table 2. Weed Control and winter wheat response to carfentrazone in combination with other broadleaf herbicides.

Treatment[a]	Rate	Wheat injury[b]	Wheat yield	Weed control SSYAL	Weed control CIRAR	Weed control ANTCO	Weed control GALAP
		%	lb/A	%			
carfentrazone + 90% NIS	0.008 lb/A + 0.25% v/v	5	91	95	93	93	93
carfentrazone + 90% NIS + 28% UAN	0.008 lb/A + 0.25% v/v + 4% v/v	5	91	95	77	94	95
carfentrazone + 28% UAN	0.008 lb/A + 4% v/v	9	93	95	93	93	95
carfentrazone + 2, 4-D amine + 90% NIS	0.008 lb/A + 0.25 lb/A + 0.25% v/v	10	98	93	93	93	95
carfentrazone + 2, 4-D amine + 90% NIS + 28% UAN	0.008 lb/A + 0.25 lb/A + 0.25% v/v + 4% v/v	13	94	95	93	95	95
carfentrazone + MCPA amine + 90% NIS	0.008 lb/A + 0.375 lb/A + 0.25% v/v	8	99	95	92	93	93
carfentrazone + MCPA amine + 90% NIS + 28% UAN	0.008 lb/A + 0.375 lb/A + 0.25% v/v + 4% v/v	13	91	95	92	93	95
carfentrazone + dicamba + 90% NIS	0.008 lb/A + 0.094 lb/A + 0.25% v/v	14	84	90	93	94	90
carfentrazone + dicamba + 90% NIS + 28% UAN	0.008 lb/A + 0.094 lb/A + 0.25% v/v + 4% v/v	11	92	90	93	93	90
carfentrazone + thifensulfuron/tribenuron + 90% NIS	0.008 lb/A + 0.0156 lb/A + 0.25% v/v	11	89	83	92	95	95
thifensulfuron/tribenuron + bromoxynil/MCPA + 90% NIS	0.0156 lb/A + 0.25 lb/A + 0.25% v/v	4	94	88	90	94	95
carfentrazone + 2, 4-D ester + 90% NIS	0.008 lb/A + 0.25 lb/A + 0.25% v/v	19	90	92	95	95	95
carfentrazone + MCPA ester + 90% NIS	0.008 lb/A + 0.375 lb/A + 0.25% v/v	13	96	93	92	93	95
carfentrazone + bromoxynil/MCPA + 90% NIS	0.008 lb/A + 0.25 lb/A + 0.25% v/v	34	94	95	95	94	95
carfentrazone + bromoxynil/MCPA + 28% UAN	0.008 lb/A + 0.25 lb/A + 4% v/v	30	88	93	95	96	95
carfentrazone + bromoxynil/MCPA	0.008 lb/A + 0.25 lb/A	28	89	95	93	95	95
carfentrazone + fluroxypyr + 90% NIS	0.008 lb/A + 0.125 lb/A + 0.25% v/v	9	88	95	93	95	97
carfentrazone + fluroxypyr + 90% NIS	0.008 lb/A + 0.0625 lb/A + 0.25% v/v	10	90	95	95	94	94
untreated control	--	-	86	-	-	-	-
LSD(0.05)		7	11	5	5	3	NS

[a]thifensulfuron/tribenuron, and bromoxynil/MCPA were applied as the commercial formulations.

[b]May 13, 1999 evaluation date.

Annual grass control in winter wheat. Traci A. Rauch and Donald C. Thill. (Plant Science Division, University of Idaho, Moscow, ID 83844-2339) Two studies were established near Moscow, ID in 'Madsen' winter wheat. Experiment one examined the effects of grass herbicides alone and in combination with broadleaf herbicides on wild oat (AFEVA) and interrupted windgrass (APEIN) control and crop response. Experiment two examined wild oat and interrupted windgrass control and crop response to difenzoquat with different adjuvants. In both experiments, plots were 8 by 30 ft arranged in a randomized complete block with four replications. All herbicide treatments were applied with a CO_2 pressurized backpack sprayer calibrated to deliver 10 gpa at 30 psi and 3 mph (Table 1). Wheat injury was evaluated visually on June 4, 1999 in experiment one, June 14, 1999 in both experiments, and July 13, 1999 in experiment two. Wild oat and interrupted windgrass control was evaluated on July 13, 1999 in both experiments. Wild oat and interrupted windgrass populations were not uniform and were evaluated only in two and three replications, respectively. Wheat seed was harvested with a small plot combine from a 4 by 27 ft area in each plot on August 24, 1999.

Table 1. Application data.

		Experiment one		Experiment two
Application date		May 13, 1999	May 26, 1999	May 26, 1999
Wheat growth stage		2 to 3 tiller	jointing	jointing
AFEVA and APEIN growth stage		1 to 2 leaf	3 to 5 leaf	3 to 5 leaf
Air temp (F)		42	62	62
Relative humidity (%)		70	40	40
Wind (mph, direction)		5, WNW	1, W	1, W
Cloud cover (%)		30	0	0
Soil temperature at 2 in (F)		50	64	64
pH	5.1			
OM (%)	2.66			
CEC (meq/100g)	17			
Texture	silt loam			

In experiment one, all imazamethabenz + difenzoquat combinations injured wheat 2 to 9% on June 4, 1999 (Table 2). By June 14, no injury was visible from any treatment (data not shown). All treatments, except diclofop, tralkoxydim, and tralkoxydim + AMS, controlled interrupted windgrass 88% or better. Imazamethabenz, imazamethabenz + difenzoquat, and tralkoxydim controlled wild oat 70 to 75%. All other treatments controlled wild oat 90% or greater. Imazamethabenz + fenoxaprop/safener and clodinafop + thifensulfuron/tribenuron + MCPA ester yielded 8% more grain than the untreated check, while imazamethabenz + difenzoquat + bromoxynil/MCPA yielded 9% less grain than the untreated check. All other treatments did not differ from the untreated check.

In experiment two, all treatments injured wheat 9 to 15% on June 14, 1999 (Table 3). By July 13, no injury was visible from any treatment (data not shown). No treatment adequately controlled interrupted windgrass (29 to 65%). All treatments controlled wild oat 99%. Winter wheat yield in the difenzoquat + NIS treatments was 9% less than the untreated check. Wheat yield for all other treatments did not differ from the untreated check.

Table 2. Annual grass control in winter wheat with various grass and broadleaf herbicide combinations.

Treatment[a]	Rate	Application timing	Wheat injury[b]	Weed control APEIN	Weed control AFEVA	Wheat yield
	lb/A			%		lb/A
Imazamethabenz	0.47	1 to 2 leaf	0	98	70	6062
Imazamethabenz + difenzoquat	0.235 + 0.5	3 to 5 leaf	9	93	75	5693
Imazamethabenz + fenoxaprop/safener	0.235 + 0.041	1 to 2 leaf	0	98	99	6326
Imazamethabenz + difenzoquat + bromoxynil/MCPA	0.235 + 0.5 + 0.75	3 to 5 leaf	4	98	97	5264
Imazamethabenz + difenzoquat + bromoxynil	0.235 + 0.5 + 0.375	3 to 5 leaf	2	98	92	5819
Tralkoxydim	0.24	1 to 2 leaf	0	63	72	5783
Tralkoxydim + AMS	0.24 + 1.5	1 to 2 leaf	0	75	92	5856
Fenoxaprop/safener	0.083	1 to 2 leaf	0	98	90	6209
Diclofop	1	1 to 2 leaf	0	52	90	5902
Clodinafop	0.05	1 to 2 leaf	0	99	99	5948
Clodinafop + bromoxynil	0.05 +0.5	1 to 2 leaf	0	99	99	5923
Clodinafop + thifensulfuron/tribenuron	0.05 + 0.014	1 to 2 leaf	0	94	99	5878
Clodinafop + thifensulfuron/tribenuron + MCPA ester	0.05 + 0.014 + 0.37	1 to 2 leaf	0	88	99	6312
Untreated check			--	--	--	5794
LSD (0.05)			2	NS	16	518
plants/ft^2				5	11	

[a]NIS (90% nonionic surfactant) applied at 0.25% v/v with all imazamethabenz treatments. Crop oil, nonionic surfactant blend (TF8035) applied at 0.5% v/v with all tralkoxydim treatments. Crop oil concentrate (Score) applied at 0.8% v/v rate with all clodinafop treatments. AMS is liquid ammonium sulfate.
[b]June 4, 1999 evaluation.

Table 3. Annual grass control in winter wheat with difenzoquat and adjuvant combinations.

Treatment[a]	Rate	Wheat injury[b]	Weed control APEIN	Weed control AVEFA	Wheat yield
	lb/A		%		lb/A
Difenzoquat	1	10	65	99	5412
Difenzoquat + NIS	1 + 0.25	10	48	99	4801
Difenzoquat + SS	1 + 4	9	29	99	5144
Difenzoquat + SS	1 + 6	15	34	99	5420
Untreated check	--	--	--	--	5302
LSD (0.05)		2	NS	NS	409
plants/ft^2			5	11	

[a]NIS (90% nonionic surfactant) applied at % v/v and SS [sticker spreader (NuFilm)] at oz of product/A.
[b]June 14, 1999 evaluation.

Downy brome control in winter wheat with sulfosulfuron and MKH 6561. Traci A. Rauch and Donald C. Thill. (Plant Science Division, University of Idaho, Moscow, ID 83844-2339) Two studies were established near Tammany, ID in 'Symphony' winter wheat. Experiment one examined the effects of application timing and spray solution pH of sulfosulfuron on downy brome (BROTE) control and crop response. Experiment two examined downy brome control and crop response to sulfosulfuron, MKH 6561 alone, and MKH 6561 combined with metribuzin. In both experiments, plots were 8 by 30 ft arranged in a randomized complete block with four replications. All herbicide treatments were applied with a CO_2 pressurized backpack sprayer calibrated to deliver 10 gpa at 30 psi and 3 mph (Table 1). Wheat injury was evaluated visually on April 14 and May 5, 1999 in experiment one and May 28 and July 13, 1999 in experiment two. Downy brome control was evaluated on May 28 and July 13, 1999 in both experiments. Wheat seed was harvested with a small plot combine from a 4 by 27 ft area in each plot on August 18, 1999.

Table 1. Application data.

	Experiment one		Experiment two	
Application date	April 2, 1999	April 14, 1999	April 14, 1999	May 5, 1999
Wheat growth stage	1 to 2 tiller	2 to 3 tiller	2 to 3 tiller	jointing
Downy brome growth stage	3 to 4 leaf	5 to 6 leaf	5 to 6 leaf	10% heading
Air temp (F)	48	45	45	44
Relative humidity (%)	45	50	50	64
Wind (mph, direction)	0	3, W	3, W	3, NW
Cloud cover (%)	30	0	0	10
Soil temperature at 2 in (F)	50	45	45	46
pH	4.9			
OM (%)	3.8			
CEC (meq/100g)	24			
Texture	silt loam			

In experiment one, no treatment visually injured wheat (data not shown). Spray solution pH affected downy brome control. Sulfosulfuron at spray solution pH 6, averaged over application timing, controlled downy brome best overall (77%), while control was least (57%) at spray solution pH 7 (Table 2). Application timing and spray solution pH affected wheat yield. The 3 to 4 leaf application, on average, yielded 8% more grain than the 5 to 6 leaf timing. Wheat yield was greatest at spray solution pH 4 (4875 lb/A) and lowest with spray solution pH 7 (4297 lb/A). Wheat yield for all herbicide treatments was not different from the untreated check.

In experiment two, the 5 to 6 leaf application timing of MKH 6561 injured wheat 24% on May 28, 1999 (Table 3). The 5 to 6 leaf timing of MKH 6561 and MKH 6561 + metribuzin injured wheat 10 and 14%, respectively, on July 13. MKH 6561 + metribuzin applied at the 5 to 6 leaf stage controlled downy brome 84%, while sulfosulfuron applied at heading suppressed downy brome only 48%. Wheat yield did not differ among treatments or from the untreated check.

Table 2. The effect of spray solution pH on downy brome control and wheat yield with sulfosulfuron.

Treatment[a]	Rate	Application timing	pH spray solution	BROTE[b] control	Wheat yield
	lb/A			%	lb/A
Sulfosulfuron	0.031	3 to 4 leaf	4	56	4951
Sulfosulfuron	0.031	3 to 4 leaf	5	70	5033
Sulfosulfuron	0.031	3 to 4 leaf	6	75	4686
Sulfosulfuron	0.031	3 to 4 leaf	7	45	4595
Sulfosulfuron	0.031	5 to 6 leaf	4	68	4799
Sulfosulfuron	0.031	5 to 6 leaf	5	59	4421
Sulfosulfuron	0.031	5 to 6 leaf	6	79	4443
Sulfosulfuron	0.031	5 to 6 leaf	7	69	3999
Untreated check	--	--	--	--	4424
LSD (0.05)				16	652
plants/ft²				20	

[a]NIS (90% nonionic surfactant) applied at 0.5% v/v with all treatments. Buffered distilled water was used as the carrier.
[b]July 13, 1999 evaluation.

Table 3. Downy brome control and wheat response with sulfosulfuron and MKH 6561.

Treatment[a]	Rate	Application timing	Wheat injury May 28	Wheat injury July 13	BROTE[b] control	Wheat yield
	lb/A		----------	-----%-----	----------	lb/A
Sulfosulfuron	0.31	5 to 6 leaf	0	9	55	3321
MKH 6561	0.04	5 to 6 leaf	24	10	74	3370
MKH 6561 + metribuzin	0.04 + 0.188	5 to 6 leaf	0	14	84	3403
Sulfosulfuron	0.31	heading	0	4	48	3347
MKH 6561	0.04	heading	0	0	74	3658
MKH 6561 + metribuzin	0.04 + 0.188	heading	0	6	63	3282
Untreated check	--	--	--	--	--	3503
LSD (0.05)			5	14	31	NS
plants/ft^2					20	

[a]NIS (90% nonionic surfactant) applied at 0.5% v/v with sulfosulfuron and 0.25%v/v with all other treatments.
[b]July 13, 1999 evaluation.

Field bindweed control and persistence of BAS 589 03H in rotational crops. Traci A. Rauch and Donald C. Thill. (Plant Science Division, University of Idaho, Moscow, ID 83844-2339) A study was established in 1996 near Moscow, Idaho to evaluate field bindweed control and persistence of BAS 589 03H in spring wheat and pea. The experimental design was a randomized split-block with four replications. Main plots were five herbicide treatments (applied sequentially to the same plots in 1996, 1997, and 1998) and an untreated check (16 by 30 ft). Subplots were two rotational crops (15 by 96 ft). The 1999 rotational crops, spring pea and spring wheat, (planted on half of each plot) were alternated with the spring pea and spring wheat planted in 1998. Treatments were applied with a CO_2 pressurized backpack sprayer (Table 1). Fertilizer (26-13-0-10) was applied at 250 lb/A and incorporated with a field cultivator on April 15, 1999. Rotational crops, 'Columbia' spring pea and 'Penawawa' spring wheat, were seeded at 120 lb/A perpendicular to the herbicide treatments on one-half of each plot on April 16, 1999. Metribuzin was applied to spring pea at 0.25 lb ai/A post-plant preemergence on April 23, 1999. Bromoxynil (0.375 lb ai/A) and MCPA amine (0.375 lb ai/A) were applied on May 24, 1999 to spring wheat for broadleaf weed control. Spring pea and spring wheat were harvested on August 5 and 23, 1999, respectively. Field bindweed control was evaluated visually on October 9, 1998 and August 5, 1999. Field bindweed control, crop yields, and application data for 1996 and 1997 were published in the 1998 and 1999 Western Society of Weed Science Research Progress Report, pg. 155 and 164, respectively.

Table 1. Application data and soil analysis.

Application date	September 21, 1998
Growth stage of field bindweed	8 to 11 inch runners/ blooming
Gpa	20
Psi	40
Air temperature (F)	73
Relative humidity (%)	50
Wind (mph)	1
Cloud cover (%)	10
Soil temperature at 2 in. (F)	66
pH	6.3
OM (%)	4.0
Texture	silt loam

No treatment visually injured the spring pea or wheat (data not shown). Dicamba + 2,4-D and glyphosate/2,4-D + AMS controlled field bindweed 91 and 94%, respectively, in October 1998 (Table 2). BAS 589 03H treatments controlled field bindweed 75 and 80% in fall 1998. In 1999, all treatments controlled field bindweed 91% or greater. The treatment by crop interaction and the treatment main effect were not significant for seed yield of spring pea or wheat.

Table 2. Field bindweed control and spring wheat and spring pea yield with BAS 589 03H and other herbicide combinations.

			Field bindweed control		Yield	
Treatment[a]	Rate	Timing	1998	1999	Spring pea	Spring wheat
	lb/A		%		lb/A	
BAS 589 03H	1.25	Summer 1996				
BAS 589 03H	0.62	Postharvest 1997				
BAS 589 03H	0.62	Postharvest 1998	80	91	2638	6917
BAS 589 03H	1.25	Summer 1996				
BAS 589 03H	1.25	Postharvest 1997				
BAS 589 03H	0.62	Postharvest 1998	75	94	2731	6792
Glyphosate/2,4-D + AMS	1+1.7	Summer 1996				
Glyphosate/2,4-D + AMS	1 +1.7	Postharvest 1997				
Glyphosate/2,4-D + AMS	1+1.7	Postharvest 1998	94	99	2477	6676
2,4-D	0.95	Summer 1996				
2,4-D	0.95	Postharvest 1997				
2,4-D	0.95	Postharvest 1998	60	92	2999	6532
Dicamba + 2,4-D	0.5 + 0.95	Summer 1996				
Dicamba + 2,4-D	0.5 + 0.95	Postharvest 1997				
Dicamba + 2,4-D	0.5 + 0.95	Postharvest 1998	91	93	2914	6278
Untreated check	--	--			2992	6436
LSD (0.05)			19	NS	NS	NS
Density (shoots/ft^2)			3			

[a] All BAS 589 03H treatments were applied with 0.94% v/v sunflower oil. Glyphosate/2,4-D is a commercial premix formulation. AMS = liquid ammonium sulfate.

Jointed goatgrass and Italian ryegrass control in winter wheat with different timings of grass herbicides. Traci A. Rauch and Donald C. Thill. (Plant Science Division, University of Idaho, Moscow, ID 83844-2339) Three studies were established in winter wheat near Moscow, ID. Experiments one and two in 'Fidel' (imidazolinone-resistant) winter wheat examined jointed goatgrass and Italian ryegrass control with imazamox and various other grass herbicides. Experiment three in 'Madsen' winter wheat examined Italian ryegrass control with different postemergence grass herbicides. Plots in all experiments were 8 by 30 ft arranged in a randomized complete block with four replications. All herbicide treatments were applied with a CO_2 pressurized backpack sprayer calibrated to deliver 10 gpa at 30 psi and 3 mph (Table 1 and 2). Wheat in experiments one and two winter killed and were re-seeded on April 15, 1999 with 'Fidel' wheat. Wheat injury was evaluated visually on May 5 in experiment three and June 4 and 14, 1999 in experiments one and two, respectively. Weed control was evaluated on June 10 in experiment two, June 30 in experiment three, and July 1, 1999 in experiments one and two. Wheat was not harvested from experiments one and two due to reseeding and from experiment three due to uneven fertilizer application.

Table 1. Application data for experiment one.

Application date	September 30, 1998	November 16, 1998	May 26, 1999
Wheat growth stage	preemergence	2 to 3 leaf	2 tiller
Italian ryegrass growth stage	preemergence	1 to 2 leaf	3 to 4 leaf
Jointed goatgrass growth stage	preemergence	2 to 3 leaf	5 to 6 tiller
Air temp (F)	79	46	60
Relative humidity (%)	38	77	45
Wind (mph, direction)	0	4, E	2, W
Cloud cover (%)	0	99	0
Soil temperature at 2 in (F)	58	46	60
pH	4.9		
OM (%)	3.89		
CEC (meq/100g)	21		
Texture	silt loam		

Table 2. Application data for experiments two and three.

	Experiment two		Experiment three
Application date	May 26, 1999	June 4, 1999	April 27, 1999
Wheat growth stage	2 tiller	3 to 5 tiller	2 to 3 tiller
Italian ryegrass growth stage	3 to 4 leaf	4 to 8 leaf	3 to 4 leaf
Jointed goatgrass growth stage	5 to 6 tiller	6 to 8 tiller	--
Air temp (F)	60	54	40
Relative humidity (%)	45	79	55
Wind (mph, direction)	2, W	3, NE	1, W
Cloud cover (%)	0	20	50
Soil temperature at 2 in (F)	60	50	45
pH	4.9		5.2
OM (%)	3.89		2.88
CEC (meq/100g)	21		17
Texture	silt loam		silt loam

In experiment one, MKH 6562 + metribuzin injured wheat 7% on the June 4, 1999 evaluation date (Table 3). By June 14, no injury was visible from any treatment (data not shown). Sulfosulfuron and MKH 6561 suppressed jointed goatgrass (AEGCY) 60 and 71%, respectively. All MKH 6562 treatments (alone or combined with metribuzin) controlled Italian ryegrass (LOLMU) 94 to 96%. All other treatments suppressed Italian ryegrass 65% or less.

In experiment two, no treatment injured wheat (data not shown). All imazamox treatments at either timing controlled jointed goatgrass and Italian ryegrass 98 to 99% (Table 4). Diclofop applied at the 4 to 8 leaf controlled Italian ryegrass 81%.

In experiment three, no treatment injured wheat (data not shown). Diclofop, clodinafop, and MKH 6562 at both rates controlled Italian ryegrass 85 to 97% (Table 5). All other treatments did not adequately control Italian ryegrass (32 to 75%).

Table 3. Jointed goatgrass and Italian ryegrass control and winter wheat response with flufenacet/metribuzin and other grass herbicides.

Treatment[a]	Rate	Application timing[b]	Wheat injury[c]	Weed control AEGCY	Weed control LOLMU
	lb/A		-----%	-----	-----
Flufenacet/metribuzin	0.27	Preemergence	0	2	10
Flufenacet/metribuzin	0.40	Preemergence	0	0	50
Triasulfuron	0.016	Preemergence	0	0	15
Triasulfuron	0.026	Preemergence	0	0	8
Triasulfuron + flufenacet/metribuzin	0.016 + 0.27	Preemergence	0	0	24
Chlorsulfuron	0.016	Preemergence	0	0	22
Pendimethalin	0.5	Preemergence	0	0	0
Flufenacet/metribuzin	0.27	1 to 2 leaf	0	11	2
Flufenacet/metribuzin	0.40	1 to 2 leaf	0	0	20
MKH 6562 + NIS	0.027 + 0.25	3 to 4 leaf	0	34	96
MKH 6562 + NIS	0.04 + 0.25	3 to 4 leaf	0	54	94
MKH 6562 + metribuzin + NIS	0.027 + 0.14 + 0.25	3 to 4 leaf	7	24	96
MKH 6561 + NIS	0.04 + 0.25	3 to 4 leaf	0	71	34
Sulfosulfuron + NIS	0.031 + 0.5	3 to 4 leaf	0	60	65
Diclofop	1	3 to 4 leaf	0	10	48
Untreated check	--	--	--	--	--
LSD (0.05)			1	21	34
plants/ft^2				2	2

[a]NIS (90% nonionic surfactant) was applied at a % v/v rate.
[b]Application timing based on Italian ryegrass growth stage.
[c]June 4, 1999 evaluation.

Table 4. Jointed goatgrass and Italian ryegrass control in winter wheat with imazamox.

Treatment[a]	Rate	Application timing[b]	Weed control[c] AEGCY	Weed control[c] LOLMU
	lb/A		-----%	-----
Imazamox	0.032	3 to 4 leaf	98	98
Imazamox	0.04	3 to 4 leaf	99	99
Imazamox	0.048	3 to 4 leaf	99	99
Diclofop	1	3 to 4 leaf	0	63
Imazamox	0.032	4 to 8 leaf	98	99
Imazamox	0.04	4 to 8 leaf	99	99
Imazamox	0.048	4 to 8 leaf	98	98
Diclofop	1	4 to 8 leaf	0	81
Untreated check	--	--	--	--
LSD (0.05)			1	18
plants/ft^2			1	1

[a]All imazamox treatments applied with NIS (90% nonionic surfactant) at 0.25 % v/v and 32% UAN (urea ammonium nitrate) at 1 qt/A.
[b]Application timing based on Italian ryegrass growth stage.
[c]July 1, 1999 evaluation.

Table 5. Italian ryegrass control in winter wheat with postemergence grass herbicides.

Treatment[a]	Rate	Italian ryegrass control
	lb/A	%
Flufenacet/metribuzin	0.27	39
Flufenacet/metribuzin	0.40	66
MKH 6562 + NIS	0.027 +0.25	85
MKH 6562 + NIS	0.04 + 0.25	90
MKH 6562 + metribuzin + NIS	0.027 + 0.14 + 0.25	75
MKH 6561 + NIS	0.04 + 0.25	32
Sulfosulfuron + NIS	0.031 + 0.5	54
Diclofop	1	97
Tralkoxydim + TF8035	0.18 + 0.5	42
Tralkoxydim + TF8035	0.24 + 0.5	41
Clodinafop + COC	0.05 + 0.8	92
Untreated check	--	--
LSD (0.05)		34
plants/ft^2		2

[a]NIS (90% nonionic surfactant), TF8035 (mineral oil/ nonionic surfactant blend), and COC [crop oil concentrate (Score)] applied at a %v/v rate.

Soil persistence in winter wheat with ethametsulfuron and imazamox. Traci A. Rauch and Donald C. Thill. (Plant Science Division, University of Idaho, Moscow, ID 83844-2339) Two studies were established at the University of Idaho Plant Science Farm near Moscow, Idaho in 'Madsen' winter wheat. Experiments one and two examined soil persistence of ethametsulfuron and imazamox, respectively. Ethametsulfuron and imazamox were applied to 'Legend' and imidazolinone-resistant canola, respectively, in spring 1998. Experiment one (8 by 21 ft) and experiment two (16 by 30 ft) plots were arranged in a randomized complete block with four replications. All herbicide treatments were applied with a CO_2 pressurized backpack sprayer calibrated to deliver 10 gpa at 30 psi and 3 mph (Table 1). All plots were treated with 1 lb/A of diclofop, 0.25 lb/A of bromoxynil and 0.012 lb/A of thifensulfuron/tribenuron for wild oat and broadleaf weed control. Wheat injury was evaluated visually on April 26, 1999, in both experiments. Wheat seed was harvested with a small plot combine from a 4 by 18 ft (experiment one) and 4 by 27 ft (experiment two) area in each plot on August 17, 1999.

Table 1. Application data and soil analysis.

	Experiment one		Experiment two
Application date	June 2, 1998		June 2, 1998
Canola growth stage	2 to 4 leaf		2 to 4 leaf
Air temp (F)	65		51
Relative humidity (%)	62		79
Wind (mph, direction)	3, NW		0
Cloud cover (%)	5		40
Soil temperature at 2 in (F)	54		55
pH		5.4	
OM (%)		3.2	
CEC (meq/100g)		20	
Texture		silt loam	

In both experiments, no treatment visually injured winter wheat (data not shown). Wheat yield in experiments one and two ranged from 6824 to 7202 and 6587 to 7081 lb/A, respectively, and did not differ among treatments or from the untreated check (Table 2 and 3).

Table 2. Wheat seed yield with ethametsulfuron.

Treatment[a]	Rate	Wheat yield
	lb/A	lb/A
Ethametsulfuron	0.027	6824
Ethametsulfuron	0.054	7202
Untreated check	--	7185
LSD (0.05)		NS

[a]All treatments applied with 90% nonionic surfactant at 0.25% v/v.

Table 3. Wheat seed yield with imazamox.

Treatment[a]	Rate	Wheat yield
	lb/A	lb/A
Imazamox	0.024	6749
Imazamox	0.032	6785
Imazamox	0.040	6595
Imazamox	0.048	7081
Imazamox	0.080	6808
Untreated check	--	6587
LSD (0.05)		NS

[a]All treatments were mixed with 32% UAN (urea ammonium nitrate) at 1 quart/A and 90% NIS (nonionic surfactant) at 0.25% v/v.

Efficacy of imazamox on jointed goatgrass in imidazlinone-resistant wheat. Michael J. Wille and Don W. Morishita. (Twin Falls Research and Extension Center, University of Idaho, Twin Falls, ID 83303-1827) A study was established in Power County, Idaho, to compare the efficacy of imazamox applied at different rates in early and mid-spring for jointed goatgrass control in winter wheat ('Fidel'). The experimental design was a randomized complete block with four replications. Individual plots were 8 by 25 ft. Winter wheat was planted September 28, 1999. Herbicides were broadcast-applied with a CO_2-pressurized bicycle-wheel sprayer calibrated to deliver 10 gpa with 11001 flat fan nozzles on April 19 and May 12. Jointed goatgrass density was 10 plants/ft^2. Environmental conditions are given in Table 1. Crop injury for the early spring treatments was evaluated visually May 12. All treatments were evaluated visually for crop injury and jointed goatgrass control June 15. Grain was harvested September 9 with a small-plot combine.

Table 1. Application data.

Application date	4/19	5/12
Wheat growth stage	4 inches, tillered	7 inches, tillered
Jointed goatgrass growth stage	Tillered	Tillered
Air temperature (F)	64	58
Soil Temperature (F)	60	54
Relative humidity (%)	48	42
Wind velocity (mph)	3	6
Cloud cover (%)	100	100

Herbicide treatments did not injure the winter wheat. Imazamox applied in early spring at 0.40 or 0.48 lb/A controlled jointed goatgrass 63 to 73% compared to 37% control with imazamox at 0.32 lb/A on May 12. Jointed goatgrass control on June 15 ranged from 80 to 98% and did not differ among herbicide treatments. Winter wheat grain yield ranged from 17 to 25 bu/A and did not differ among herbicide treatments or from the untreated check.

Table 2. Effect of imazamox rate and timing on crop injury, jointed goatgrass control, and grain yield.

			May 12		June 15		
Treatment[b]	Rate	Application Date	Crop injury	AEGCY[a] control	Crop injury	AEGCY control	Yield
			%				bu/A
Check			0	0	0	0	17
Imazamox +	0.032	April 19	0	37	0	86	23
UAN +	32 fl oz						
NIS	0.25% v/v						
Imazamox +	0.040	April 19	0	63	0	97	23
UAN +	32 fl oz						
NIS	0.25% v/v						
Imazamox +	0.048	April 19	0	73	0	98	23
UAN +	32 fl oz						
NIS	0.25% v/v						
Imazamox +	0.032	May 12		—	0	82	25
UAN +	32 fl oz						
NIS	0.25% v/v						
Imazamox +	0.040	May 12		—	0	80	19
UAN +	32 fl oz						
NIS	0.25% v/v						
Imazamox +	0.048	May 12		—	0	80	24
UAN +	32 fl oz						
NIS	0.25% v/v						
LSD (0.05)			NS	11	NS	NS	NS

[a]Jointed goat grass (AEGCY) was the weed species evaluated.
[b]UAN is a 28% urea ammonium nitrate solution, NIS is a nonionic surfactant

Control of six kochia accessions at three growth stages with fluroxypyr and dicamba. David S. Belles and Philip Westra. (Bioagricultural Sciences and Pest Management Dept., Colorado State University, Fort Collins CO 80523) A study was established at the Colorado State University Agricultural Research Demonstration and Extension Center in Larimer County, Colorado to compare the efficacy of fluroxypyr and dicamba on six accessions of kochia, representing three levels of dicamba tolerance, susceptible (S), medium (MT), and high (HT), when applied at three growth stages, large, medium, and small. The kochia accessions were screened previously for dicamba tolerance. Kochia was planted on May 11, 1999. The experimental design was a completely randomized design with each treatment replicated three times. Plots were 10 by 16 ft. Fluroxypyr and dicamba at 0.0175, 0.035, 0.07, 0.14, 0.28, and 0.42 lb/A were sprayed on July 6, 1999 with a CO_2 pressurized backpack sprayer calibrated to deliver 24 GPA at 35 psi. Treatments were applied to kochia at three growth stages, designated by three height classes, 3 to 11, 12 to 15, and 16 to 24 inches tall. Environmental conditions at application were air temperature 78 F, relative humidity 63%, soil temperature 66 F at four inches, soil dry, and sky overcast. Kochia control was evaluated visually on July 29, 1999. The average plant height and kochia biomass was determined by measuring, harvesting, and drying 5 plants of each kochia accession in each treatment on August 6, 1999 and dividing the results by the number of plants harvested.

Fluroxypyr at all rates and accessions controlled kochia better than dicamba. Fluroxypyr controlled kochia greater than 80% at 0.28 lb/A. There were no consistent differences between control of different kochia accessions with fluroxypyr (Table 1). Dicamba at 0.42 lb/A controlled susceptible kochia 83% and Sato HT kochia 86%. Dicamba did not control other kochia accessions at 0.42 lb/A. All other rates of dicamba provided unacceptable control of all kochia accessions (Table 1). Applying fluroxypyr to large, medium, and small kochia did not consistently affect kochia control across individual accessions (data not shown). Fluroxypyr and dicamba did not consistently control small, medium, and large kochia differently. However, there was a trend for increased control of small kochia at fluroxypyr rates of 0.28 to 0.42 lb/A. Fluroxypyr controlled large, medium, and small kochia 58, 55, and 59%, respectively, across all rates and accessions (Table 2). Results of applying dicamba to large, medium, and small kochia were variable. Some rates on some accessions showed increased control when small kochia was sprayed. The same rates on other accessions showed the opposite trend and trends were not consistent across rates applied to the same accession (data not shown). Averaged across rates and kochia accessions, dicamba controlled large, medium, and small kochia 28, 28, and 26%, respectively (Table 2).

All herbicide treatments reduced kochia biomass, averaged over heights and accessions. Fluroxypyr reduced biomass greater than dicamba only at 0.035 and 0.07 lb/A. Dicamba at 0.28 to 0.42 lb/A reduced biomass greater than 0.0175 to 0.07 lb/A. Fluroxypyr applied at 0.035 lb/A reduced biomass greater than 0.0175 lb/A. Higher rates of fluroxypyr generally did not reduce biomass further (Figure 1). Kochia biomass of medium and high tolerant kochia averaged over herbicide rate and application height was not greater than susceptible kochia treated with dicamba and fluroxypyr sprayed with the same rate. All rates of fluroxypyr and dicamba reduced the kochia biomass of each accession compared to the untreated plants of each accession except accession 94-26 MT in which neither fluroxypyr nor dicamba consistently reduced kochia biomass (data not shown). Also, fluroxypyr at 0.0175 lb/A did not reduce the biomass of the Sato HT and Forsyth HT kochia accessions compared to untreated plants. When averaged across rates and accessions, dicamba reduced kochia biomass of large, medium, and small kochia by 51, 60, and 64%, respectively and fluroxypyr reduced kochia biomass of large, medium, and small kochia by 58, 67, and 68%, respectively (data not shown).

All herbicide treatments reduced kochia height averaged over height and accession except dicamba at 0.0175 lb/A. Fluroxypyr reduced kochia height more than dicamba at each herbicide rate. Dicamba rates of 0.28 and 0.42 lb/A were comparable to fluroxypyr at 0.035 lb/A (Figure 2). Fluroxypyr reduced kochia height of each accession greater than dicamba. Henry HT and Forsyth HT accessions treated with dicamba or fluroxypyr were taller than susceptible and medium tolerant accessions. Heights of susceptible kochia, accession 77-10 S, were similar when treated with fluroxypyr and dicamba rates of 0.07 to 0.42 lb/A (data not shown). Fluroxypyr at all rates reduced kochia height greater than dicamba on all other accessions, except Sato HT. Averaged across rates and accessions, dicamba reduced the kochia height of large, medium, and small kochia by 36, 41, and 46%, respectively, and fluroxypyr reduced the kochia height of large, medium, and small kochia by 64, 20, and 66%, respectively (data not shown).

Table 1. Visual evaluation of kochia control for herbicide treatments averaged over three kochia heights.

		Kochia control[a,b]					
Treatment	Rate	77-10 S	94-33 MT	94-26 MT	Henry HT	Sato HT	Forsyth HT
	lb/A	% control					
Dicamba	0.0175	6	4	2	4	4	4
Dicamba	0.035	10	11	12	5	12	8
Dicamba	0.07	30	16	18	8	17	16
Dicamba	0.14	38	18	8	11	41	23
Dicamba	0.28	74	34	36	25	60	42
Dicamba	0.42	83	68	53	28	86	64
Fluroxypyr	0.0175	23	22	26	23	22	21
Fluroxypyr	0.035	28	25	19	26	32	31
Fluroxypyr	0.07	48	47	49	47	44	53
Fluroxypyr	0.14	73	65	61	69	77	75
Fluroxypyr	0.28	86	84	81	88	88	89
Fluroxypyr	0.42	92	92	91	91	92	90
	LSD (0.05)	9					

[a]July 29, 1999 evaluation.
[b]S = susceptible, MT = moderate tolerance, HT = high tolerance to dicamba.

Table 2. Visual evaluation of kochia control for herbicide treatments averaged over kochia accessions.

		Kochia control[a]		
Treatment	Rate	Small	Medium	Large
	lb/A	% control		
Dicamba	0.0175	4	3	5
Dicamba	0.035	13	7	9
Dicamba	0.07	17	16	19
Dicamba	0.14	24	21	25
Dicamba	0.28	36	53	47
Dicamba	0.42	60	67	60
Fluroxypyr	0.0175	21	24	24
Fluroxypyr	0.035	26	21	33
Fluroxypyr	0.07	56	43	46
Fluroxypyr	0.14	74	67	68
Fluroxypyr	0.28	88	86	84
Fluroxypyr	0.42	93	91	90
	LSD (0.05)	8		

[a]July 29, 1999 evaluation.

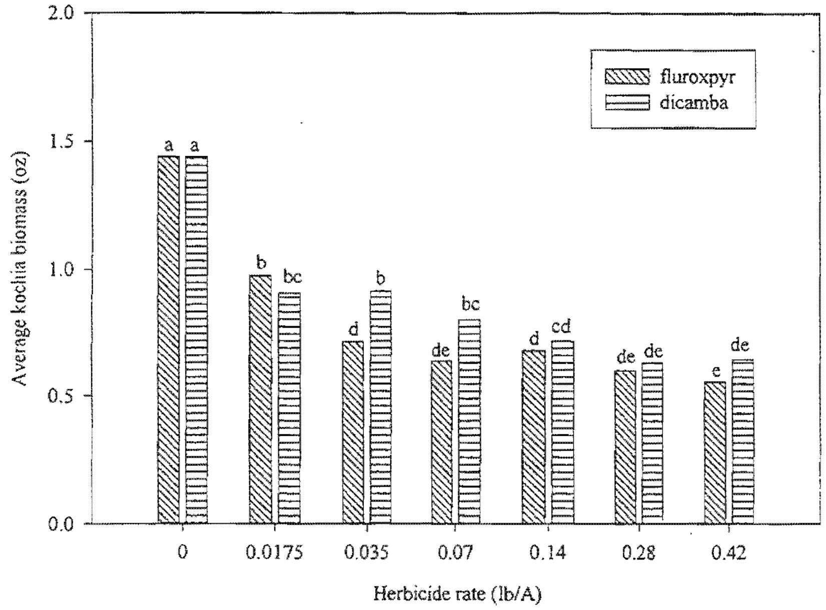

Figure 1. Fluroxypyr and dicamba rate effect on average kochia biomass.

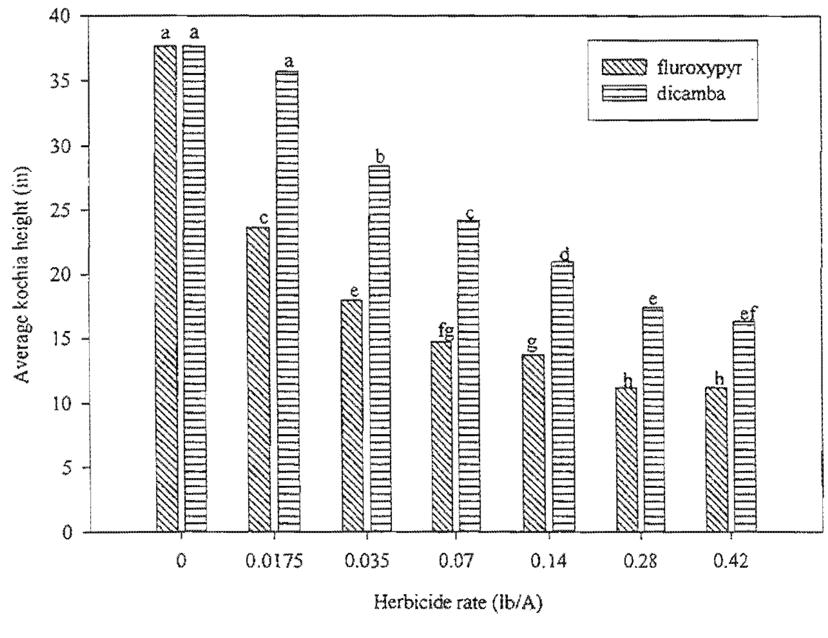

Figure 2. Fluroxypyr and dicamba rate effect on average kochia height.

Control of biennial wormwood with various herbicides. Brian Jenks and Gary Willoughby. (NDSU, North Central Research Extension Center, Minot, ND 58701). Biennial wormwood has become a problem weed in crop production fields throughout North Dakota. Various herbicides were applied June 14 to a high population of biennial wormwood (2-10") to evaluate efficacy. No crop was seeded. Individual plots were 10 x 30 ft arranged in a RCBD with three replications. All postemergence treatments were applied with XR8001 flat fan nozzles delivering 10 gpa at 40 psi.

Glufosinate provided excellent control of biennial wormwood. Glyphosate at 0.75 lb was slightly more effective than 0.38 lb. Bromoxynil + MCPA burned down the wormwood soon after application, but substantial regrowth occurred after the first evaluation. Fomesafen, lactofen, and imazamox were not effective on biennial wormwood. Clopyralid activity on wormwood was very slow.

Table. Control of biennial wormwood with various herbicides.

Treatment[a]	Rate	June 21	August 31
		ARTBI	
	lb/A	control (%)	
Fomesafen + MSO	0.24 + 0.5%	37	12
Lactofen + COC	0.094 + 1%	62	15
Glyphosate + AMS	0.38 + 2%	84	82
Glyphosate + AMS	0.75 + 2%	96	96
Imazamox + Quad 7	0.039 + 1%	45	27
Glufosinate + AMS	0.44 + 3 lb	99	99
2,4-D ester	0.25	68	47
Clopyralid	0.035	13	48
Bromoxynil + MCPA	0.50	86	40
Untreated		0	0
LSD		7	15
CV		7	19

[a] Bromoxynil + MCPA applied as commercial premix

Broadleaf weed control in roundup ready field corn with preemergence followed by postemergence herbicides. R.N. Arnold and Dan Smeal. (New Mexico State University Agricultural Science Center, Farmington, NM 87499) Research plots were established on May 11, 1999 at the Agricultural Science Center, Farmington, New Mexico to evaluate the response of Roundup Ready field corn (var. Dekalb 512RR) and annual broadleaf weeds to preemergence followed by postemergence herbicides. Soil type was a Wall sandy loam with a pH of 7.8 and an organic matter content 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 11. Preemergence treatments were applied on May 11 and immediately incorporated with 0.75 in of sprinkler applied water. Postemergence treatments were applied on June 3, June 17, and July 1. Black nightshade, redroot and prostrate pigeed, and common lambsquarters infestations were heavy and Russian thistle infestations were light throughout the experimental area. The preemergence treatment was evaluated on June 14. Preemergence followed by postemergence treatments were evaluated on July 6 and 19 and August 2.

S-metolachlor applied preemergence at 1.3 lb/A followed by a postemergence treatment of primisulfuron plus dicamba at 0.178 plus 0.125 had the highest injury rating of 9. Common lambsquarters, redroot and prostrate pigweed, and black nightshade control were excellent with all treatment except the check. Russian thistle control were good to excellent with all treatments except glyphosate applied postemergence on June 3 and 17, and July 1 at 0.75 lb/A, S-metolachlo applied preemergence at 1.3 lb/A followed by glyphosate applied postemergence on July 1 at 0.75 lb/A, and the check.

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

Treatment[a]	Rate	Corn injury	Weed control				
			CHEAL	AMARE	AMABL	SOLNI	SASKR
	lb/A	%					
S-metolachlor + atrazine[b] (pm)	1.9	0	100	100	100	100	100
S-metolachlor + atrazine (pm)/ glyphosate[c]	1.9/0.75	0	100	100	100	100	100
S-metolachlor + atrazine (pm)/ glyphosate[d]	1.9/0.75	0	100	100	100	100	100
S-metolachlor + atrazine (pm)/ glyphosate[e]	1.9/0.75	0	100	100	100	100	100
S-metolachlor + atrazine (pm)/ primisulfuron + dicamba[d,f]	1.9/0.178+0.125	5	100	100	100	100	100
Glyphosate[c]	0.75	0	100	97	96	100	83
Glyphosate[d]	0.75	0	100	100	100	100	80
Glyphosate[e]	0.75	0	100	100	100	96	70
S-metolachlor/glyphosate[c]	1.3/0.75	0	100	100	100	100	82
S-metolachlor/glyphosate[d]	1.3/0.75	0	100	100	100	100	99
S-metolachlor/glyphosate[e]	1.3/0.75	0	100	100	100	100	70
S-metolachlor/primisulfuron + dicamba[d,f]	1.3/0.178+0.125	9	100	100	100	100	100
S-metolachlor/ primisulfuron + dicamba + prosulfuron[d,f] (pm)	1.3/0.148	2	100	100	100	100	100
S-metolachlor + atrazine (pm) pimisulfuron + dicamba + prosulfuron[d,e] (pm)	1.9/0.148	2	100	100	100	100	100
Atrazine[b]	1.5	0	100	100	100	100	100
Weedy check		0	0	0	0	0	0
LSD 0.05		1	1	1	1	1	3

[a] pm = packaged mix.
[b] Treatments applied preemergence.
[c] Postemergence treatments applied on June 3, and evaluated on July 6.
[d] Postemergence treatments applied on June 17, and evaluated on July 19.
[e] Postemergence treatments applied on July 1, and evaluated on August 2.
[f] NIS added to postemergence treatments at 0.25% v/v. All other postemergence treatments had AMS added at 1.5% v/v.

PROJECT 4: TEACHING & TECH TRANSFER

Khosro Khodayari, Chair

Evaluation of reduced wild oat herbicide rates in three large plot demonstration trials in southern Idaho. M. Ann Pool, Chad Cheyney, Christi Falen, Don W. Morishita, Stuart Parkinson, and Michael J. Wille. (Twin Falls Research and Extension Center, University of Idaho, Twin Falls, ID 83303-1827) In 1998, on-farm replicated large plot wild oat control trials were initiated in three southern Idaho counties. The purpose of these trials was to determine the impact of using reduced herbicide rates for wild oat control in three counties with different cropping practices. This report represents the second year of a four year project. The on-farm plots were established in Franklin, Minidoka, and Butte counties. At each study site, the experimental design was completely random with three replications. A different field was used at Franklin County in 1999. At this location, each of the six plots were 53 by 900 ft. 'Colter' barley was seeded April 26, 1999, at 110 lb/A, in an Ant Flat silty clay loam soil with an average pH of 6.7, 3% organic matter, and a CEC of 22.5 meq/100 g soil. On May 21, wild oat populations were determined by counting wild oat within 0.25 m^2 areas of each plot at 100 foot intervals alternating 7 ft from the center of each plot. A total of 60 counts were taken. Wild oat seed rain was collected at the same sampling points in each plot August 4. Counting sites were mapped with a GPS to enhance future counts in the same areas through the rotations. Herbicide was applied June 10, at the crop 3 to 4-leaf and wild oat 2 to 3-leaf stage. A Ro-Gator commercial sprayer with a 58 foot boom was used to make all applications at 10 gpa. Barley was harvested August 24, 1999, using a farmer owned combine with a 25 foot header, taking one pass through each plot (Table 1). Imazamethabenz did not show any visual damage to the crop. Field bindweed became quite abundant in this field.

Table 1. Wild oat plant population, seed rain, and crop yield in Franklin County.

	Wild oat			
herbicide	population	seed rain	seed/plant	Barley yield
	plants/ft^2	seed/ft^2		bu/A
1 X rate	23	58.9	1.6	62
1/2 X rate	24.7	92.7	6.5	59

At Minidoka county, the study was located in a field with a crop rotation of grain, sugar beet, grain, and potato. Sugar beet was planted in 1999. Plots were reestablished and wild oat populations were determined June 21 by the method similar to that described above but without GPS mapping (Table 2). No further data was collected from this field this season.

Table 2. Wild oat populations in each plot at Minidoka County.

application rate	replication	wild oat population
		plants/ft^2
1X	1	21
0.5X	1	14
1X	2	4
0.5X	2	9
1X	3	3
0.5X	3	1

The third location in Butte County was planted to barley again in 1999. Imazamethabenz, at 0.235 and 0.47 lb/A was applied with a commercial sprayer June 29. Barley was 6 inches tall and fully tillered and the wild oat was in the 1 to 4-leaf stage. Green foxtail was in the 3 to 6-leaf stage. Wild oat and barley populations were not counted in 1999. A combine with a 20.9 ft header was used to harvest the barley on September 28. Like 1998, barley yields were equal between the 0.5X and 1.0X imazamethabenz rate.

Newly reported weed species; potential weed problems in Idaho. Wayne S. Belles, Donald C. Thill, and Don W. Morishita. (Idaho Agricultural Experiment Station, University of Idaho, Moscow, Idaho, 83844-2339) The occurrence and distribution of weed species are dynamic phenomena. Few programs devote resources to systematically surveying weed floras or documenting changes in weed species distributions. The distribution of weed species in Idaho submitted from all sources for identification by weed science diagnostic personnel, and of weed species in Idaho otherwise called to the attention of the University of Idaho Lambert C. Erickson Weed Diagnostic Laboratory since 1984, were examined to discover recent changes in distributions. The distribution was categorized into three groups. Three species were found to be new to the Pacific Northwest (Idaho, Oregon and Washington) in 1999. One species was found to be a new record for Idaho in 1999. Fifteen species were found to be new records for individual counties in 1999. As this diagnostic service continues to build the data base, as extension weed identification programs increase, and as county staff and consultants gain in diagnostic ability, fewer questions are submitted, and fewer unrecorded species are reported. This is considered to be a measure of successful state and county extension programs. These new records document the reporting and verification of the presence of these species, not necessarily their time of entry into the state or county. Not all are recognized weeds; some are native to the continent, region, state, or district; others are simply escaped ornamentals or crops; none are native to the location reported. The reporting period for these data was October 1, 1998 to September 30, 1999. The following lists cite the scientific name, Bayer code (when extant), Weed Science Society of America common name (or common name from other references when WSSA common name is not available), family name, and location(s) of each new record. Additional data are maintained on permanent file.

Group I: New regional records: species not previously documented for the Pacific Northwest by the Weed Diagnostic Laboratory, nor currently listed in Flora of the Pacific Northwest (new regional as well as state and county records).

1. *Galinsoga parviflora* Cav. (GASPA), galinsoga, smallflower; Asteraceae. County: Kootenai
2. *Linaria purpurea* (L.) Miller (*), toadflax, purple; Scrophulariaceae. County: Twin Falls.
3. *Monarda citriodora* Cerv. ex Lag. (MOACI), beebalm, lemon; Lamiaceae. County: Oneida.

Group II: New state records: species not previously documented for Idaho by the Weed Diagnostic Laboratory, although currently listed in Flora of the Pacific Northwest (new state as well as county records).

1. *Reseda alba* L. (RESAL), mignonette, white; Resedaceae. County: Kootenai.

Group III: New county records: species not previously submitted and/or reported to the Weed Diagnostic Laboratory in the county listed, although previously reported in one or more counties in Idaho.

1. *Bacopa rotundifolia* (Michx.) Wettst. (BAORO), waterhyssop, disc; Scrophulariaceae. County: Gem.
2. *Berteroa incana* (L.) DC. (BEFIN), alyssum, hoary; Brassicaceae. Counties: Custer and Blaine.
3. *Centaurium umbellatum* Gilib. (CTIER), centaury, common; Gentianaceae. County: Latah.
4. *Chaenorrhinum minus* (L.) Lange (CHNMI), snapdragon, dwarf; Scrophulariaceae. County: Kootenai.
5. *Chamaesyce glyptosperma* (Engelm.) (EPHGL), spurge, ridgeseed; Euphorbiaceae. County: Latah.
6. *Chamaesyce maculata* (L.) Small (EPHMA), spurge, spotted; Euphorbiaceae. County: Oneida.
7. *Conringia orientalis* (L.) Dumort. (CNHOR), mustard, haresear; Brassicaceae. County: Latah.
8. *Coreopsis tinctoria* Nutt. (CRLTI), coreopsis, plains; Asteraceae. County: Canyon.
9 *Knautia arvensis* T. Coult (KNAAR), bluebuttons; Dipsacaceae. County: Bear Lake.
10. *Oxalis dillenii* Jacq. (OXAST), woodsorrel, southern yellow; Oxalidaceae. County: Latah.
11. *Parietaria pensylvanica* Muhl. (PAIPE), pellitory, Pennsylvania; Urticaceae. County: Payette.
12. *Sisymbrium officinale* (L.) Scop. (SSYOF), mustard, hedge; Brassicaceae. County: Clearwater.
13. *Trifolium arvense* L. (TRFAR), clover, rabbitfoot; Fabaceae. County: Nez Perce.
14. *Triodanis perfoliata* (L.) Nieuwl. (TJDPE), venuslookingglass, common; Campanulaceae. County: Kootenai.
15. *Atriplex hortensis* L. (ATXO) orach, garden; Chenopodiaceae. County; Bannock.

(*) Bayer code not listed in WSSA Composite List of Weeds

PROJECT 5: WEEDS OF WETLANDS & WILDLANDS

Scott M. Stenquist, Chair

Response of the prairie fringed orchid to herbicides for leafy spurge control. John J. Sterling, Rodney G. Lym, and Donald R. Kirby. (Plant Sciences and Animal and Range Sciences Department, North Dakota State University, Fargo, ND 58105). Approximately 15 to 20% of the Sheyenne National Grassland in southeastern North Dakota is infested with leafy spurge. These infestations threaten habitat of the western prairie fringed orchid, which is on the federal threatened and endangered species list. The purpose of this research was to evaluate various herbicide treatments to control leafy spurge while sustaining western prairie fringed orchid populations and other non-target species.

The first experiment was established to evaluate various herbicides for leafy spurge control in an area likely to support the western prairie fringed orchid on the Sheyenne National Grassland. Herbicides included glyphosate plus 2,4-D, imazapic plus MSO plus 28% N and quinclorac plus MSO and were applied in September 1997 and reapplied in 1998 to the same plots. Treatments were applied using a hand-held sprayer delivering 8.5 gpa at 35 psi. The plots were 10 by 30 feet, in a randomized complete block design with four replications. Leafy spurge stem density and control was evaluated in July 1998 and 1999, 10 and 22 months after the first treatment (MAFT), respectively.

Quinclorac and imazapic provided the best leafy spurge control and reduced leafy spurge density to an average of 5 and 45 stems/m^2 10 and 22 MAFT, respectively, compared to 158 and 314 stems/m^2, respectively, in the untreated control (Table 1). There was a tendency for leafy spurge stem density to decline as the herbicide application rate increased. Glyphosate plus 2,4-D reduced stem density less than quinclorac or imazapic and control was similar to the untreated check 22 MAFT.

A seed bank study was conducted in conjunction with the herbicide efficacy trial. Each plot was divided in half and five soil cores were taken from both the left and right side for a total of 10 cores per plot. The top 2.5 cm of the soil surface plus the litter layer was removed using a standard golf cup cutter (10 cm in diameter). Soil cores were taken in May 1998 and the soil was washed through a 4 mm sieve and a 0.2 mm sieve to remove coarse and fine materials. Samples were then spread 3 to 5 mm deep on a layer of sterile sand (approximately 1 cm deep) over a 2 inch layer of potting soil. Seed from a total of 56 composite (4 replications, 7 herbicide treatments, 2 subsamples) soil cores were grown in the greenhouse. Seedlings were counted and removed after identification. Leafy spurge comprised 40% of all germinated seedlings, with grasses 25%, forbs 22%, grasslike 10%, and other species 3% (Table 2).

The second experiment was established at two locations in July 1998 to evaluate herbicide efficacy on the western prairie fringed orchid. The orchid populations were located in an exclosure located on the Sheyenne National Grassland and along a right-of-way of Highway 27 adjacent to the Grassland. A total of 48 orchids in the exclosure and 40 orchids along Highway 27 were tagged for treatment and later identification. The treatments included glyphosate plus 2,4-D at 0.4 + 0.6 lb/A, imazapic plus MSO plus 28% N at 0.125 lb +1qt + 1qt/A and quinclorac plus MSO at 1lb + 1qt/A and an untreated control. The plots were 1 m^2 located randomly within the exclosure and along Highway 27 with 12 and 10 replications, respectively. Orchids were counted on July 6, 1999 (10 MAFT) in the exclosure. However, orchids could not be counted at the Highway 27 location because of persistent flooding during the growing season.

The growth of the western prairie fringed orchid was not affected by the herbicides evaluated in this study. At least one orchid reappeared in 9 of 11 replications of the quinclorac treatment (one plot was lost) (Figure 1). Orchids reappeared in 7 of 12 replications of the imazapic and glyphosate plus 2,4-D treatments with one or more orchids present where they reappeared. The orchid reappeared in 6 of 12 replications of the control with one or more orchids where they reappeared. Orchid numbers were highest following the quinclorac treatments with 21 orchids reappearing in 1999, while imazapic, glyphosate plus 2,4-D and the untreated control had 11, 16 and 13 orchids, respectively (Figure 2).

In summary, both quinclorac and imazapic controlled leafy spurge when fall applied with no affect on the western prairie fringed orchid. Leafy spurge likely will be the first and most abundant plant to appear following a disturbance of the soil surface or after removal of the current vegetation canopy using herbicides. Thus a long-term management plan is needed to control this weed in western prairie fringed orchid habitat.

Table 1. Effect of fall applied herbicides on leafy spurge stem density applied twice[a].

Treatment	Rate	Stem density MAFT[b] 10	Stem density MAFT[b] 22
	—— lb/A ——	—— % ——	
Quinclorac+MSO	0.8+1qt	10	62
Quinclorac+MSO	1+1qt	0	19
Imazapic+MSO+28%N	0.0625+1qt+1qt	9	77
Imazapic+MSO+28%N	0.125+1qt+1qt	1	22
Glyphosate + 2,4-D	0.2+0.3	140	300
Glyphosate + 2,4-D	0.4+0.6	78	296
Control		158	314
LSD (0.05)		57	111

[a] Treatments applied in September 1997 and 1998.
[b] Months after first treatment.

Table 2. Evaluation of the seed bank in a leafy spurge infestation averaged over treatment[a].

Plant class	Total species present		Desirable	Undesirable
	– % –	— No. —	—— % ——	
Leafy spurge	40	NA	NA	NA
Grasses	25	13	15	85
Grasslike	10	2	NA	NA
Forb	22	28	14	86
Other	3	1	NA	NA

[a] Soil was sampled for seed in approximately 9 months after the first herbicide treatment. Data are averaged over the treatments detailed in Table 1.

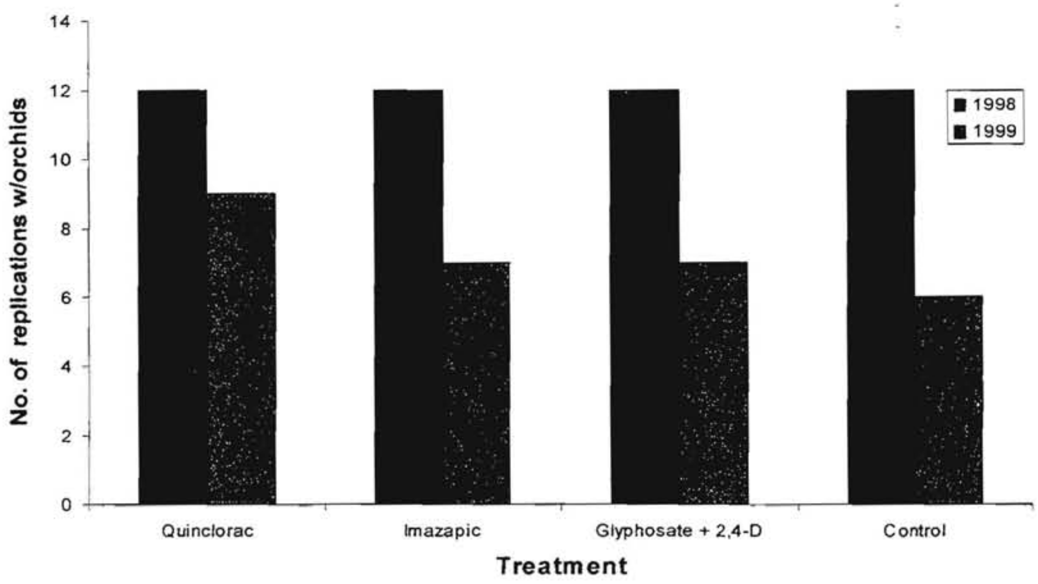

Figure 1. Effect of herbicide treatment on western prairie fringed orchid reappearance the following growing season.

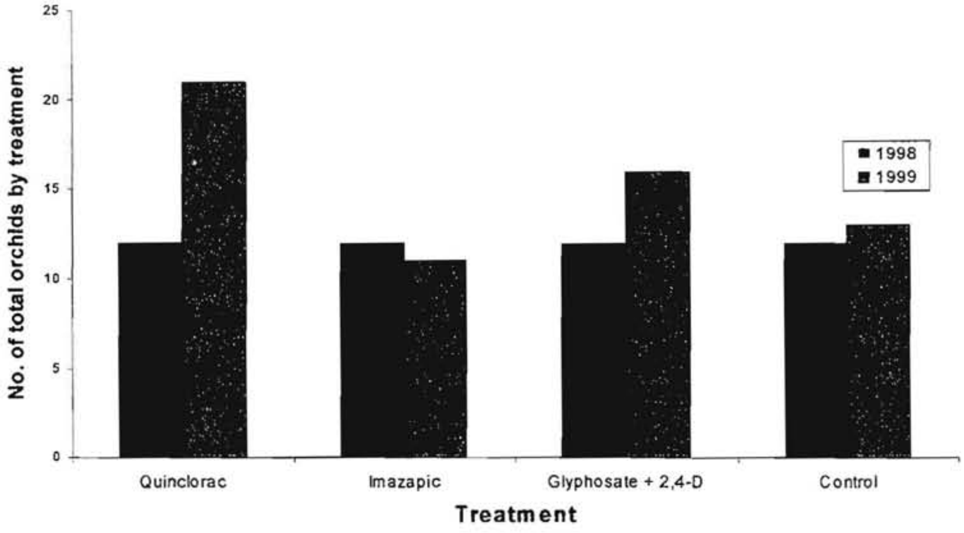

Figure 2. Total number of western prairie fringed orchids that regrew following a fall herbicide treatment.

Evaluation of diflufenzopyr with auxin herbicides for Canada thistle and spotted knapweed control. Rodney G. Lym. (Department of Plant Sciences, North Dakota State University, Fargo, ND 58105). The auxin transport inhibitor (ATI) diflufenzopyr suppresses the transport of naturally occurring IAA and synthetic auxin-like compounds in plants. The purpose of this research was to evaluate Canada thistle and spotted knapweed control by auxin herbicides applied with diflufenzopyr.

In the first experiment auxin herbicides were applied at approximately 50% below the normal use rate for season-long control to more quickly determine if diflufenzopyr caused increased weed control compared to the herbicides applied alone. The experiment was established near Fargo on June 13, 1997, with an air temperature of 82 F and a dew point of 66 F. Canada thistle was in the early bud growth stage and 4 to 16 inches tall. The herbicides were applied using a hand-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. All treatments were applied with the surfactant X-77 at 0.25% plus 28% N at 1.25%, (v/v). Canada thistle foliage injury was visually evaluated 1 MAT (month after treatment) and control based on percent stand reduction compared to the control was evaluated 3 and 12 MAT.

Canada thistle foliage injury was increased when diflufenzopyr was applied with any of the herbicides evaluated (Table 1). Plants treated with diflufenzopyr plus herbicide desiccated faster and tended to turn black in color rather than brown as observed when plants were treated with only a herbicide. The greatest increase in foliage injury occurred when diflufenzopyr was applied with picloram, 2,4-D, or quinclorac, which averaged 77% foliage injury 1 MAT compared to only 34% when the herbicides were applied alone.

Canada thistle control 3 MAT increased when diflufenzopyr was applied with dicamba, 2,4-D, quinclorac, and clopyralid compared to the herbicides applied alone (Table 1). The most dramatic increase occurred when diflufenzopyr was applied with quinclorac. Quinclorac generally does not control Canada thistle, yet when applied with diflufenzopyr control 3 MAT averaged 67% compared to only 6% when the herbicide was applied alone. Control increased from 37 to 70% with dicamba and from 44 to 83% with 2,4-D when the herbicides were applied with diflufenzopyr compared to herbicides alone. No treatment provided satisfactory control 12 MAT.

The second experiment evaluated Canada thistle control with dicamba, quinclorac, and clopyralid plus 2,4-D at standard use rates alone and with diflufenzopyr at various ratios (herbicide:ATI) Treatments were applied on June 9, 1998, near Fargo as previously described. Canada thistle plants were beginning to bolt and were 4 to 10 inches tall.

Canada thistle control with quinclorac was greatly improved when the herbicide was applied with diflufenzopyr compared to quinclorac alone (Table 2). Control averaged 64% when quinclorac was applied at 12 oz/A plus diflufenzopyr compared to only 5% when the herbicide was applied alone 2 MAT. However, control was similar regardless of the ratio of quinclorac:diflufenzopyr. Initial control with dicamba and clopyralid plus 2,4-D was similar whether the herbicides were applied alone or with the ATI. Canada thistle control with dicamba and clopyralid plus 2,4-D was higher 15 MAT when the herbicides were applied with diflufenzopyr compared to the herbicides alone. The increase in control was independent of the diflufenzopyr application rate.

The third experiment was established on June 9, 1999, to evaluate dicamba and quinclorac applied at various rates with diflufenzopyr for Canada thistle control. Canada thistle was in the early-bolt growth stage and 5 to 10 inches tall. The weather was hot and humid with an air temperature of 84 F, a dew point of 75 F, and the soil temperature at 1 inch was 92 F. There was a tendency for increased Canada thistle control at a given herbicide rate as the diflufenzopyr application rate increased (Table 3). The data were quite variable between replications; however, due to frequent heavy rains that caused the experiment to be under water much of the growing season.

The fourth experiment evaluated diflufenzopyr applied with various herbicides for spotted knapweed control. The experiment was established near Hawley, MN, on June 12, 1997, and treatments were applied as previously described. Spotted knapweed was in the early bolt growth stage, 4 to 6 inches tall, and had been mowed in August 1996. Spotted knapweed control was similar regardless of herbicide or the addition of diflufenzopyr (Table 4). Spotted knapweed control was quite variable over the entire experiment; however, there was a trend for long-term spotted knapweed control to be improved when diflufenzopyr was applied with any of the herbicides evaluated, except dicamba. Spotted knapweed control averaged over all herbicides evaluated except dicamba was 67% 24 MAT when the treatment included diflufenzopyr compared to 27% control when the herbicides were applied alone.

In summary, Canada thistle control improved when diflufenzopyr was applied with an auxin herbicide compared to the herbicide alone. Generally, control was similar regardless of the ratio of herbicide to diflufenzopyr. There was a trend for long-term spotted knapweed control to be improved when diflufenzopyr was applied with all auxin herbicides evaluated, except dicamba. In general, diflufenzopyr will improve long-term perennial weed control with auxin herbicides, but the increase is dependant on the herbicide and/or weed evaluated.

Table 1. Canada thistle control with auxin herbicides applied either alone or with diflufenzopyr in June 1997.

Treatment	Rate	Foliage inj[a] 1 MAT[b]	Control 3 MAT[b]	Control 12 MAT[b]
	oz/A	%		
Dicamba	4	54	37	15
Dicamba + diflufenzopyr[c]	4 + 1.6	76	70	11
Picloram	2	46	94	24
Picloram + diflufenzopyr	2 + 0.8	89	88	13
2,4-D	4	36	44	18
2,4-D + diflufenzopyr	4 + 1.6	65	83	18
Picloram + 2,4-D	2 + 4	63	93	24
Picloram + 2,4-D + diflufenzopyr	2 + 4 + 0.8	84	94	34
Quinclorac	8	19	6	1
Quinclorac + diflufenzopyr	8 + 3.2	76	67	11
Clopyralid	1.6	65	83	19
Clopyralid + diflufenzopyr	1.6 + 0.6	88	97	34
LSD (0.05)		13	21	NS

[a] Based on foliage topgrowth injury with 0 = no injury and 100 = all topgrowth killed.
[b] Months after treatment.
[c] Commercial mixture of dicamba plus diflufenzopyr - Distinct.

Table 2. Diflufenzopyr applied at various ratios with auxin herbicides for Canada thistle control in June 1998.

Treatment	Rate	Control/MAT[a] 2	12	15
	oz/A	%		
Dicamba + X-77 + 28% N	8 + 0.25% + 1 qt	81	8	0
Dicamba + diflufenzopyr + X-77 + 28% N	8 + 0.8 + 0.25% + 1 qt	84	22	23
Dicamba + diflufenzopyr + X-77 + 28% N	8 + 1.6 + 0.25% + 1 qt	84	31	27
Dicamba + diflufenzopyr + X-77 + 28% N	8 + 3.2 + 0.25% + 1 qt	96	28	10
Quinclorac + Scoil[b]	12 + 1 qt	5	6	0
Quinclorac + diflufenzopyr + Scoil[b]	12 + 1.6 + 1 qt	68	2	0
Quinclorac + diflufenzopyr + Scoil[b]	12 + 3.2 + 1 qt	51	9	7
Quinclorac + diflufenzopyr + Scoil[b]	12 + 4.8 + 1 qt	73	9	0
Clopyralid + 2,4-D[c]	4 + 16	94	56	13
Clopyralid + 2,4-D[c] + diflufenzopyr	4 + 16 + 2	97	42	65
Clopyralid + 2,4-D[c] + diflufenzopyr	4 + 16 + 4	100	63	51
Clopyralid + 2,4-D[c] + diflufenzopyr	4 + 16 + 8	100	36	42
LSD (0.05)		24	24	20

[a] Months after treatment.
[b] Methylated seed-oil by AGSCO.
[c] Commercial formulation-Curtail

Table 3. Evaluation of dicamba and quinclorac applied with various rates of diflufenzopyr for Canada thistle control.

Treatment	Rate	Control/ 4 MAT[a]
	lb/A	%
Dicamba + diflufenzopyr + X-77	2 + 0.8 + 0.25%	73
Dicamba + diflufenzopyr + X-77	2 + 0.2 + 0.25%	81
Dicamba + diflufenzopyr + X-77	1 + 0.4 + 0.25%	87
Dicamba + diflufenzopyr + X-77	1 + 0.1 + 0.25%	59
Dicamba + diflufenzopyr + X-77	0.5 + 0.2 + 0.25%	49
Dicamba + diflufenzopyr + X-77	0.5 + 0.05 + 0.25%	38
Quinclorac + diflufenzopyr + Scoil[b]	0.75 + 0.3 + 1 qt	21
Quinclorac + diflufenzopyr + Scoil[b]	0.75 + 0.075 + 1 qt	8
Quinclorac + diflufenzopyr + Scoil[b]	0.5 + 0.20 + 1 qt	28
Quinclorac + diflufenzopyr + Scoil[b]	0.5 + 0.05 + 1 qt	14
Quinclorac + diflufenzopyr + Scoil[b]	0.25 + 0.10 + 1 qt	24
Quinclorac + diflufenzopyr + Scoil[b]	0.25 + 0.025 + 1 qt	0
Diflufenzopyr + X-77	0.10 + 0.25%	0
Diflufenzopyr + X-77	0.20 + 0.25%	0
Diflufenzopyr + X-77	0.40 + 0.25%	0
Diflufenzopyr + X-77	0.80 + 0.25%	0
Picloram + 2,4-D	0.5 + 1	99
LSD (0.05)		28

[a] Months after treatment.
[b] Methylated seed-oil by AGSCO.

Table 4. Diflufenzopyr applied with various auxin herbicides for spotted knapweed control in June 1997.

Treatment[a]	Rate	Foliage injury 1 MAT[b]	Control/MAT[b] 3	12	15	24
	oz/A	%				
Dicamba	4	68	69	84	78	70
Dicamba + diflufenzopyr	4 + 1.6	63	48	48	51	41
Picloram	2	55	28	40	34	21
Picloram + diflufenzopyr	2 + 0.8	61	42	83	68	68
2,4-D	4	61	48	40	44	33
2,4-D + diflufenzopyr	4 + 1.6	70	71	79	76	68
Picloram + 2,4-D	2 + 4	40	25	36	33	16
Picloram + 2,4-D + diflufenzopyr	2 + 4 + 0.8	51	55	65	59	66
Quinclorac	8	46	50	50	66	51
Quinclorac + diflufenzopyr	8 + 3.2	57	68	85	82	73
Clopyralid	1.6	49	26	45	33	16
Clopyralid + diflufenzopyr	1.6 + 0.6	70	68	79	68	61
LSD (0.05)		NS	NS	NS	NS	NS

[a] All treatments were applied with X-77 + 28% N at 0.25% + 1.25%, respectively.
[b] Months after treatment.

Evaluation of imazapic for spotted knapweed and perennial sowthistle control. Rodney G. Lym. (Plant Sciences Department, North Dakota State University, Fargo, 58105). Imazapic has been used for rangeland renovation including leafy spurge control and has a narrower weed control spectrum than the more commonly used picloram plus 2,4-D. The purpose of this research was to evaluate imazapic for spotted knapweed control in an industrial location and perennial sowthistle control in cropland.

The first experiment to evaluate imazapic applied alone or with picloram for spotted knapweed control was established on a moderate infestation of spotted knapweed near Hawley, MN. Herbicides were applied on June 12, 1997 (spring) or September 18, 1997 (fall) using a hand-boom sprayer delivering 8.5 gpa at 35 psi. All treatments containing imazapic were applied with a methylated seed oil (MSO). The experiment was in a randomized complete block design with four replications and each plot was 10 by 30 feet. Evaluations were based on visual percent stand reduction compared to an untreated control.

Imazapic applied alone did not control spotted knapweed regardless of application date (Table 1). Control averaged less than 30% with some grass injury observed following the spring applied treatments. Picloram at 4 oz/A applied alone or with imazapic provided nearly complete spotted knapweed control in May 1999. The treatments could not be evaluated in August 1999 because the study area had been mowed.

The second experiment was established at the same location as the first to evaluate imazapic applied with 2,4-D for spotted knapweed control. The treatments were applied on June 30, 1998 when spotted knapweed was in the early bolt growth stage. The air temperature was 66 F, the dew point was 54 F, and the soil temperature at 2 inches was 65 F. Imazapic did not provide satisfactory spotted knapweed control whether applied alone or with 2,4-D (Table 2).

The third experiment evaluated imazapic applied alone or with clopyralid plus 2,4-D for perennial sowthistle control. The experiment was established near Fargo, ND in a dense stand of perennial sowthistle. Herbicides were applied as previously described on June 30, 1998, when perennial sowthistle was in the rosette growth stage just prior to bolting. The air temperature was 72 F and the dew point was 67 F. All imazapic treatments were applied with an MSO.

Imazapic applied with 2,4-D provided better perennial sowthistle control than either herbicide applied alone (Table 3). For instance, imazapic applied at 3 oz/A alone provided 65% perennial sowthistle control 2 months after treatment (MAT) but control declined to 26% 12 MAT. However, when imazapic was applied at 3 oz/A with 2,4-D at 4 or 8 oz/A control improved to an average of 90% and 61% 2 and 12 MAT, respectively. Clopyralid provided the best long-term perennial sowthistle control which averaged 94% 12 MAT.

In general, imazapic provided poor spotted knapweed and perennial sowthistle control when applied alone regardless of application date. The addition of 2,4-D with imazapic improved perennial sowthistle but not spotted knapweed control compared to imazapic applied alone. Imazapic applied with picloram provided similar spotted knapweed control to picloram applied alone.

Table 1. Imazapic applied alone and with picloram in May or September 1997 for spotted knapweed control.

		August 1997		May 1998		Aug 1998	May 1999
Treatment	Rate	Control	Grass inj.	Control	Grass inj.	Control	Control
Spring applied	— oz/A —			%			
Imazapic + MSO[a]	2 + 1 qt	28	5	23	0	10	5
Imazapic + MSO[a]	2.5 + 1 qt	5	11	0	0	0	0
Imazapic + MSO[a]	3 + 1 qt	13	16	13	0	0	5
Imazapic + picloram + MSO[a]	2 + 4 + 1 qt	100	20	99	0	100	90
Imazapic + picloram + MSO[a]	2.5 + 4 + 1 qt	100	27	97	0	99	88
Picloram	4	100	5	99	0	99	94
Fall applied							
Imazapic + MSO[a]	2 + 1 qt			21	0	5	0
Imazapic + MSO[a]	2.5 + 1 qt			24	0	5	7
Imazapic + MSO[a]	3 + 1 qt			11	0	13	13
Imazapic + picloram + MSO[a]	2 + 4 + 1 qt			99	13	100	95
Imazapic + picloram + MSO[a]	2.5 + 4 + 1 qt			100	18	99	91
Picloram	4			99	7	100	94
LSD (0.05)		21	22[b]	30	7	11	11

[a] Methylated seed oil was Sun-It by AGSCO.
[b] LSD = (0.10).

Table 2. Spotted knapweed control with imazapic applied alone or with 2,4-D in June 1998.

		Control/MAT[a]	
Treatment	Rate	2	12
	— oz/A —	%	
Imazapic + Scoil[b]	2 + 1 qt	11	22
Imazapic + Scoil[b]	3 + 1 qt	11	1
Imazapic + 2,4-D + Scoil[b]	2 + 4 + 1 qt	13	6
Imazapic + 2,4-D + Scoil[b]	3 + 4 + 1 qt	12	16
Imazapic + 2,4-D + Scoil[b]	2 + 8 + 1 qt	13	6
Imazapic + 2,4-D + Scoil[b]	3 + 8 + 1 qt	12	15
2,4-D	4	7	31
2,4-D	8	16	5
Picloram	4	99	83
LSD (0.05)		3	27

[a] Months after treatment.
[b] Methylated seed-oil by AGSCO.

Table 3. Perennial sowthistle control with imazapic applied alone or with 2,4-D in June 1998.

		Control/MAT[a]	
Treatment	Rate	2	12
	oz/A	%	
Imazapic + Scoil[b]	2 + 1 qt	81	26
Imazapic + Scoil[b]	3 + 1 qt	65	26
Imazapic + 2,4-D + Scoil[b]	2 + 4 + 1 qt	44	29
Imazapic + 2,4-D + Scoil[b]	3 + 4 + 1 qt	96	60
Imazapic + 2,4-D + Scoil[b]	2 + 8 + 1 qt	92	61
Imazapic + 2,4-D + Scoil[b]	3 + 8 + 1 qt	84	62
2,4-D	4	10	50
2,4-D	8	11	59
Clopyralid	4	95	94
LSD (0.05)		20	25

[a] Months after treatment.
[b] Methylated seed-oil by AGSCO.

Biological control of purple loosestrife in North Dakota. Rodney G. Lym, Katheryn M. Christianson, and Jeffrey A. Nelson. (Department of Plant Sciences, North Dakota State University, Fargo, ND 58105). Purple loosestrife was added to the North Dakota Noxious Weed List in 1996. Purple loosestrife is found in 11 North Dakota counties with the largest infestations in urban areas. Biological control of purple loosestrife fits well in urban areas considering public apprehension of herbicides sprayed in close proximity to residential areas. Three species of purple loosestrife biological agents were introduced in North Dakota in 1997 and 1998. The objective of this research was to evaluate purple loosestrife control with biological agents.

The first experiment was established along a water way at Sertoma Park (park site) and along a walking trial (channel site) in Grand Forks, North Dakota in 1997. Approximately 5,000 leaf beetle adults, *Galerucella calmariensis* and *G. pusilla*, were released at a single release point at both locations in June 1997. An additional 10,000 leaf beetle adults were released in 1999 at both locations at the same release points as in 1997. *Galerucella* spp. overwinter as adults and begin to lay eggs soon after emergence. The number of *Galerucella* spp. adults and egg masses, as well as purple loosestrife stems, plant height, and spike length were recorded at 50 foot increments from and including the release point.

A second experiment to evaluate purple loosestrife control with *Gallerucella* spp. was established in Chataque Park along the Sheyenne River in Valley City, North Dakota. Approximately 4,000 and 10,000 leaf beetle adults were released at a single release point in June 1998 and 1999, respectively. A demonstration area was also established along the Souris River on the east and west ends of Minot, North Dakota in 1998. Evaluation of purple loosestrife reduction and *Gallerucella* population was similar to the first experiment.

Galerucella spp. successfully established at both the channel and park sites in Grand Forks and had begun to reduce the number of flowering stems and cover (Tables 1 and 2). For instance, the number of flower stems had decreased from 25 and 19 in 1997, to 1 and 0 in 1999, at the channel and park sites, respectively (Table 1). Also, purple loosestrife cover had decreased to 20% or less over the entire study area.

Adults and egg masses were observed on purple loosestrife plants at both sites on June 11, 1998, 1 yr after release (Table 2). Egg masses were removed and introduced into an artificial enclosure with purple loosestrife plants to evaluate egg viability. Eggs hatched, larvae increased in size, pupated, and emerged as adults within the enclosure confirming *Galerucella* spp. life cycle could be completed in North Dakota. Few adult *Galerucella* spp. were observed in the field at either the channel or park locations. The reason few adults were observed in the field is unknown; however, adults will drop from foliage when disturbed and readily disperse from the experiment location so the population density may have been underestimated.

Galerucella spp. established at the Valley City location as both adults and egg masses were found in 1999, 1 yr after release (Tables 3 and 4). Although, the population was too low to affect purple loosestrife growth, it was once again demonstrated that *Galerucella* could establish in North Dakota.

An experiment was established at Sertoma Park to evaluate the effect of *Hylobius transversevittatus,* a root feeding weevil, on purple loosestrife in July 1997. Approximately 1,000 *H. transversevittatus* eggs were placed into cut purple loosestrife stems or on the roots. This biological agent is nocturnal so evaluations of population density were not conducted. However, the effect of *H. transversevittatus* on purple loosestrife was evaluated by estimating stem density, plant height, and spike length in four square meter quadrats within the experiment.

Purple loosestrife stems that had been infested with *H. transversevittatus* eggs were harvested in September 1997 and dissected to determine egg viability and larval feeding. Over 50% of the harvested stems contained *H. transversevittatus* larvae. Larvae were allowed to feed but failed to develop into adults under artificial conditions. There was little reduction in stem density, stem height, and spike length from the *H. transversevittatus* release site the first 2 yrs following release (Table 5). However, numerous purple loosestrife plants appeared stunted and flowered later than plants outside the release area. Delayed flowering maybe an indication of *H. transversevittatus* larval feeding.

North Dakota State University initiated an outreach program for biological control of purple loosestrife in 1998. An implementation grant from the National Biological Control Institute provided funds to release *G. calmariensis* and *G. pusilla* at locations in Minot and Valley City, North Dakota. An educational tour was held at the Valley City location in July 1999. The demonstration areas at Minot were flooded due to frequent heavy rains and subsequent rises in the Souris River. A tour could not be held, however, *Gallerucella* spp. adults were observed on plants at the west Minot location in May 1999 (data not shown).

In summary, *Gallerucella* spp. have establish in North Dakota and have over-wintered for 2 yr. Purple loosestrife cover decreased at the Grand Forks location 2 yr after release even though *Gallerucella* spp. populations were low.

Table 1. Purple loosestrife control with *Galerucella* spp. released in 1997 at two locations in Grand Forks, ND.

Distance from	Flowering stems			Stem height		Cover		
release[a]	1997	1998	1999	1997	1998	1997	1998	1999
Channel site	No.			m		%		
0 (release)	25	60	1	1.3	1.7	100	75	5
50 ft	10	8	5	1.3	1.7	33	18	8
100 ft	15	26	23	1.2	1.8	38	34	18
150 ft	12	0	0	1.2	0	10	0	0
Park site								
0 (release)	19	10	0	1.5	1.1	60	25	0
50 ft	27	19	16	1.3	1.1	45	19	11
100 ft	20	13	16	1.3	1.1	33	28	15
150 ft	17	16	5	1.3	1.3	55	15	8

[a] Estimates of purple loosestrife control were made in mid-July each year.

Table 2. Population change over time of *Galerucella spp.* on purple loosestrife at two locations in Grand Forks, ND.

Distance from	1998		1999		
release[a]	Adult	Egg masses	Adult	Larvae	Egg masses
Channel site	No.		No.		
0 (release)	0	12	1	0	1
50 ft	0	2	1	0	0
100 ft	0	1	1	0	1
150 ft	0	0	0	0	0
Park site					
0 (release)	2	21	3	0	0
50 ft	0	3	0	1	0
100 ft	0	0	0	4	0
150 ft	0	1	0	5	2

[a] Estimates of *Galerucella* adults and egg masses were made in July of each year.

Table 3. Purple loosestrife control with *Galerucella* spp. released in 1998 in Valley City, ND.

	Flowering stems	Stem		Stem height	Spike length
Distance from release[a]	1998	1998	1999	1999	1999
	No.	No.		m^2	
0 (release)	0	10	15	1.4	0
25 feet	6	14	19	1.2	10
50 feet	0	35	14	0.9	6

[a] Estimates of purple loosestrife control were made in mid-July each year.

Table 4. Population change over time of *Galerucella spp.* on purple loosestrife at Valley City, ND.

Distance from release[a]	1998			1999		
	Eggs	Larvae	Adults	Eggs	Larvae	Adults
	No.					
0 (release)	0	2	1	0	0	0
25 feet	2	1	0	2	0	2
50 feet	0	1	0	6	0	2

[a] Estimates of *Galerucella* adults and egg masses were made in July of each year.

Table 5. Purple loosestrife control with *Hylobius transversovittatus* introduced as eggs in Grand Forks, ND[a].

Flower stems			Stem		Stem height		Spike length	
1997	1998	1999	1997	1998	1997	1998	1997	1998
No./m²					m			
25	24	31	85	24	1.9	1.5	0.6	0.4

[a] Approximately 1000 eggs were placed into cut purple loosestrife stem in July 1997.

PROJECT 6: BASIC SCIENCES

Kassim Al-Khatib, Chair

Interference between yellow mustard or canola with wild oat in a greenhouse. Oleg Daugovish and Donald C. Thill. (Department of Plant, Soil and Entomological Sciences, University of Idaho, Moscow, ID 83844-2339) Use of alternative crops is an important tool in non-chemical suppression of wild oat in cereal grain production systems. A greenhouse experiment at the University of Idaho compared the competitive ability of 'Idagold' yellow mustard with wild oat and 'Sunrise' canola with wild oat using a replacement series design with total density of 75 plants/m². Sixteen plants were randomly spaced in 45 by 45 cm, 19 L pots at weed/crop proportions of 0/100,33/66, 50/50, 66/33 and 100/0%. Measurements of plant height and leaf production were done weekly. Inflorescence production was determined weekly from the beginning of flowering for crops and at harvest for wild oat. All observations were done on two plants of each species in each pot, which were harvested to determine plant dry biomass.

On average, 33, 50, and 66% of yellow mustard in proportion with wild oat reduced above ground biomass of the wild oat by 35% and panicle production by 60%. However, canola had little or no effect on wild oat per plant biomass and number of panicles. A single yellow mustard plant was equally competitive with two wild oat plants while a single canola plant was competitively equal to 0.8 wild oat plants. Crop development data and observations suggest that rapid germination and early growth of yellow mustard are responsible for it's greater interference with wild oat. This study indicated greater importance of intraspecific interference for yellow mustard and interspecific interference for canola with wild oat. The effects of intra- and interspecific interference for both crops are being quantified in on-going addition series field experiments.

Table. Effect of interference of yellow mustard and canola on wild oat in a greenhouse replacement series experiment. [a]

Wild oat in proportion	Wild oat in wild oat/canola proportions			Wild oat in wild oat/yellow mustard proportions		
	Biomass	Number of tillers	Number of panicles	Biomass	Number of tillers	Number of panicles
%	g			g		
100	11.9	6.5	1.2	11.8	5.5	2.4
66	10.9	5.6	2.3	7.8	4.7	1
50	15.1	7	0.9	7.6	3.6	1
33	12.1	5.5	1.3	7.8	4.9	0.8

[a] All measurements are on per plant basis at harvest, which was at the crop flowering stage.

Interference between yellow mustard or canola with wild oat in the field. Oleg Daugovish and Donald C. Thill. (Department of Plant, Soil and Entomological Sciences, University of Idaho, Moscow, ID 83844-2339) Use of alternative crops is an important tool in non-chemical suppression of wild oat in cereal grain production. A field experiment was conducted near Genesee, Idaho and compared interference between 'Sunrise' canola and wild oat with 'Idagold' yellow mustard and wild oat. The study was an addition series design with all possible weed-crop combinations of five densities (0, 75, 150, 225 and 300 plants/m^2). Plant biomass was harvested and crop seed yields and wild oat seed production were determined. The data will be used to develop and compare models that quantify intra- and interspecific interference for both crops.

Yellow mustard seed yield was independent from wild oat densities, while wild oat biomass in wild oat/yellow mustard combinations was reduced on average by 85% compared to the pure wild oat stands. Canola seed yield tended to decrease with increasing wild oat density, except for the unexplainable increase at the highest wild oat density. Wild oat biomass in wild oat/canola combinations was reduced on average by 69% compared to the pure wild oat stand. Greater competitive ability of yellow mustard with wild oat compared to canola also was observed in a greenhouse.

Table. Effect of wild oat/canola and wild oat/yellow mustard interference on crop yield and wild oat biomass near Genesee, ID in 1999 [a].

Weed/crop combination	Wild oat/canola		Wild oat/yellow mustard	
	Crop yield	Wild oat biomass	Crop yield	Wild oat biomass
plants/m² [b]	kg/ha	g/m²	kg/ha	g/m²
0/75	1476	0	1817	0
0/150	1192	0	1820	0
0/225	1416	0	1739	0
0/300	1333	0	1683	0
75/0	0	166	0	182
75/75	1070	61	1389	34
75/150	1195	52	1627	18
75/225	1417	49	1681	17
75/300	1559	33	1601	9
150/0	0	318	0	286
150/75	707	155	1498	47
150/150	692	104	1576	30
150/225	843	143	1596	41
150/300	753	69	1475	20
225/0	0	298	0	285
225/75	588	105	1362	98
225/150	562	107	1232	32
225/225	692	98	1531	63
225/300	839	34	1399	25
300/0	0	352	0	288
300/75	1086	135	1473	73
300/150	984	85	1752	45
300/225	973	118	1633	71
300/300	1179	58	1461	30

[a] Biomass was harvested on July 1, when crops were at the flowering stage.
[b] Wild oat density always listed first.

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HERBICIDE CHEMICAL NAMES

Common Name or Code Designation (Trade Name): Chemical Name

2,4-D (Several): (2,4-dichlorophenoxy)acetic acid
2,4-DB (Butoxone, Butyrac): 4-(2,4-dichlorophenoxy)butanoic acid
acetochlor (Harness): 2-chloro-*N*-(ethoxymethyl)-*N*-(2-ethyl-6-methylphenyl)acetamide
alachlor (Lasso): 2-chloro-N-(2,6-diethylphenyl)-N-(methoxymethyl)acetamide
atrazine (Aatrex, others): 6-chloro-N-ethyl-N'-(1-methylethyl)-1,3,5-triazine-2,4-diamine
BAS 589 03H (Not available)
BAS 654H (diflufenzopyr): 2-[1-[[[[3,5-difluorophenyl]amino]-carbonyl]hydrazono]ethyl]-3-pyridinecarboxylic acid
BAS 662H (BAS 654H (diflufenzopyr + dicamba)
benefin (Balan): N-butyl-N-ethyl-2,6,dinitro-4-(trifluoromethyl)benzenamine
benoxacor (proposed): 4-(dichloroacetyl-3,4-dihydro-3-methyl-2*H*-1,4-benzoxazine
bensulfuron (Londax): -[[[[[(4,6-dimethoxy-2-pyrimidinyl)amino]carbonyl]amino]sulfonyl] methyl]benzoate
bensulide (Prefar): *O,O*-bis(1-methylethyl) S-[2-[(phenylsulfonyl)amino]ethyl] phosphorodithioate
bentazon (Basagran): 3-(1-methylethyl)-(1H)-2,1,3-benzothiadiazin-4(3H)-one 2,2-dioxide
bromoxynil (Buctril, others): 3,5-dibromo-4-hydroxybenzonitrile
cacodylic acid (Various): dimethyl arsinic acid
calcium cyanamide (Perlka): CaCN2
carfentrazone(Aim): alpha,2-dichloro-5[4-(difluoromethyl)-4,5-dihydro-3-methyl-5-oxo-1H-1,2,4-triazol-1-yl]-4-fluorobenzenepropanoic acid
carfentrazone-ethyl (Affinity): alpha,2-dichloro-5[4-(difluoromethyl)-4,5-dihydro-3-methyl-5-oxo-1H-1,2,4-triazol-1-yl]-4-fluorobenzenepropanoic ethyl ester
chlorflurenol (NA):
chlorimuron (Classic): 2-[[[[(4-chloro-6-methoxy-2-pyrimidinyl)amino]carbonyl]amino] sulfonyl]benzoic acid
chlorsulfuron (Glean): 2-chloro-N-[[(4-methoxy-6-methyl-1,3,5-triazin-2-yl)amino] carbonyl]benzenesulfonamide
cinmethylin (Cinch): exo-1-methyl-4-(1-methylethyl)-2-[(2-methylphenyl)methoxy] -7-oxabicyclo[2.2.1]heptane
cinosulfuron
clethodim (Select, Prism): (*E,E*)-(±)-2-[1-[[3-chloro-2-propenyl)oxy]imino]propyl]-5-[2-(ethylthio)propyl]-3-hydroxy-2-cyclohexene-1-one
clodinafop (Discover, Conduct): 2-propynyl-(R)-2-[4-(5-chloro-3-fluoro-2-pyridyloxy)-phenoxyl]-propionate
clomazone (Command): 2-[(2-chlorophenyl)methyl]-4,4-dimethyl-3-isoxazolidinone
clopyralid (Lontrel): 3,6-dichloro-2-pyridinecarboxylic acid
cloransulam (Firstrate): 3-chloro-2-[[(5-ethoxy-7-fluoro[1,2,4]triazolo[1,5-c]pyrimidin-2yl)sulfonyl]amino]benzoic acid
cloransulam-ethyl (Frontrow): 3-chloro-2-[[(5-ethoxy-7-fluoro[1,2,4]triazolo[1,5-c]pyrimidin-2yl)sulfonyl]amino]benzoic methyl ester

cyanazine (Bladex): 2-[[4-chloro-6-(ethylamino)-1,3,5-trizain-2-yl]amino]-2-methylpropanenitrile
cycloate (Ro-Neet): S-ethyl cyclohexylethylcarbamothioate
DCPA (Dacthal): dimethyl 2,3,5,6-tetrachloro-1,4-benzenedicarboxylate
desmedipham (Betanex): ethyl[3-[[(phenylamino)carbonyl]oxy]phenyl]carbamate
dicamba (Banvel, Clarity): 3,6-dichloro-2-methoxybenzoic acid
dichlobenil (Casoron): 2,6-dichlorobenzonitrile
diclofop (Hoelon): (±)-2-[4-(2,4-dichlorophenoxy)phenoxy]propanoic acid
dichlorprop (several): (+)-2-(2,4-dichlorophenoxy) propanoic acid
diethatyl (Antor): N-(chloroacetyl)-N-(2,6-diethylphenyl)glycine
difenzoquat (Avenge): 1,2-dimethyl-3,5-diphenyl-1H-pyrazolium
diflufenzopyr (Distinct): 2-(1-((((3,5-difluoro phenyl)amino)carbonyl)hydrazono)ethyl)-3-pyridine carboxyic acid
diflufenacet:
dimethenamid (Frontier): (1RS,aRS)-2-chloro-*N*-(2,4-dimethyl-3-thienyl)-*N*-(2-methoxy-1-methylethyl)-acetamide
diquat (Various): 6,7,-dihydrodipyrido[1,2-∀:2N1N*c*]pyrazinediium ion
dithiopyr (Dimension, MON-15100): S,S-dimethyl 2-(difluromethyl)-4-(2-methylpropyl) -6-(trifluromethyl)-3,5-pyridinedicarbothioate
diuron (Karmex, others): N'-(3,4-dichlorophenyl)-N,N-dimethylurea
EPTC (Eptam): S-ethyl dipropyl carbamothioate
ethalfluralin (Sonalan, Curbit): *N*-ethyl-*N*-(2-methyl-2-propenyl)-2,6-dinitro-4-(trifluoromethyl) benzenamine
ethametsulfuron (Muster): methyl 2-[[[[[4-ethoxy-6-(methylamino)-1,3,5-triazin-2-yl]amino]carbonyl]amino]sulfonyl]benzoate
ethofumesate (Nortron): (±)-2-ethoxy-2,3-dihydro-3,3-dimethyl-5-benzofuranyl methanesulfonate
EXP 31130A (None) AG30: 5-cyclopropyl-4-(2-methylsulphonyl-4-trifluoromethylbenzoyl)isoxazole
fenoxaprop (Option or Acclaim): (±)-2-[4-[(6-chloro-2-benzoxazolyl)oxy] phenoxy] propanoic acid
flamprop (Mataven): *N*-benzoyl-*N*-(3-chloro-4-fluorophenyl)DL-alanine
fluazifop-p (Fusilade DX): (*R*)-2-[4-[[5-trifluoromethyl)-2-pyridinyl] oxy]phenoxy]propanoic acid
fluamide [see fluthiamide]:
flucarbazone-sodium
flumetsulam (Broadstrike, Python): *N*-(2,6-difluorophenyl)-5-methyl[1,2,4]triazolo[1,5-*a*]pyrimidine-2-sulfonamide
flumiclorac (Resource, Stellar): [2-chloro-4-fluoro-5-(1,3,4,5,6,7-hexahydro-1,3-dioxo-2*H*-isoindol-2-yl)phenoxy]acetic acid
flumioxazin (V-53482): 2-[7-fluoro-3,4-dihydro-3-oxo-4-(2-propynyl)-2H-1,4-benzoxazin-6-yl]4,5,6,7-tetrahydro-1H-isoindole-1,3(2H)-dione
fluometuron (Cotoran, Meturon): N,N'-dimethyl-N'-[3-(trifluoromethyl)phenyl]urea
fluroxypyr (Starane): 4-amino-3,5-dichloro-6-fluoro-2-pyridyloxyacetic acid

fluthiamide (BAY FOE 5043orphenyl)-N-(1-methylethyl)-2-[5-trifluoromethyl-(1,3,4-thiadiazol-2-yl)oxy]acetamide
fomesafen (Reflex, Flexstar): 5-[2-chloro-4(trifluoromethyl)phenoxy]-N-(methylsulfonyl)-2-nitrobenzamide
glufosinate (Finale, Liberty): 2-amino-4-(hydroxymethylphosphinyl) butanoic acid
glyphosate (Roundup, others): N-(phosphonomethyl) glycine
halosulfuron (formerly MON 12000) (Permit): methyl-5-[[(4,6-dimethoxy-2-pyrimidinyl) amino]carbonylaminosulfonyl]-3-chloro-1-methyl-1-*H*-pyrazole-4-carboxylate
haloxyfop (Verdict): 2-[4-[[3-chloro-5-(trifluromethyl)-2-pyridinyl]oxy] phenoxy]propanoic acid
hexazinone (Velpar): 3-cyclohexyl-6-(dimethylamino)-1-methyl-1,3,5-triazine -2,4(1H,3H)-dione
imazamethabenz (Assert): (±)-2-[4,5-dihydro-4-methyl-4-(1-methylethyl)-5-oxo-1H-imidazol-2-yl]-4 (and 5)-methylbenzoic acid (3:2)
imazamox (Raptor): 2-(4-isopropyl-4-methyl-5-oxo-2-imidazolin-2-yl)-5-(methoxymethyl)nicotinic acid (IUPAC)
imazapic (Plateau): (±)-2-[4,5-dihydro-4-methyl-4-(1-methylethyl)-5-oxo-1*H*-imidazol-2-yl]-5-methyl-3-pyridinecarboxylic acid
imazapyr (Arsenal): (±)-2-[4,5-dihydro-4-methyl-4-(1-methylethyl)-5-oxo-1H-imidazol-2-yl]-3-pyridinecarboxylic acid
imazaquin (Scepter): 2-[4,5-dihydro-4-methyl-4-(1-methylethyl)-5-oxo-1H-imidazol-2-y1]-3-quinolinecarboxylic acid
imazethapyr (Pursuit): 2-[4,5-dihydro-4-methyl-4-(1-methylethyl)-5-oxo-1H-imidazol-2-yl]-5-ethyl-3-pyridine-carboxylic acid
isoxaben (Gallery, Snapshot): *N*-[3-(1-ethyl-1-methylpropyl)-5-isoxazolyl]-2,6-dimethoxybenzamide
isoxaflutole (proposed Balance, Merlin): 5-cyclopropyl-4(2-methylsulphonyl-4-trifluoromethyl-benzoyl)isoxazole
lactofen (Cobra): (±)-2-ethoxy-1-methyl-2-oxoethyl 5-[2-chloro-4-(trifluoromethyl)phenoxy]-2-nitrobenzoate
linuron (Lorox, Linex): N-(3,4-dichlorophyenyl)-N-methoxy-N-methylurea
MCPA (several): (4-chloro-2-methylphenoxy) acetic acid
MCPB (This-trol): 4-(4-chloro-2-methylphenoxy)butanoic acid
mecoprop (several): (+)-2-(4,chloro-2-methylphenoxy) propanoic acid
metha (Vapam): methylcarbamodithioic acid
metham (Vapam): methylcarbamodithioic acid
metolachlor (Dual II): 2-chloro-N-(2-ethyl-6-methylphenyl)-N-(2-methoxy-1-methylethyl) acetamide
metribuzin (Lexone, Sencor): 4-amino-6-(1,1-dimethylethyl)-3-(methylthio)-1,2,4-triazin -5(4H)-one
metsulfuron (Ally, Escort): methyl 2-[[[[(4-methoxy-6-methyl- 1,3,5-triazin-2-yl)amino] carbonyl]amino]sulfonyl]benzoate
molinate (Ordram): S-ethyl hexahydro-1H-azepine-1-carbothioate
MSMA (several): monosodium methanearsonate
napropamide (Devrinol): N,N-diethyl-2-(1-naphthalenyloxy)propanamide

naptalam (Alanap): 2-[(1-naphthalenylamino)carbonyl] benzoic acid
nicosulfuron (Accent): 2-[[[[(4,6-dimethoxy-2-pyrimidinyl)amino]carbonyl]amino]sulfonyl]-N,N-dimethyl-3-pyridinecarboxamide
norflurazon (Zorial): 4-chloro-5-(methylamino)-2-(3-(trifluoromethyl)phenyl)-3(2H)-pyridazinone
oryzalin (Surflan): 4-(dipropylamino)-3,5-dinitrobenzenesulfonamide
oxadiazon (Chipco Ronstar): 3-[2,4-dichloro-5-(1-methylethoxy)phenyl]-5-(1,1-dimethylethyl)-1,3,4-oxadiazol-2-(3*H*)-one
oxyfluorfen (Goal): 2-chloro-1-(3-ethoxy-4-nitrophenoxy)-4-(trifluoromethyl)benzene
paraquat (Gramoxone Extra): 1,1N-dimethyl-4,4N bipyridinium ion
pelargonic acid (Scythe): fatty acid or carboxylic acid
pendimethalin (Prowl, others): N-(1-ethylpropyl)-3,4-dimethyl-2,6-dinitrobenzenamine
phenmedipham (Spin-Aid, Betanal): 3-[(methoxycarbonyl)amino]phenyl (3-methylphenyl)carbamate
picloram (Tordon): 4-amino-3,5,6-trichloro-2-pyridinecarboxylic acid
primisulfuron (Beacon): 2-[[[[[4,6-bis(difluoromethoxy)-2-pyrimidinyl]amino]carbonyl] amino]sulfonyl]benzoic acid methyl ester
prodiamine (Rydex): 2,4-dinitro-N3,N3-dipropyl-6-(trifluoromethyl)-1,3-benzenediamine
prometryn (Caparol): N,N'-bis(1-methylethyl)-6-(methylthio)-1,3,5-triazine-2,4-diamine
pronamide (Kerb): 3,5-dichloro(N-1,1-dimethyl-2-propynyl)benzamide
propachlor (Ramrod): 2-chloro-*N*-(1-methylethyl)-*N*-phenylacetamide
propanil (Stampede, Vertac): N-(3,4-dichlorophenyl) propanamide
propazine (Milogard): 6-chloro-*N*,*N*'-bis(1-methylethyl)-1,3,5-triazine-2,4-diamine
propham (Chem Hoe): 1-methylethyl phenylcarbamate
prosulfuron (Peak, Exceed): 1-(4-methoxy-6-methyl-triazin-2-yl)-3-[2-(3,3,3-trifluoropropyl)-phenylsulfonyl]-urea
pyrazosulfuron
pyrazon (Pyramin): 5-amino-4-chloro-2-phenyl-3(2H)-pyridazinone
pyridate (Tough or Lentagran): O-(6-chloro-3-phenyl-4-pyridazinyl)S-octyl carbonothioate
pyrithiobac-sodium (Staple): 2-chloro-6-[(4,6-dimethoxy-2-pyrimidinyl)thio]benzoic acid
quinclorac (Facet): 3,7-dichloro-8-quinolinecarboxylic acid
quizalafop (Assure II): (*R*)-2-[4-[(6-chloro-2-quinoxalinyl)oxy]phenoxy]propanoic acid
RH-123652 (none): Not available
rimsulfuron (Matrix): *N*-[[4,6-dimethoxy-2-pyrimidinyl)amino]carbonyl]-3-(ethylsulfonyl)-2-pyridinesulfonamide
SAN 582H See dimethenamid
sethoxydim (Poast, Ultima 160): 2-[1-(ethoxyimino)butyl]-5-[2-(ethylthio)propyl] -3-hydroxy-2-cyclohexen -1-one
simazine (Various): 6-chloro-N,NN-diethyl-1,3,5-triazine-2,4-diamine
sodium chlorate (Various): NaClO3
sulfometuron (Oust): methyl 2-[[[[(4,6-dimethyl-2-pyrimidinyl) amino]carbonyl]amino] sulfonyl] benzoate
sulfosate (Touchdown): N-phosphonamethylglycine trimethyl suflonium salt
SMY-1500 (Tycor): (4-amino-6-(1,1-dimethyl-ethyl)-3-(ethylithio)-1,2,4-triazine-5(4H)-one

sulfentrazone (Authority): *N*-[2,4-dichloro-5-[4-(difluoromethyl)-4,5-dihydro-3-methyl-5-oxo-1 *H*-1,2,4-triazol-1-yl] phenyl]methanesulfonamide
sulfosulfuron (Maverick, MON 37500): {1-[2-ethylsulfonylimidazo(1,2-a)pyridin-3-yl-sulfonyl]-3-(4,6-dimethoxypyrimidin-2-yl)urea}
tebuthiuron (Spike): N-[5-(1,1-dimethylethyl)-1,3,4-thiadiazol-2-yl]-N,N'-dimethylurea
terbacil (Sinbar): 5-chloro-3-(1,1-dimethylethyl)-6-methyl-2,4(1H, 3H)-pyrimidinedione
thiafluamide [proposed] See FOE 5043
thiazopyr (Visor): methyl 2-(difluoromethyl)-5-(4,5-dihydro-2-thiazolyl)-4-(2-methylpropyl)-6-(trifluoromethyl)-3-pyridinecarboxylate
thifensulfuron (Pinnacle): 3-[[[[(4-methoxy-6-methyl-1,3,5-triazin-2-yl)amino]carbonyl] amino]sulfonyl]-2-thiophene carboxylic acid
tralkoxydim (Achieve): 2-[1-ethoxyimino)propyl]-3-hydroxy-5-mesitylcyclohex-2-enone
triallate (Far-Go): S-(2,3,3-trichloro-2-propenyl) bis(1-methylethyl)carbamothioate
triasulfuron (Amber): 2-(2-chloroethoxy)-*N*-[[4-methoxy-6-methyl-1,3,5-triazin-2-yl)amino] carbonyl] benzenesulfonamide
tribenuron (Express): 2-[[[[(4-methoxy-6-methyl-1,3,5-triazin-2-yl)-methylamino]carbonyl] amino]sulfonyl]benzoic acid
tribuphos (Folex): s,s,s-tributylphosphorotrithioate
triclopyr (Garlon): [(3,5,6-trichloro-2-pyridinyl)oxy]acetic acid
tridiphane (Tandem): 2-(3,5-dichlorophenyl)-2-(2,2,2-trichloroethyl)oxirane
trifluralin (Treflan, others): 2,6-dinitro-N,N-dipropyl-4-(trifluoromethyl)benzeneamine
triflusulfuron (Upbeet): methyl-2-[[[[4-dimethylamino)-6-(2,2,2-trifluoroethoxy)-1,3,5-triazin-2-yl]amino]carbonyl]amino]sulfonyl]-3-methylbenzoate