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FORWARD

The 2001 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

Linda Wilson, Chair

Control of yellow starthisle with quinclorac and diflufenzopyr plus dicamba. 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 Tammany, Idaho to evaluate yellow starthistle control with quinclorac and diflufenzopyr plus dicamba. Soil type at Tammany was a silt loam (38% sand, 9% clay, 53% silt, pH 6.6, and 4.5% 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 April 7, 2000 with a CO_2 pressurized backpack sprayer calibrated to deliver 94 L/ha at 214 kPa (Table 1). Yellow starthistle control was evaluated visually May 9 and August 15, 2000.

Table 1. Application data.

Yellow starthistle stage (CENSO)	4 to 5 leaves
Air temperature (C)	17
Relative humidity (%)	32
Wind (km/h)	1
Cloud cover (%)	0
Soil temperature at 5 cm (C)	5

Quinclorac alone suppressed yellow starthistle 43% on May 9, 2000 (Table 2). Quinclorac + BAS 654 UB H controlled yellow starthistle 85% on May 9, 2000. Diflufenzopyr plus dicamba alone or in combination with quinclorac controlled yellow starthistle 98% or greater. By August 15, 2000, all treatments controlled yellow starthistle 100%. Downy brome and bluebunch wheatgrass were not injured at either rating time (data not shown).

Table 2. Yellow starthistle control with quinclorac and diflufenzopyr plus dicamba.

		CENSO	
		May 9, 2000	August 15, 2000
Treatment[a]	Rate	control	
	kg/ha	%	
Quinclorac	0.42	43	100
Quinclorac + BAS 654 UB H	0.42 + 0.043	85	100
Diflufenzopyr + dicamba	0.29	100	100
Diflufenzopyr + dicamba	0.39	100	100
Quinclorac + diflufenzopyr + dicamba	0.42 + 0.20	98	100
Quinclorac + diflufenzopyr + dicamba	0.42 + 0.29	100	100
Quinclorac + diflufenzopyr + dicamba	0.42 + 0.39	100	100
LSD (0.05)		23	-

[a]All treatments were applied with a methylated seed oil at 1.0% v/v.

Tolerance of grass species and control of yellow starthistle with imazapic and imazapic plus 2,4-D. 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 Tammany, Idaho to evaluate yellow starthistle control with imazapic, picloram, and 2,4-D plus imazapic. Soil type was a silt loam (20% sand, 18% clay, 62% silt, pH 5.6, and 2.6% 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 April 7, 2000 with a CO_2 pressurized backpack sprayer calibrated to deliver 94 L/ha at 214 kPa (Table 1). Yellow starthistle and downy brome control and bluebunch wheatgrass injury were evaluated visually on May 7 and July 7, 2000.

Table 1. Application data.

Yellow starthistle stage (CENSO)	4 to 8 leaves
Downy brome stage (BROTE)	6 to 10 leaves
Bluebunch wheatgrass stage (AGRSP)	20 to 30 leaves
Air temperature (C)	17
Relative humidity (%)	32
Wind (km/h)	2
Cloud cover (%)	20
Soil temperature at 5 cm (C)	5

Imazapic alone and in combination with 2,4-D visibly suppressed yellow starthistle 40 to 45%, 30 DAT compared to the untreated control (Table 2). Imazapic in combination with 2,4-D at the highest rate controlled yellow starthistle 93%, 60 DAT. Picloram controlled yellow starthistle 100%. Imazapic alone controlled downy brome about 60%. Imazapic in combination with 2,4-D at 0.63 kg/ha controlled downy brome 70%, 60 DAT. Bluebunch wheatgrass was injured 29 to 30%, 30 DAT. By 60 DAT, bluebunch wheatgrass had completely recovered from herbicide injury (data not shown).

Table 2. Tolerance of bluebunch wheatgrass and control of yellow starthistle and downy brome.

		CENSO	BROTE	AGRSP	CENSO	BROTE
		(30 DAT)			(60 DAT)	
Treatment	Rate	control		injury	control	
	kg/ha	%				
Imazapic[1]	0.21	40	60	30	43	61
Imazapic + 2,4-D[2]	0.21	40	50	29	15	15
Imazapic + 2,4-D	0.42	43	50	30	76	40
Imazapic + 2,4-D	0.63	45	63	30	93	70
Picloram	0.42	100	0	0	100	0
LSD (0.05)		8	15	2	30	25

[1]All imazapic treatments were applied with a methylated seed oil plus surfactant at 1.25% v/v.
[2]Imazapic plus 2,4-D formulation was 0.24 kg/L imazapic and 0.48 kg/L 2,4-D ester.

Tolerance of forage grass species to spring-applied imazapic and imazapic plus 2,4-D. Sandra L. Shinn and Donald C. Thill. (Plant Science Division, University of Idaho, Moscow, ID 83844-2339) A study was established on pasture land near Genesee, Idaho to evaluate tolerance of forage grass species to imazapic, picloram, and imazapic plus 2,4-D. Soil type was a silt loam (37% sand, 7% clay, 56% silt, pH 6.4, and 4.8% 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 April 5, 2000 with a CO_2 pressurized backpack sprayer calibrated to deliver 94 L/ha at 214 kPa (Table 1). On June 29, 2000, downy brome, smooth brome, bulbous bluegrass, and medusahead were evaluated visually for percent height reduction and plants were cut from a 0.25m^2 area, dried for 72 hours, and weighed.

Table 1. Application data.

Downy brome stage (BROTE)	6 to 10 leaves
Smooth brome stage (BROEN)	5 to 8 leaves
Bulbous bluegrass stage (POABU)	4 to 5 leaves
Medusahead stage (TAEAS)	3 to 4 leaves
Air temperature (C)	13
Relative humidity (%)	54
Wind (km/h)	3
Cloud cover (%)	30
Soil temperature at 5 cm (C)	8

Bulbous bluegrass and medusahead plant height were reduced 53% in plots treated with imazapic at 0.07 kg/ha (Table 2). Imazapic applied alone at 0.14 and 0.21 kg/ha reduced height of all forage grass species 25 to 52% compared to the untreated control. Imazapic applied in combination with 2,4-D at 0.63 kg/ha reduced height of all forage species 43 to 68%. Picloram reduced medusahead plant height 35%. Annual grass biomass was reduced 11 to 29% in plots treated with imazapic applied alone or in combination with 2,4-D at 0.42 and 0.63 kg/ha compared to the untreated control. Imazapic applied alone at 0.14 and 0.21 kg/ha reduced perennial grass biomass 31 to 39% compared to the untreated control.

Table 2. The effect of herbicide treatment on grass height and biomass near Genesee, ID.

		Height reduction				Biomass[1]	
Treatment	Rate	BROEN	BROTE	POABU	TAEAS	Annual grass	Perennial grass
	kg/ha	%				g/m^2	
Imazapic[2]	0.07	0	20	53	53	2	38
Imazapic	0.14	40	25	45	35	5	15
Imazapic	0.21	52	33	43	43	6	13
Imazapic + 2,4-D[3]	0.21	0	0	10	8	11	33
Imazapic + 2,4-D	0.42	0	0	18	15	6	27
Imazapic + 2,4-D	0.63	67	43	68	60	5	23
Picloram	0.42	0	20	5	35	15	37
Untreated control	–	–	–	–	–	20	21
LSD (0.05)		14	45	31	39	16	24

[1]Annual grass species consisted of 40% downy brome, 30% bulbous bluegrass, and 30% medusa head rye and perennial grass species consisted of smooth brome.
[2]All imazapic treatments were applied with a methylated seed oil plus surfactant at 1.25% v/v.
[3]Imazapic plus 2,4-D formulation was 0.24 kg/L imazapic and 0.48 kg/L 2,4-D ester.

Yellow starthistle control with herbicides applied at two growth stages. 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 Tammany, Idaho to evaluate yellow starthistle control with several PBI Gordon experimental herbicides. Soil type was a loam (46% sand, 8% clay, 46% silt, pH 7.0, and 5.0% 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 November 16, 1999 and June 21, 2000 with a CO_2 pressurized backpack sprayer calibrated to deliver 187 L/ha at 413 kPa (Table 1). Yellow starthistle control and bluebunch wheatgrass and downy brome injury were evaluated on May 10, and July 19, 2000.

Table 1. Application data.

Application date	November 16, 1999	June 21, 2000
Yellow starthistle stage (CENSO)	rosette (2 to 4 leaves)	bud stage
Downy brome stage (BROTE)	1 to 3 leaves	3 to 8 tillers
Bluebunch wheatgrass stage (AGRSP)	vegetative	heading
Air temperature (C)	15	26
Relative humidity (%)	58	46
Wind (km/h)	2	3
Cloud cover (%)	90	0
Soil temperature at 5 cm (C)	10	17

Experimental compound NB30027, NB30408 and 2,4-D dimethylamine salt plus 2,4-D diethanolamine salt controlled yellow starthistle 100% (Table 2). NB30409 and NB30410 applied at the rosette stage suppressed yellow starthistle 38 to 56% on May 10, 2000. By July 19, 2000, NB30409 and NB30410 applied at the rosette stage did not control yellow starthistle. All treatments applied at the bud stage controlled yellow starthistle 40 to 73%. No treatment injured downy brome or bluebunch wheatgrass (data not shown).

Table 2. Yellow starthistle control with experimental herbicides.

			Control	
			May 10, 2000	July 19, 2000
Treatment[1]	Rate	Growth stage	CENSO	
	kg/ha		%	
NB30027	2.20	rosette	100	100
NB30408	2.24	rosette	100	100
NB30409	1.03	rosette	56	0
NB30410	1.12	rosette	38	0
2,4-D dimethylamine plus 2,4-D diethanolamine	2.13	rosette	100	100
NB30027	2.20	bud	–	73
NB30408	2.24	bud	–	68
NB30409	1.03	bud	–	56
NB30410	1.12	bud	–	40
2,4-D dimethylamine plus 2,4-D diethanolamine	2.13	bud	–	56
LSD (0.05)			10	24

[1]All treatments were applied with a non-ionic surfactant at 0.25% v/v.
[2]2,4-D dimethylamine salt plus 2,4-D diethanolamine salt formulation was 0.15 kg/L dimethylamine salt and 0.30 kg/L diethanolamine salt

Evaluation of dicamba and quinclorac applied alone and with diflufenzopyr for general broadleaf weed control in pasture. Rodney G. Lym and Katheryn M. Christianson. (Department of Plant Sciences, North Dakota State University, Fargo, ND 58105). Previous research at North Dakota State University has shown that leafy spurge and Canada thistle control increased when diflufenzopyr, an auxin transport inhibitor, was applied with various auxin herbicides compared to the herbicides alone. A unique attribute of quinclorac is the narrow spectrum of weed control compared to other herbicides used for leafy spurge control. Quinclorac generally does not injure most desirable broadleaf plants but the addition of diflufenzopyr may broaden the spectrum or weed control. The purpose of this research was to evaluate diflufenzopyr applied alone and with quinclorac or dicamba for general broadleaf weed control in pasture.

The experiment was established in a pasture that contained a variety of broadleaf weeds on the NDSU Albert Ekre Experiment Station near Walcott, ND. Treatments were applied on June 14, 1999, when most of the weeds were in the vegetative growth stage. Herbicides were applied alone and with diflufenzopyr at a ratio of 2.5:1 or 10:1 herbicide:diflufenzopyr. Treatments were applied with a hand-held boom sprayer delivering 8.5 gpa at 35 psi. The plots were 10 by 30 feet, and treatments were replicated four times in a randomized complete block design.

The major species present included wild licorice [Pursh *Glycyrrhiza lepidota* (Nutt.)], hairy vervain (*Verbena stricta* Vent.), and goldenrod (*Solidago* spp.), with common ragweed (*Ambrosia artemisiifolia* L.) and common milkweed (*Asclepias syriaca* L.) found occasionally throughout the experiment. None of the major weed species was found in every plot, so each plot was evaluated for species presence or absence prior to herbicide application. Weed control evaluations were based on presence or absence of the various species and reported as percent present or absent by plot compared to the initial population.

Diflufenzopyr applied alone tended to injure hairy vervain, goldenrod, and ragweed but not wild licorice, or common milkweed (Tables 1 and 2). Injury was independent of diflufenzopyr application rate regardless of weed species.

Quinclorac applied alone or with diflufenzopyr generally did not injure wild licorice except at the highest quinclorac plus diflufenzopyr rate of 0.75 + 0.3 lb/A (Table 1). Quinclorac alone had very little effect on hairy vervain. The increase in control when diflufenzopyr was applied with quinclorac likely reflected the effect that diflufenzopyr alone had on hairy vervain. However, quinclorac did reduce goldenrod stands and control increased as the quinclorac application rate increased, especially when diflufenzopyr was applied with the herbicide. For example, quinclorac at 0.25 and 0.75 lb/A alone reduced goldenrod to 25 and 0%, respectively, of the initial infestation 11 months after treatment (MAT). When quinclorac was applied with diflufenzopyr goldenrod was nearly eliminated regardless of quinclorac rate or diflufenzopyr ratio. Quinclorac controlled common ragweed but not common milkweed whether applied alone or with diflufenzopyr (Table 2).

In general, dicamba controlled goldenrod but not wild licorice whether applied alone or with diflufenzopyr (Table 1). Dicamba only slightly injured hairy vervain when applied alone at 0.5 and 1 lb/A and injury only increased when dicamba was applied with diflufenzopyr at the highest application rates. Dicamba generally controlled both common ragweed and common milkweed whether applied alone or with diflufenzopyr (Table 2).

A wider diversity of broadleaf plants remained following quinclorac application compared to dicamba regardless if the herbicides were applied alone or with diflufenzopyr. But diflufenzopyr did tend to broaden the quinclorac weed control spectrum. The spectrum of weeds controlled by an auxin herbicide will likely increase when applied with diflufenzopyr, but the amount of increase is herbicide and weed species dependent.

Table 1. Effect of quinclorac or dicamba applied alone or with diflufenzopyr for control of three pasture weeds.

Treatment[b]	Rate	Wild licorice/MAT[a]				Hairy vervain/MAT[a]				Goldenrod/MAT[a]			
		0	2	11	13	0	2	11	13	0	2	11	13
	— lb/A —	% of plots in the treatment with plants											
Diflufenzopyr+X-77	0.1+0.25%	25	50	50	100	50	25	50	50	100	25i[c]	25	25
Diflufenzopyr+X-77	0.2+0.25%	75	50	50	75	75	50i[c]	0	25	100	50i[c]	50	50
Diflufenzopyr+X-77	0.4+0.25%	100	75	75	75	75	50i[c]	25	25	100	75i[c]	100	100
Diflufenzopyr+X-77	0.8+0.25%	50	25	75	75	25	25i[c]	25	25	100	50i[c]	50	75
Quinclorac+MSO[d]	0.25+1 qt	100	75	50	75	75	100i[c]	75	75	100	50i[c]	25	25
Quinclorac+MSO[d]	0.5+1 qt	100	100	25	50	0	50	25	75	100	25i[c]	0	0
Quinclorac+MSO[d]	0.75+1 qt	75	50i[c]	50	50	50	75i[c]	50	75	100	25i[c]	0	0
Quin+diflu + MSO[d]	0.25+0.025+1 qt	75	75	25	75	50	50i[c]	50	50	100	0	25	25
Quin+diflu + MSO[d]	0.25+0.1+1 qt	50	50	75	75	75	25i[c]	0	50	100	0	0	0
Quin+diflu + MSO[d]	0.5+0.05+1 qt	50	50	50	50	0	25	25	50	100	25i[c]	0	0
Quin+diflu + MSO[d]	0.5+0.2+1 qt	100	75	100	100	50	25i[c]	25	25	100	0	0	0
Quin+diflu + MSO[d]	0.75+0.075+1 qt	75	75	50	75	50	0	0	25	100	0	0	0
Quin+diflu + MSO[d]	0.75+0.3+1 qt	75	50	25	25	50	0	25	25	100	0	0	0
Dicamba+X-77	0.5+0.25%	100	75	25	75	25	75	25	75	100	25i[c]	25	25
Dicamba+X-77	1+0.25%	75	50	75	75	25	50i[c]	25	50	100	0	0	0
Dicamba+X-77	2+0.25%	75	75	50	75	50	0	0	0	100	0	25	25
Dicamba+diflu+X-77	0.5+0.05+0.25%	100	75	50	100	25	25	0	25	100	0	0	0
Dicamba+diflu+X-77	0.5+0.2+0.25%	75	75	50	50	50	25	50	50	100	25	25	25
Dicamba+diflu+X-77	1+0.1+0.25%	50	50	25	50	0	0	25	50	100	0	0	0
Dicamba+diflu+X-77	1+0.4+0.25%	75	75	50	50	25	0	0	0	100	25	0	0
Dicamba+diflu+X-77	2+0.2+0.25%	75	50	75	75	50	0	25	50	100	0	0	0
Dicamba+diflu+X-77	2+0.8+0.25%	75	0	0	25	100	0	0	0	100	0	0	0
Picloram+2,4-D	0.5+1	100	25	25	50	0	0	50	50	100	25	0	0

[a] Months after treatment.
[b] Quin = quinclorac, diflu = diflufenzopyr.
[c] Plants were present but had auxin herbicide type injury or were otherwise stunted.
[d] Methylated seed oil by AGSCO, Grand Forks, ND.

Table 2. Effect of quinclorac or dicamba applied alone or with diflufenzopyr for control of common ragweed and common milkweed.

Treatment[b]	Rate	Ragweed/MAT[a] 0	2	11	Milkweed/MAT[a] 0	2	11	Other plant species noted growing in at least one plot
	lb/A	Plants found occasionally[c]						
Diflufenzopyr+X-77	0.1+0.25%	p	a	a	p	p	p	wood violet, western snowberry (*Symphoricarpos occidentalis* Hook.)
Diflufenzopyr+X-77	0.2+0.25%	a	a	a	p	p	a	
Diflufenzopyr+X-77	0.4+0.25%	a	a	a	a	a	a	
Diflufenzopyr+X-77	0.8+0.25%	p	a	a	p	p	p	wood violet, western snowberry, thistle
Quinclorac+MSO[d]	0.25+1 qt	a	a	a	p	p	a	
Quinclorac+MSO[d]	0.5+1 qt	a	a	a	p	p	p	wood violet (*Viola* spp.),western. snowberry
Quinclorac+MSO[d]	0.75+1 qt	p	a	a	a	a	p	wood violet
Quin+diflu[d] + MSO[d]	0.25+0.025+1 qt	p	a	a	p	p	p	parsnip (*Pastinaca sativa* L.), wild strawberry (*Fragaria virginiana* Duchn.), yarrow (*Achillea* spp.)
Quin+diflu + MSO[d]	0.25+0.1+1 qt	p	a	a	a	a	p	wood violet, thistle (Cirsium spp.)
Quin+diflu + MSO[d]	0.5+0.05+1 qt	p	a	a	a	a	a	western snowberry
Quin+diflu + MSO[d]	0.5+0.2+1 qt	a	a	a	p	p	a	wood violet, western snowberry
Quin+diflu + MSO[d]	0.75+0.075+1 qt	p	a	a	a	a	p	wood violet
Quin+diflu + MSO[d]	0.75+0.3+1 qt	p	a	a	a	a	a	wild rose (*Rosa arkansana*)
Dicamba+X-77	0.5+0.25%	p	a	a	p	p	a	wood violet, western snowberry, thistle
Dicamba+X-77	1+0.25%	p	a	a	p	p	a	wood violet, western snowberry
Dicamba+X-77	2+0.25%	a	a	a	p	p	a	wood violet
Dicamba+diflu+X-77	0.5+0.05+0.25%	p	a	a	p	a	a	wood violet
Dicamba+diflu+X-77	0.5+0.2+0.25%	p	a	a	p	p	a	wood violet
Dicamba+diflu+X-77	1+0.1+0.25%	p	a	a	a	a	a	wood violet, western snowberry
Dicamba+diflu+X-77	1+0.4+0.25%	p	a	a	a	a	a	wood violet
Dicamba+diflu+X-77	2+0.2+0.25%	p	a	a	p	p	a	wood violet
Dicamba+diflu+X-77	2+0.8+0.25%	a	a	a	p	a	a	wood violet
Picloram+2,4-D	0.5+1	p	a	a	p	a	a	

[a] Months after treatment.

[b].Quin = quinclorac, diflu = diflufenzopyr.

[c] P = plants were present, a= plants were absent in any of the plots prior to or following herbicide application.

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

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 was increased when diflufenzopyr was applied with various auxin herbicides including dicamba, quinclorac, picloram, and 2,4-D. In the initial trials diflufenzopyr was applied at a ratio of 2.5:1 herbicide:diflufenzopyr. The purpose of this research was to evaluate the effect of varying the ratio of herbicide to diflufenzopyr on both short- and long-term leafy spurge control with various herbicides.

The first experiment evaluated the optimum ratio of diflufenzopyr when applied with dicamba or quinclorac. The diflufenzopyr ratio varied from the standard ratio of 2.5:1 herbicide:diflufenzopyr to 5:1 and 10:1. Experiments were established near Jamestown and Valley City, North Dakota, in early June 1998 when leafy spurge was in the true-flower growth stage. The herbicides were applied using a hand-held boom sprayer delivering 8.5 gpa at 35 psi. The plots were 10 by 30 feet, and treatments were replicated four times in a randomized complete block design. Leafy spurge topgrowth control was visually evaluated based on percent stand reduction compared to the untreated check.

Both initial foliar injury 1 month after treatment (MAT) and topgrowth control 3 MAT usually were higher when diflufenzopyr was applied with dicamba and quinclorac compared to the herbicide applied alone (Table 1). However, injury and control were similar regardless of diflufenzopyr rate. For instance, leafy spurge control 3 MAT with dicamba applied alone averaged 84% 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 3 MAT averaged 78% when diflufenzopyr was applied with glyphosate plus 2,4-D compared to 44% when the herbicide combination was applied alone.

The addition of diflufenzopyr increased long-term leafy spurge control when applied with either dicamba or quinclorac compared to the herbicides applied alone. For instance, leafy spurge control 24 MAT averaged 63 with dicamba plus diflufenzopyr, versus 39% with dicamba alone (Table 1). The increase in control was similar regardless of the dicamba:diflufenzopyr ratio. Similarly, long-term leafy spurge control 24 MAT averaged 71% when diflufenzopyr was applied with quinclorac compared to only 49% when quinclorac was applied alone. Again, the increase in control was similar regardless of the quinclorac:diflufenzopyr ratio. The addition of diflufenzopyr to glyphosate plus 2,4-D did not result in a long-term increase in leafy spurge control.

The second and third 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 second experiment was established. When the third experiment was established on September 15, 1998, leafy spurge was in the fall regrowth stage with approximately 15% yellow foliage, and the air temperature was 78 F with a dew point of 60 F.

Consistent with the previous experiments long-term leafy spurge control 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 2 and 3). Leafy spurge control 15 MAT averaged 88 and 83% when picloram or picloram plus 2,4-D were applied with diflufenzopyr compared to 62 or 38%, respectively, when the herbicides were applied (Table 3). Control averaged 84% with picloram at 8 oz/A plus diflufenzopyr 27 MAT compared to only 31% when picloram was applied alone.

In general, long-term leafy spurge control also was increased when diflufenzopyr plus picloram or picloram plus 2,4-D was fall applied, but the increase was erratic (Table 3). For instance, leafy spurge control 12 MAT with picloram plus 2,4-D at 4 + 16 oz/A averaged only 1% 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. Leafy spurge control with picloram at 8 oz/A averaged 37% 21 MAT compared to an average of 57% when applied with diflufenzopyr.

The fourth experiment was established to further evaluate the effect of the diflufenzopyr ratio on leafy spurge control with dicamba or quinclorac. Herbicides were applied at various rates with an herbicide:diflufenzopyr ratio of 2.5:1 or 10:1. The experiment was established at two locations, in early June 1999 near Valley City when leafy spurge was in the flowering growth stage and in mid-July near Fargo when leafy spurge was in late seed-set stage.

Leafy spurge control was similar when herbicides were applied at comparable rates regardless of the diflufenzopyr ratio (Table 4). Although not directly comparable, leafy spurge control tended to be higher when the herbicides were applied during the flowering growth stage compared to the seed-set stage. Control was independent of diflufenzopyr ratio (2.5:1 or 10:1).

In summary, diflufenzopyr increased long-term leafy spurge control by auxin-type herbicides and the increase was independent of the herbicide:diflufenzopyr ratio. No increase in non-target plant injury, such as grass injury, was observed at any location.

Table 1. Diflufenzopyr applied at various ratios with herbicides for leafy spurge control averaged over Jamestown and Valley City locations in North Dakota.

Treatment	Rate	Foliar injury 1 MAT[a]	Control/MAT[a] 3 MAT[a]	12	15	24
	oz/A	%				
Dicamba + X-77 + 28% N	32 + 0.25% + 1 qt	64	84	29	25	39
Dicamba + diflufenzopyr + X-77 + 28% N	32 + 3.2 + 0.25% + 1 qt	67	94	75	58	65
Dicamba + diflufenzopyr + X-77 + 28% N	32 + 6.4 + 0.25% + 1 qt	78	99	89	57	60
Dicamba + diflufenzopyr + X-77 + 28% N	32 + 12.8 + 0.25% + 1 qt	70	98	83	59	63
Quinclorac + MSO[b]	12 + 1 qt	47	78	85	54	49
Quinclorac + diflufenzopyr + MSO[b]	12 + 1.6 + 1 qt	61	96	96	83	72
Quinclorac + diflufenzopyr + MSO[b]	12 + 3.2 + 1 qt	60	97	98	82	70
Quinclorac + diflufenzopyr + MSO[b]	12 + 4.8 + 1 qt	66	98	96	75	71
Glyphosate + 2,4-D[c]	6 + 10	88	44	31	17	30
Glyphosate + 2,4-D[c] + diflufenzopyr	6 + 10 + 6.4	84	78	53	27	31
LSD (0.05)		8	8	14	13	15

[a] Months after treatment.
[b] Methylated seed-oil was Scoil by AGSCO, Grand Forks, ND.
[c] Commercial formulation - Landmaster BW.

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

Treatment	Rate	Control/MAT[a] 3	12	15	24	27
	oz/A	%				
Picloram + diflufenzopyr	8 + 1.6	99	96	85	83	79
Picloram + diflufenzopyr	8 + 3.2	99	99	88	91	88
Picloram + diflufenzopyr	8 + 4.8	99	99	90	91	87
Picloram + diflufenzopyr	8 + 6.4	99	99	89	92	83
Picloram + 2,4-D + diflufenzopyr	4 + 16 + 1.6	99	90	79	81	53
Picloram + 2,4-D + diflufenzopyr	4 + 16 + 3.2	98	93	82	79	65
Picloram + 2,4-D + diflufenzopyr	4 + 16 + 4.8	99	96	85	84	80
Picloram + 2,4-D + diflufenzopyr	4 + 16 + 6.4	99	98	85	81	76
Picloram	8	92	85	62	51	31
Picloram + 2,4-D	4 + 16	80	79	38	52	40
LSD (0.05)		5	11	13	16	22

[a] Months after treatment.

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

Treatment	Rate	Control/MAT[a]		
		9	12	21
	oz/A	%		
Picloram + diflufenzopyr	8 + 1.6	99	66	63
Picloram + diflufenzopyr	8 + 3.2	97	44	34
Picloram + diflufenzopyr	8 + 4.8	99	83	70
Picloram + diflufenzopyr	8 + 6.4	99	74	60
Picloram + 2,4-D + diflufenzopyr	4 + 16 +1.6	88	36	20
Picloram + 2,4-D + diflufenzopyr	4 + 16 + 3.2	93	65	43
Picloram + 2,4-D + diflufenzopyr	4 + 16 + 4.8	95	45	34
Picloram + 2,4-D + diflufenzopyr	4 + 16 + 6.4	95	40	31
Picloram	8	88	53	37
Picloram + 2,4-D	4 + 16	45	1	0
LSD (0.05)		12	26	22

[a] Months after treatment.

Table 4. Leafy spurge control with dicamba and quinclorac combined with various ratios of diflufenzopyr applied in June 1999 at Valley City during the flowering growth stage or in July 1999 during seed-set at Fargo.

Treatment	Rate	1999		2000		
		September		June		Aug
		Valley City	Fargo	Valley City	Fargo	Fargo
	lb/A	% control				
Dicamba + diflufenzopyr + X-77	2 + 0.2 + 0.25%	99	96	94	94	87
Dicamba + diflufenzopyr + X-77	2 + 0.8 + 0.25%	100	97	98	91	83
Dicamba + diflufenzopyr + X-77	1 + 0.1 + 0.25%	96	94	87	90	86
Dicamba + diflufenzopyr + X-77	1 + 0.4 + 0.25%	98	88	74	67	60
Dicamba + diflufenzopyr + X-77	0.5 + 0.05 + 0.25%	90	85	73	60	46
Dicamba + diflufenzopyr + X-77	0.5 + 0.2 + 0.25%	89	83	45	64	28
Quinclorac + diflufenzopyr + MSO[a]	0.75 + 0.075 + 1 qt	98	94	95	87	72
Quinclorac + diflufenzopyr + MSO[a]	0.75 + 0.3 + 1 qt	99	95	97	83	77
Quinclorac + diflufenzopyr + MSO[a]	0.5 + 0.05 + 1 qt	99	98	97	59	31
Quinclorac + diflufenzopyr + MSO[a]	0.5 + 0.20 + 1 qt	98	97	97	86	73
Quinclorac + diflufenzopyr + MSO[a]	0.25 + 0.025 + 1 qt	96	93	76	80	54
Quinclorac + diflufenzopyr + MSO[a]	0.25 + 0.10 + 1 qt	98	96	92	58	29
Diflufenzopyr + X-77	0.10 + 0.25%	0	0	0	14	0
Diflufenzopyr + X-77	0.20 + 0.25%	0	0	26	12	0
Diflufenzopyr + X-77	0.40 + 0.25%	0	0	0	8	0
Diflufenzopyr + X-77	0.80 + 0.25%	0	5	54	10	0
Picloram + 2,4-D	0.5 + 1	99	94	97	55	37
LSD (0.05)		4	8	32	21	29

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

Leafy spurge control with imazapic combined or alternated with picloram plus 2,4-D. Rodney G. Lym. (Department of Plant Sciences, North Dakota State University, Fargo, ND 58105). Research at North Dakota State University has shown that imazapic provides good leafy spurge control when applied in the fall but can injure grass, especially cool-season species. Thus, picloram plus 2,4-D may need to be applied every other year to reduce grass injury in a long-term management program. 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 1998 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 oz/A in the spring or 2 oz/A in the fall. Picloram plus 2,4-D was applied at the common 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. Any treatment that included imazapic also contained methylated seed oil plus 28% N liquid fertilizer.

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.

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 99% in June 2000, 24 months after treatment (MAT). This high level of control was unexpected and is better than the long-term average of picloram applied alone at 32 oz/A, which generally provides the best long-term control in the region. The same three-herbicide treatment applied in the fall only averaged 61 and 15% control 12 and 24 MAT, respectively.

The best split treatments for long-term leafy spurge control 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. These treatments averaged 85 and 61% control in August 1999 and 2000, respectively. No grass injury was observed following any of the rotational treatments.

In general, control at the Valley City location was better than at the Jamestown location. For instance, picloram plus 2,4-D plus imazapic spring applied provided 98% control in June 2000, 24 MAT at Jamestown, but control began to decline by August 2000 to an average of 75%. In comparison, leafy spurge control averaged 91% in August 2000 at Valley City. The high long-term control from the three-way mixture exceeded that from any previous herbicide treatments evaluated at North Dakota State University. To maintain such long-term control usually requires two or three annual applications of either imazapic or picloram plus 2,4-D.

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

				1998			1999						2000					
				August			June			August			June			August		
Treatment	Rate	Treatment	Rate	JMS[a]	VC[a]	Mean	JMS[a]	VC[a]	Mean	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	64	82	73	42	75	58
Imazapic+MSO[c]+28% N	1+1qt+1qt	Picloram+2,4-D	8+16	28	58	43	99	99	99	53	82	67	43	76	59	18	69	43
Picloram+2,4-D+imazapic +MSO[c]+28% N	4+16+1+ 1qt+1qt	None		99	95	97	95	99	99	97	99	98	98	99	99	75	91	83
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	98	95	96	47	82	64
Imazapic+MSO[c]+28% N	2+1qt+1qt	Picloram + 2,4-D	8+16				99	99	99	96	98	97	77	81	79	25	62	43
Picloram+2,4-D+ imazapic+MSO[c]+28% N	8+16+2+ 1qt+1qt	None					99	99	99	59	64	61	26	50	38	3	28	15
LSD (0.05)							NS	2	NS	11	16	9[d]	11	16	10[d]	29	14	15[d]

[a] JMS = Jamestown, VC = Valley City

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

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

[d] Control at Valley City was higher than at Jamestown.

Using sonic sound waves to increase leafy spurge control with herbicides. Rodney G. Lym and Katheryn M. Christianson. (Department of Plant Sciences, North Dakota State University, Fargo, ND 58105). A manufacturer (Dan Carlson Scientific Enterprises, Inc. 708-119th Lane N. E., Blaine, MN 55434) markets a system of sound emitters used with nutrient solutions (SonicBloom®) that reportedly increases plant growth both in greenhouse and field conditions. Recently, claims have been made that the use of the sound system with herbicides (SonicDoom®) can increase weed control compared to the herbicides alone. The purpose of this study was to evaluate the use of sound with various herbicides for leafy spurge control.

The experiment was established in separate growth chambers (sound and no sound) set at a 16 h photoperiod, a 75/65 day/night temperature and 30 to 40% relative humidity. Leafy spurge was propagated from cuttings in the greenhouse in cone-tanners (Lym, R. G. 1992. Propagation of *Euphorbia esula*) for leafy spurge biocontrol agents, *Weed Sci.* 40:326-332) and grown for 6 weeks, then the topgrowth was removed and the plants were allowed to regrow prior to treatment. Leafy spurge plants were 10 to 18 inches tall and vegetative (two replicates) or flowering (two replicates) at treatment. The plants were placed in growth chambers, with or without the sound source, 72 h prior to treatment. A sound box that emitted continuous sound in wavelengths designed to increase herbicide absorption[1] was turned on 48 h prior to treatment, during treatment (in the spray hood), and 24 h following herbicide treatment. Herbicides were applied with a one nozzle greenhouse sprayer delivering 17 gpa at 35 psi at rates that typically produce injury but not complete plant kill under greenhouse conditions. Thus, any increase in herbicide activity due to the sound treatment would be readily apparent. Plants were returned to the respective growth chamber immediately following treatment for 24 h and then moved to the greenhouse for the remainder of the study.

Leafy spurge control was evaluated by estimating injury to the topgrowth 7 and 14 days after treatment (DAT) with 0 equal to no injury and 100 equal to complete topgrowth kill. Then the topgrowth was removed and the plants were allowed to regrow for 6 weeks when the number of live plants was determined. The regrowth was harvested, dried, and weighed which provided an estimate of herbicide injury to the roots. There were four plants per treatment and the study was repeated.

Leafy spurge injury and plant regrowth with each herbicide treatment was similar whether or not the sound treatment was included (Table). For instance, picloram plus 2,4-D averaged 40% top growth injury 14 DAT, 218 and 223 mg of regrowth, and 100% and 88% live plants, when the herbicides were applied with our without sound, respectively. Mean dry weight of plant regrowth averaged 197 and 193 mg/plant with and without sound, respectively. Quinclorac provided the greatest leafy spurge injury and reduction in regrowth, but the results were similar regardless if applied with or without the sound treatment. In summary, no increase in leafy spurge control was observed when herbicides were applied with the sound emitter. Similar results would be expected with field applications.

Table. Leafy spurge control with various herbicides applied with and without a sonic sound treatment.

Treatment	Rate	Topgrowth injury (DAT[a]) 7	Topgrowth injury (DAT[a]) 14	Plant regrowth (8 WAT[b]) Dry weight	Plant regrowth (8 WAT[b]) Live plants
	— oz /A —	— % —		mg/plant	— % —
With sound					
Picloram + 2,4-D + X-77	2 + 3 + 0.25%	25	40	218	100
Imazapic	0.015	10	15	151	100
Quinclorac + MSO[c]	3 + 1 qt	50	60	3	19
Glyphosate + 2,4-D	3.2 + 4.8	35	60	320	88
Dicamba + diflufenzopyr	3 + 1.2	55	60	165	75
Control		0	0	325	100
Mean (with sound)				197	
Without sound					
Picloram + 2,4-D + X-77	2 + 3 + 0.25%	35	40	223	88
Imazapic	0.015	5	15	250	88
Quinclorac + MSO[c]	3 + 1 qt	60	70	0	13
Glyphosate + 2,4-D	3.2 + 4.8	35	60	303	88
Dicamba + diflufenzopyr	3 + 1.2	45	60	267	88
Control		0	0	333	100
Mean (without sound)				193	NS
LSD (0.05) Trt				205	
LSD (0.05) Trt by sound				NS	

[a] Days after treatment.
[b] Weeks after treatment.
[c] Methylated seed oil was Sunit by AGSCO, Grand Forks, ND.

The competitive effects of five cool-season perennial grasses on foxtail barley. Tom D. Whitson and Jerry M. Langbehn. (Department of Plant Sciences, University of Wyoming, Laramie, WY 82071-3354) 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 pH, 1.6% organic matter, 38% and, 23% silt and 39% clay. Plots were 12 ft by 50 ft 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/A 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/A. 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 by clipping individual species on July 8, 1999 and August 21, 2000. In 1999 (four) M^2 and 2000 (three) M^2 quadrats were clipped by species within each of three replications, samples were oven- and air-dried, then weighed.

The two perennial grasses, (Jose) tall wheatgrass and (Newhy) hybrid wheatgrass continued to establish and provided stronger competition three years after establishment. Tall wheatgrass increased from 90% control in 1999 to 96% in 2000. Newhy hybrid wheatgrass provided 56% control of foxtail barley in 1999 but it continued to establish and become more competitive, providing 94% control in 2000. Shoshone beardless wildrye provided a 12% increase in foxtail barley control from 19% in 1999 to 31% in 2000, while Pryor slender wheatgrass and Prairie land Altai wildrye provided less competition in 2000 compared to the previous year. (Wyoming Agric. Exp. Sta., Laramie, WY 82071, SR____).

Table. A three-year comparison of foxtail barley control with five perennial grasses.

Grass species	% control			Yields (air-dried)			
				Perennial grasses		Foxtail barley	
	1998	1999	2000	1999	2000	1999	2000
Hybrid wheatgrass (Newhy)[1]	47	56	94	1371	1669	795	80
Slender wheatgrass (Pryor)	3	59	50	2598	1150	1005	655
Tall wheatgrass (Jose)	57	90	96	4485	2734	356	44
Beardless wildrye (Shoshone)	0	19	31	721	617	2014	916
Altai wildrye (Prairieland)	2	27	0	1086	0	2462	1330

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

2. All species were clipped by species (four) M^2 (1999) and (three) M^2 (2000) quadrats/rep. oven and air-dried, then weighed.

Common mullein control 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 at Cherry Creek Reservoir State Park, Aurora, 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 made in July, August, and October 1999, 41, 76, and 106 days after treatment (DAT), and June 2000, approximately 11 months after treatment (MAT). All treatments controlled less than 68% of VESTH 30 DAT. Bolted VESTH control at 41 amd 76 DAT evaluation dates were very similar. 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 106 DAT evaluation due to a flush of fall rosettes. Increased rates of picloram plus fluroxypyr or picloram plus 2,4-D provided fair to good VESTH control (50 to 84%) 106 DAT. The only treatment that controlled rosettes and bolted VESTH was 0.25 lb picloram + 1 lb 2,4-D (78 and 81% respectively) 106 DAT. There was no residual VESTH control evident 11 MAT from any treatment used in this study. Although picloram plus 2,4-D controlled up to 80% VESTH 106 DAT, it may require higher rates of picloram to provide residual control 1 YAT.

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 (lb ai/A)	Common Mullein (Control %) July 1, 1999	August 6, 1999	October 5, 1999 Bolted	October 5, 1999 Fall Rosettes	June 7, 2000
Fluroxypyr	0.13	0	10	10	0	0
	0.19	6	13	13	0	0
	0.25	11	14	14	0	0
	0.5	3	14	14	0	0
Picloram + Fluroxypyr[b]	0.1 + 0.15	58	50	50	8	0
	0.15 + 0.23	60	69	69	31	0
	0.21 + 0.29	65	84	84	15	0
2,4-D	0.13 + 0.5	10	15	15	0	0
Picloram[c] + 2,4-D	0.13 + 0.5	61	53	48	86	0
	0.19 + 0.75	59	65	65	80	0
	0.25 + 1.0	68	81	81	78	0
Picloram[d] + 2,4-D	.013	1	0	0	0	0
	+ 0.25	60	73	73	33	0
LSD (0.05)		9	13	12	13	0

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

The influence of picloram, 2,4-D, or picloram + 2,4-D on broom snakeweed and wild tarragon 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, 1999, and 2000 approximately 1, 2, 3, and 4 years after treatment (YAT). All treatments controlled GUESA 5 to 100% (Table 2). It required 0.3 lb of picloram or 0.2 lb of picloram plus 0.71 lb 2,4-D to provide greater than 65% GUESA control 1 to 4 YAT. It required 0.4 lb/A of picloram or 0.3 lb/A + 1 lb/A of picloram plus 2,4-D to greater than 80% GUESA control 4 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 64% of ARTDR was controlled with 0.4 lb picloram or 0.3 + 1.0 lb/A of picloram plus 2,4-D 1 to 4 YAT. The only treatment that provided 80% or greater ARTDR control 4 YAT was 0.4 lb picloram plus 1.5 lb 2,4-D .

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.

	Rate	Broom Snakeweed				Wild Taragon			
Herbicide[a]	(lb ai/A)	----------Control (%)----------							
		1997	1998	1999	2000	1997	1998	1999	2000
Picloram	0.06	5	8	8	8	5	0	0	0
	0.13	45	33	31	24	54	34	15	5
	0.2	56	39	38	33	59	30	25	18
	0.3	86	86	80	73	79	64	55	41
	0.4	93	96	93	81	90	84	80	69
Picloram[b] + 2,4-D	0.13 0.5	66	59	53	51	63	48	39	38
2,4-D	2.0	34	33	30	28	28	26	20	18
Picloram[c] + 2,4-D	0.07 + 0.25	21	20	19	18	29		13	4
	0.13 + 0.5	59	48	44	39	60	35	29	23
	0.2 + 0.71	81	76	71	66	80	69	59	53
	0.3 + 1.0	90	94	93	89	91	81	75	64
	0.4 + 1.5	99	100	100	95	96	94	93	80
Control		0	0	0	0	0	0	0	0
LSD (0.05)		18	21	19	19	19	19	21	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

The influence of picloram, 2,4-D, or picloram + 2,4-D on prickly pear and sand sagebrush 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 in 1996 to evaluate prickly pear (OPUPO) and sand sagebrush (ARTFI) 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 on August 2, 1996 when OPUPO was in the vegetative growth stage and ARTFI was flowering. 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 made in June 1997, August 1998 and 1999, and September 2000, approximately 1, 2, 3, and 4 years after treatments (YAT) were applied. OPUPO died slowly after treatments were applied. OPUPO control continued to increase from the August 1996 application to the fourth year after treatment. All treatments controlled less than 63% of OPUPO 1 YAT (Table 2). When treatments were evaluated 2, 3, or 4 YAT, control ranged from 6 to 100%. More than 80% of OPUPO was controlled 2 to 4 YAT with 0.2 lb of picloram or more. It required 0.3 + 1 lb of picloram + 2,4-D to decrease OPUPO populations to zero 4 YAT. The addition of 2,4-D to picloram did not aid OPUPO control nor was there a difference between premixed formulation or field-mixed formulation of picloram plus 2,4-D on OPUPO control. However, the addition of 2,4-D to picloram increased ARTFI control in most combination treatments. OPUPO was controlled poorly (6%) by 2, 4-D alone.

All treatments controlled less than 35% of ARTFI 1 YAT. Picloram alone controlled ARTFI poorly (6 to 34%) while picloram plus 2,4-D controlled 18 to 65% of ARTFI 2 to 4 YAT. When 2,4-D was applied alone, there was 58 to 65% ARTFI control 2 to 4 YAT and the addition of picloram did not improve control. If both prickly pear and sand sagebrush are present at a potential spray site, it may be advantageous to combine picloram plus 2,4-D to control both plants. However, if prickly pear is present alone, there appears to be no advantage to adding 2,4-D.

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

Herbicide[a]	Rate	Prickly Pear				Sand Sagebrush			
		% Control							
	(lb ai/A)	1997	1998	1999	2000	1997	1998	1999	2000
Picloram	0.06	29	55	66	76	34	19	19	15
	0.13	19	70	73	86	13	21	15	11
	0.2	13	55	83	81	8	9	11	9
	0.3	35	87	86	94	11	6	9	5
	0.4	29	91	96	100	11	15	18	18
Picloram[b] + 2,4-D	0.13 +0.5	30	70	79	88	2	50	45	33
2,4-D	2.0	21	6	6	6	0	65	64	58
Picloram[c] + 2,4-D	0.07 + 0.3	18	34	49	63	1	19	18	18
	0.13 +0.5	35	75	79	86	5	41	35	30
	0.2 +0.7	24	70	81	96	1	39	35	31
	0.3 +1.0	48	88	98	100	1	65	69	65
	0.4 +1.5	63	94	100	100	3	56	56	46
LSD (0.05)		26	21	21	32	9	21	21	19

[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 + the triisopropanolamine salt of 2,4-D (Grazon P&D).

Oxeye daisy control on Colorado rangeland. James R. Sebastian and K.G. Beck. (Department of Bioagriculture Sciences and Pest Management, Colorado State University, Fort Collins, CO 80538) An experiment was established near Durango, CO to evaluate oxeye daisy (CHRLE) control. The experiment was designed as a randomized complete block with four replications.

Herbicides were applied on July 27, 1999 when CHRLE was in the full bloom growth stage. All treatments were applied with a CO_2-pressurized backpack sprayer using 11003LP flat fan nozzles at 21 gal/A, 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 made in September 1999 and July 2000, approximately 60 days after treatment (DAT) and 1 year after treatment (YAT). Metsulfuron treatments controlled CHRLE faster than others. For example, CHRLE control from metsulfuron 60 DAT was 73 to 84% whereas picloram controlled 53% of CHRLE 60 DAT. Metsulfuron treatments controlled 100% of CHRLE and picloram 73% 1 YAT. Clopyralid plus 2,4-D amine, 2,4-D amine, and imazapic treatments controlled CHRLE poorly (16 to 54%). Imazapic was the only treatment that caused cool season grass injury (36% stand loss). The addition of nitrogen to metsulfuron did not improve CHRLE control nor did nitrogen alone control CHRLE.

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

Environmental data	
Application date	July 27, 1999
Application time	1:00 PM
Air temperature, F	78
Relative humidity, %	69
Wind speed, mph	0 to 5

Application date	species	growth stage	height (in.)
July 27, 1999	CHRLE	Full Bloom	12 to 27

Table 2. Oxeye daisy control on Colorado rangeland.

Herbicide[a]	Rate (OZ A/A)	Oxeye Daisy Control (%)		Grass Injury (%)
		September 1999	July 2000	July 2000
Metsulfuron	0.3	73	100	3
	0.45	81	100	4
	0.6	84	100	3
Metsulfuron + Nitrogen fertilizer	0.45 + 32	80	100	4
Picloram	4	53	74	4
Clopyralid + 2,4-D amine	0.38 + 2	30	13	5
	0.77 + 4	41	23	0
	1.52 + 7.9	55	54	0
Imazapic	8	58	54	36
2,4-D amine	16	45	16	0
	32	54	36	0
Nitrogen fertilizer	32	0	0	0
LSD (0.05)		10	10	7

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

Perennial pepperweed and Canada 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 near Longmont, CO to evaluate perennial pepperweed (LINVU) and Canada thistle (CIRAR) control with prosulfuron plus primisulfuron, metsulfuron, triasulfuron, dicamba, glyphosate, glyphosate plus 2,4-D amine, and their combinations. The experiment was designed as a randomized complete block with four replications.

Herbicides were applied on June 28, 1999 when LEPLA was in the early flower growth stage and CIRAR growth stage ranged from bolting to early flower. 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 made on August 5, 1999, approximately 90 days after treatment (DAT) and June 19, 2000, approximately 1 year after treatment (YAT). Metsulfuron alone or tank mixed, prosulfuron plus primisulfuron plus glyphosate, and triasulfuron plus glyphosate provided the best control of both LEPLA and CIRAR (75 to 98%) 90 DAT. At approximately 1 YAT these same herbicides provided 60 to 96% control of both LEPLA and CIRAR. Metsulfuron alone performed as well as metsulfuron tank mixes. Prosulfuron plus primisulfuron or triasulfuron tank mixed with dicamba or glyphosate provided 75 to 100% LEPLA and CIRAR control, while these same herbicides applied alone provided only 12 to 36% control.

Table 1. Perennial pepperweed and Canada thistle control on Colorado rangeland.

Environmental data	
Application date	June 28, 1999
Application time	1:30 PM
Air temperature, F	81
Relative humidity, %	36
Wind speed, mph	0 to 5

Application date	species	growth stage	height (in.)
June 28, 1999	LEPLA	early flower	42 to 54
	CIRAR	bolt to early flower	24 to 42

Table 2. Perennial pepperweed and Canada thistle control on Colorado rangeland.

Herbicide	Rate	Perennial Pepperweed Control (%)			Canada thistle Control (%)		
	(oz/A)	September 1999	June 2000	September 2000	September 1999	June 2000	September 2000
Prosulfuron + Primisulfuron	1 + 1	79	49	40	18	12	6
Prosulfuron + Primisulfuron + Dicamba	0.5 + 0.5 + 12.3	44	24	18	75	76	20
	1 + 1 + 12.3	66	53	43	98	99	56
Prosulfuron + Primisulfuron + Glyphosate	0.5 + 0.5 + 25	75	58	35	96	96	75
	1 + 1 + 25	81	60	49	84	81	54
Dicamba	12.3	5	0	0	78	62	19
Glyphosate	25	58	21	21	78	68	25
Metsulfuron	0.5	93	74	74	76	65	38
Metsulfuron + Dicamba	0.5 + 12.3	83	64	64	75	73	46
Metsulfuron + Glyphosate	0.5 + 25	93	76	74	100	78	74
Triasulfuron	0.6	49	18	9	11	36	26
Triasulfuron + Dicamba	0.6 + 12.3	64	45	41	85	88	76
Triasulfuron + Glyphosate	0.6 + 25	75	63	54	99	100	89
Prosulfuron + Primisulfuron + Triasulfuron	1 + 1 + 0.6	94	71	48	63	58	58
Glyphosate + 2,4-D	6 + 9.6	66	33	24	41	14	6
Glyphosate + 2,4-D	8.1 + 13	70	51	43	51	39	28
Triasulfuron + Glyphosate + 2,4-D	0.3 + 6 + 9.6	70	59	53	65	43	14
LSD (0.05)		19	24	27	22	38	36

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 near 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 stages. 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 made in July and August 1999, 42 and 80 days after treatments (DAT) were applied and in October 2000, approximately 14 months after treatments (MAT) were applied. Herbicide treatments that contained dicamba controlled ONRAC faster than others. For example, ONRAC control from metsulfuron was 58% whereas metsulfuron plus dicamba controlled 78% of ORNAC 42 DAT. Both treatments controlled 100% of ONRAC 2 MAT. All treatments except prosulfuron plus primisulfuron applied alone (1 oz + 1 oz A/A) controlled 98 to 100% of ONRAC 1 MAT and all treatments controlled 76 to 100% of ONRAC approximately 14 MAT. Scotch thistle was very susceptible to control from all the treatments used in this study.

Table 1. Application data for Scotch thistle 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 1999	August 1999	October 2000
Triasulfuron	0.6	45	98	88
Triasulfuron + Dicamba	0.6 + 8.0	61	100	76
Triasulfuron + Imazapic + Dicamba	0.6 + 4.0 + 8.0	75	100	99
Prosulfuron[b] + Primisulfuron	1.0 + 1.0	46	55	99
Prosulfuron[b] + Primisulfuron + Dicamba	1.0 + 1.0 + 8.0	73	100	99
Prosulfuron[b] + Primisulfuron + Imazapic + Dicamba	1.0 + 1.0 + 4.0 + 5.3	66	100	100
Triasulfuron[c] + Dicamba + Metsulfuron	0.6 + 2.4 + 1.0	56	100	100
Metsulfuron	1.0	58	100	100
Metsulfuron + Dicamba	1.0 + 8.0	78	100	100
Metsulfuron + Imazapic + Dicamba	1.0 + 4.0 + 5.3	73	100	99
Prosulfuron[b] + Primisulfuron + Triasulfuron	1.0 + 1.0 + 0.6	48	98	100
Control		0	0	0
LSD (0.05)		8	6	10

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

Yellow toadflax control 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 Camp Hale, CO in 1998 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 in the 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 made on July 29, 1999 and August 9, 2000, approximately 1 and 2 years after treatment (YAT). It took at least 1.0 lb ai/A of picloram alone or in combination to achieve greater than 74% LINVU control approximately 1 or 2 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 and 2 YAT (94%). Grass injury increased as the rate of picloram increased (9 to 35%) 1 YAT but recovered 2 YAT. LINVU was controlled poorly (0 to 8%) by chlorflurenol or fluroxypyr alone or in combination with each other.

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 (lb ai/A)	Yellow toadflax Control (%) July 1999	Yellow toadflax Control (%) August 2000	Grass Injury (%) July 1999	Grass Injury (%) August 2000
Picloram	0.5	68	68	16	0
	1.0	89	83	29	0
	2.0	99	94	35	0
Picloram + chlorflurenol	0.5 + 0.13	54	35	9	0
	0.5 + 0.25	39	38	13	0
	1.0 + 0.25	74	80	19	0
	1.0 + 0.5	88	84	25	0
Picloram[a] + 2,4-D	0.5 + 2.0	64	63	20	0
Picloram[a] + 2,4-D + Chlorflurenol	0.5 +2.0 +0.25	61	55	16	0
Fluroxypyr	0.25	8	5	0	0
	0.5	8	3	0	0
Fluroxypyr + Chlorflurenol	0.25 + 0.07	0	0	0	0
Fluroxypyr + Chlorflurenol	0.25 + 0.13	0	0	0	0
Chlorflurenol	0.07	9	9	0	0
	0.13	0	0	0	0
	0.25	0	0	0	0
	0.5	0	0	0	0
LSD (0.05)		14	15	7	0

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

Management of four brush species with various herbicides. Tom D. Whitson. (Department of Plant Sciences, University of Wyoming, Laramie, WY, 82071-3354) Four species of brush are highly competitive with desirable perennial grasses and forbs on rangeland near Saratoga, Wyoming. They include: Big sagebrush (*Artemisia tridentata* Nutt.), silver sagebrush (*Artemisia cana* Pursh), grey rabbitbrush (*Chrysothamnus nauseosus* (Pallas) Britt. and Douglas rabbitbrush (*Chrysothamnus viscidiflorus* (Hook.) Nutt. Various triclopyr, fluroxypyr, 2,4-D and metsulfuron treatments were applied to actively growing brush species on June 4, 1999. Evaluations were made Sept. 21, 2000. Brush species were rapidly growing with excellent conditions at the time of application. Applications of 30 gpa were made to 10 by 27 ft plots with four replications. Air temperatures were 60°F while soil temperatures ranged from 70°F on the surface to 27°F at a 4-inch depth. Soils had 3.8% organic matter, a 6.5 pH with 70% sand, 18% silt and 12% clay. Individual brush species were counted within plots before application and were compared to counts a year later for percent control. No herbicide or herbicide combination provided effective control for silver sagebrush, grey rabbitbrush or Douglas rabbitbrush. Triclopyr at 0.75 lb/A and 2,4-D LVE at 2.0 lb/A were the only treatments that provided greater than 85% big sagebrush control. (Published with the approval of the Wyoming Agricultural Experiment Station).

Treatment	Rate	% control			
		Big sagebrush	Silver sagebrush	Grey rabbitbrush	Douglas rabbitbrush
	lb/A	%			
Triclopyr (Remedy)	0.5	62	18	0	6
Fluroxypyr	0.13	42	7	0	5
Fluroxypyr	0.25	50	0	0	0
Fluroxypyr	0.30	50	0	8	0
Triclopyr (Garlon GS)	0.5	70	25	0	23
Triclopyr (Garlon GS)	0.75	85	6	0	7
Triclopyr (Garlon GS)	1.0	33	7	0	7
Triclopyr (Remedy)	0.5	70	0	0	44
2,4-D (LVE)	0.5	45	0	0	0
2,4-D (LVE)	2.0	88	15	0	0
Fluroxypyr (Plenum)	0.38	62	8	0	0
Metsulfuron + Act. 90	.3 oz + .5%	50	0	10	0
Check	-	0	0	0	0

Tolerances of six cool-season perennial grasses to diflufenzopyr and quinclorac. Tom D. Whitson and Summer P. Alger. (Department of Plant Sciences, University of Wyoming, Laramie, WY 82071-3354) Before diflufenzopyr or quinclorac can be applied to pastures or rangeland, tolerances to various cool-season perennial grasses must be determined. Six grasses chosen for this study included: Meadow brome (Regar), sheep fescue (Covar), green-needlegrass (Lodorn), orchardgrass (Paiute), western wheatgrass (Rosana), Russian wildrye (Bozoisky). Trials were established May 9, 2000 on perennial grasses established in 1997 at the Torrington, Wyoming Research and Extension Center. Soils were sandy loam, 0.9% organic matter, 7.5 pH, 64% sand, 24% silt and 12% clay. Herbicides were applied in calm conditions to 10 by 24 ft plots with three replications. Soil temperatures were 60°F on the surface and 55°F at a 4-inch depth. Evaluations were made on July 9, 2000. All grasses had little injury when diflufenzopyr or quinclorac were applied alone, but when quinclorac and diflufenzopyr were combined at 1.5 lb ai/A and 0.7 lb ai/A all grasses had injury ratings between 20 and 33%. (Published with the approval of the Wyoming Agricultural Experiment Station).

Treatment	Rate	% injury					
		Meadow brome	Sheep fescue	Green-needlegrass	Orchard grass	Western wheatgrass	Russian wildrye
	lb/A	%					
quinclorac + MSO	.75 + 32 oz	0	0	0	15	17	0
quinclorac + MSO	1.5 + 64 oz	0	0	0	0	0	0
diflufenzopyr + MSO	0.35 + 32 oz	0	0	0	0	6	0
diflufenzopyr + MSO	0.70 + 64 oz	0	0	0	0	6	0
quinclorac + diflufenzopyr + MSO	.75 + .35 + 32 oz	0	0	0	0	0	0
quinclorac + diflufenzopyr + MSO	1.5 + .7 + 64 oz	33	30	20	28	25	18
Check	-	0	0	0	0	0	0

Evaluation of herbicides for total vegetation control. Rodney G. Lym and Katheryn M. Christianson. (Department of Plant Science, North Dakota State University, Fargo, ND 58105). Total vegetation weed control (bare ground) is desirable around such areas as industrial sites, storage buildings, and utility areas. The purpose of this research was to evaluate established and recently labeled herbicides for long-term total vegetation management.

The experiment was established along a railroad right-of-way in West Fargo, ND, on May 26, 1999. The plot area was beneath an abandoned communications line and contained a variety of weed species including bluegrass, smooth bromegrass, leafy spurge, western snowberry, Canada thistle, wild rose, goldenrod, common milkweed, and young (< 2 feet tall) willows. The herbicides were applied using a hand-held boom sprayer delivering 8.5 gpa at 35 psi. The plots were 10 by 30 feet and treatments were replicated four times in a randomized complete block design. The air temperature was 66 F, the dew point 54 F, and the soil temperatures at the 1 and 4 inch depth was 70 and 62 F, respectively. Total vegetation control was evaluated by visually comparing the amount of bareground in each plot to the border strips between plots. The effect of the various herbicides on individual species was noted.

Treatment	Rate	Bare ground Aug 99	May 00	Sept 00	Comments[c]
	——lb/A——	———	%	———	
Imazapyr + diuron[a] + MSO[b]	1 + 8.1 + 1 qt	82	77	60	Ex on *Poa*, fair to good control of bl.
Imazapyr + X-77	1 + 0.25%	88	82	64	Ex on *Poa*, weak on Canada thistle
Diuron	8	13	20	13	Very weak on all bl.
Diuron	16	19	71	31	Ex on *Poa* but little bl control
Bromacil	8	45	88	63	Ex on *Poa* but weak on all bl except willow.
Tebuthiuron	4	13	89	63	Ex grass but poor on all bl.
Chlorsulfuron	0.125	0	0	0	
Azafenidin	0.5	0	0	0	
LSD (0.05)		13	26	25	

[a] Commercial formulation - Sahara, American Cyanamid Co, Princeton, NJ (now BASF).
[b] Methylated seed oil was Sunit by AGSCO, Grand Forks, ND.
[c] Abbreviations: ex = excellent, bl = broadleaf species.

Treatments that contained imazapyr provided the greatest bare ground weed control and reduced leafy spurge, western snowberry, and wild rose by greater than 80% but did not control Canada thistle. Tebuthiuron provided excellent grass control but only slightly suppressed the broadleaf species present. Diuron and bromacil controlled grass species but generally did not reduce the broadleaf species, except bromacil did kill willow. Chlorsulfuron and azafenidin did not provide total vegetation control.

Yellow starthistle control. Joseph P. Yenish, John D. Toker, and Nichole A. Eaton. (Washington State University, Pullman, WA 99164-6420) A study was established in March 2000 to evaluate control of yellow starthistle by several herbicides. The study was conducted in a noncrop area on a south-facing slope along the breaks of the Snake River near Wawawai, WA. The study was designed as a randomized complete block with 4 replications. All herbicides were applied using a CO_2 backpack sprayer calibrated to deliver 10 gallons per acre at 35 psi. PRE and POST herbicides were evaluated. PRE applications were made prior to yellow starthistle emergence on March 10 and POST applications were made following complete yellow starthistle emergence on May 1. Visual estimation of yellow starthistle control was made on the dates listed in the table below.

PRE applications of DPX-R6447 provided less control of yellow starthistle than the standard treatments of POST 2,4-D, picloram, or chlorsulfuron. Yellow starthistle control improved substantially when DPX-R6447 was combined with bromacil plus diuron, but was not greater than bromacil plus diuron without DPX-R6447. POST applications of quinclorac, BAS 662 01H, and the combination of these two herbicides provided greater control than chlorsulfuron on the September 6 rating with control ratings on this date being not different than POST 2,4-D ester, picloram, or clopyralid and PRE applications of bromacil plus diuron and combinations including bromacil plus diuron.

Table. Yellow starthistle control.

Treatment	Rate	Timing	Yellow starthistle control			
			4/19/00	5/23/00	6/30/00	9/6/00
	lb/A		%			
DPX-R6447	0.2	PRE	33	25	23	21
DPX-R6447	0.3	PRE	43	30	45	38
DPX-R6447	0.4	PRE	26	28	21	18
DPX-R6447	0.5	PRE	45	19	29	31
Bromacil + diuron	3.2 + 3.2	PRE	96	89	89	94
DPX-R6447 + bromacil + diuron	0.2 + 3.2 + 3.2	PRE	96	90	91	96
DPX-R6447 + bromacil + diuron	0.3 + 3.2 + 3.2	PRE	96	90	90	95
DPX-R6447 + bromacil + diuron	0.4 + 3.2 + 3.2	PRE	97	91	91	97
DPX-R6447 + bromacil + diuron	0.5 + 3.2 + 3.2	PRE	96	93	95	94
Sulfometuron + bromacil + diuron	0.14 + 3.2 + 3.2	PRE	97	95	92	93
2,4-D ester	1	POST	NA[a]	76	53	84
Picloram	0.375	POST	NA	76	95	97
Chlorsulfuron[a]	0.07	POST	NA	46	64	60
Clopyralid	0.375	POST	NA	78	96	97
Quinclorac[c]	0.375	POST	NA	46	86	92
BAS 662 01H[c]	0.35	POST	NA	73	91	95
Quinclorac + BAS 662 01H[c]	0.375 + 0.175	POST	NA	59	86	95
Quinclorac + BAS 662 01H[c]	0.375 + 0.263	POST	NA	85	84	95
Quinclorac + BAS 662 01H[c]	0.375 + 0.35	POST	NA	64	83	95
LSD (p=0.05)			16	17	23	21

[a]NA- POST applications not completed prior to this evaluation.
[b]applied with 0.25% v/v nonionic surfactant.
[c]applied with 1.0% v/v methylated seed oil.

PROJECT 2: WEEDS OF HORTICULTURAL CROPS

Ed Peachy, Chair

Evaluation of new postemergence herbicides in cantaloupes. Kai Umeda and Nell Lund. (University of Arizona Cooperative Extension, Maricopa County, Phoenix, AZ 85040) A small plot field experiment was established at the University of Arizona Maricopa Agricultural Center, Maricopa, AZ. Cantaloupe cv. Topmark was planted on 17 April 2000 in a single seedline on every other row of 40-inch shaped beds that were furrow irrigated. Plots consisted of a single bed measuring 50 ft long, and each treatment was replicated four times. Postemergence herbicide treatments were applied on 09 May. All treatments were applied using a CO_2 backpack sprayer equipped with a hand-held boom consisting of four 8002 flat fan nozzle tips spaced 20 inches apart. All treatments were applied in 25 gpa water pressurized to 30 psi. Halosulfuron treatments included methylated seed oil at 1% v/v and Embrace (ammonium sulfate) at 5% v/v. Rimsulfuron, flumetsulam, and thifensulfuron treatments included the non-ionic surfactant Latron CS-7 at 0.25% v/v. Cantaloupes were at the 3-leaf stage of growth when treatments were applied. Weeds present were tumble pigweed at the 5 to 6 leaf stage, Palmer amaranth at the 5 to 9 leaf stage, prostrate pigweed at the 6 to 7 leaf stage, narrowleaf lambsquarters at the 5 to 8 leaf stage, 3 to 6 inch diameter purslane, Wright's groundcherry at 1 to 3 inches height, and purple nutsedge at the 6 to 8 leaf stage. At the time of POST applications, the temperature was 92 F and there was a very slight breeze at less than 3 mph. Crop injury and weed control were evaluated visually at 9 and 43 days after treatment (DAT).

Halosulfuron applied POST with an adjuvant and ammonium sulfate was effective against lambsquarters and nutsedge. Rimsulfuron at 0.01 lb/A and 0.02 lb/A at 43 DAT gave good control and showed a rate response against pigweeds. Rimsulfuron at 0.02 lb/A gave acceptable control of purslane but did not control lambsquarters. Thifensulfuron at 0.002 lb/A was effective against the pigweeds and at 0.004 lb/A against purslane. Thifensulfuron was not very active against lambsquarters. Flumetsulam at 0.02 lb/A gave good control of Palmer amaranth and prostrate pigweed but did not adequately control tumble pigweed, lambsquarters, and purslane. Halosulfuron and rimsulfuron were safe on melons and flumetsulam and thifensulfuron were marginally safe on cantaloupes. The combinations of these products may offer broader spectrum weed control. Halosulfuron with efficacy against purple nutsedge and lambsquarters could possibly be combined with rimsulfuron, thifensulfuron, and flumetsulam to complete weed control against pigweeds and purslane.

Table. Evaluation of new postemergence herbicides for weed control 9 and 43 DAT in cantaloupes.

Herbicide	Rate	Crop injury	Weed control						
			AMAAL	AMAPA	AMABL	CHEPR	POROL	PHYWR	CYPRO
	lb/A	%							
9 DAT									
Untreated check	-	0	0	0	0	0	0	0	0
Halosulfuron	0.032	0	0	0	0	87	0	0	85
Halosulfuron	0.047	2	0	0	0	81	6	0	83
Rimsulfuron	0.01	0	19	28	19	13	13	0	80
Rimsulfuron	0.02	2	81	81	86	13	31	0	0
Flumetsulam	0.01	14	84	61	84	38	75	0	52
Flumetsulam	0.02	15	88	88	88	60	64	0	28
Thifensulfuron	0.002	21	93	94	92	66	74	0	17
Thifensulfuron	0.004	23	93	93	93	58	81	0	38
LSD (p=0.05)		7	20	30	19	38	30	0	56
43 DAT									
Untreated check	-		0	0	0	0	0	0	0
Halosulfuron	0.032		38	43	73	83	13	0	99
Halosulfuron	0.047		44	48	73	76	13	0	99
Rimsulfuron	0.01		85	69	89	25	48	48	0
Rimsulfuron	0.02		86	94	91	0	86	75	0
Flumetsulam	0.01		63	71	75	49	30	13	0
Flumetsulam	0.02		74	97	85	64	56	30	0
Thifensulfuron	0.002		89	96	92	54	64	0	0
Thifensulfuron	0.004		96	96	97	0	96	0	0
LSD (p=0.05)			26	36	11	30	39	32	0

Evaluation of preemergence herbicides for weed control in cantaloupes. Kai Umeda and Nell Lund. (University of Arizona Cooperative Extension, Maricopa County, 4341 E. Broadway, Phoenix. AZ 85040) A small plot field experiment was established at the University of Arizona Maricopa Agricultural Center, Maricopa, AZ. Cantaloupe cv. Topmark was planted on 17 April 2000 in a single seedline on every other row of 40-inch shaped beds that were furrow irrigated. Plots were a single bed measuring 45 ft long and each treatment was replicated four times. Preemergence herbicide treatments were applied immediately after planting on 17 April. All treatments were applied using a CO_2 backpack sprayer equipped with a hand-held boom consisting of four 8002 flat fan nozzle tips spaced 20 in apart. All treatments were applied in 25 gpa water pressurized to 30 psi. At the time of applications, the temperature was 8O F with only a very slight breeze at about 5 mph. The soil was dry and the temperature below the surface was 72 F. Crop injury and weed control were evaluated visually following applications at 3 weeks after treatment (WAT).

All herbicide treatments, bensulide, dimethenamid, s-metolachlor, flumioxazin, and bensulide combined with *s*-metolachlor or dimethenamid caused less than 10% injury on cantaloupes. Dimethenamid at 0.75 lb/A, s-metolachlor at 1.0 lb/A, flumioxazin at 0.03 and 0.05 lb/A controlled weeds similar to bensulide. Bensulide at 4.0 lb/A combined with dimethenamid at 0.38 lb/A or s-metolachlor at 0.5 lb/A controlled tumble pigweed (89% and 94%, respectively), narrowleaf lambsquarters (95%), Wright's groundcherry (97%), and horse purslane (94%). None of the preemergence herbicide treatments controlled purple nutsedge.

Table. Evaluation of preemergence herbicides for weed control in cantaloupes.

Treatment	Rate	Crop injury	Weed Control				
			AMAAL	CHEPR	PHYWR	TRTPO	CYPRO
	lb/A	%			%		
Untreated check		0	0	0	0	0	0
Bensulide	6.0	3	88	9.1	94	96	0
Dimethenamid	0.5	1	84	88	95	75	0
Dimethenamid	0.75	9	86	9.1	95	88	0
S-metolachlor	0.75	5	88	89	95	79	0
S-metolachlor	1.0	4	91	89	97	89	0
Flumioxazin	0.03	4	8.1	90	93	88	0
Flumioxazin	0.05	4	83	85	91	76	0
Bensulide + s-metolachlor	4.0 0.5	8	89	95	97	91	0
Bensulide + dimethenamid	4.0 0.38	5	94	95	97	94	0
LSD (p=0.05)		7.1	7.2	7.4	6	16.7	0

Screening new herbicides for cantaloupe and watermelon. Kai Umeda, Dudley MacNeil, Nell Lund, and Desiree 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 31 May 2000, preemergence (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. The sprays were applied in 24 gpa water pressurized to 30 psi. At the time of PREE applications, the weather was clear with an air temperature of 94 F and there was a very slight breeze. The soil was dry and the soil surface temperature was 88 F. The field was irrigated after herbicide applications on the same day. Postemergence (POST) herbicide applications were made on 15 June with the same equipment and delivery system that was used for the PREE applications. An adjuvant, Latron CS-7 at 0.25% v/v was added to all POST treatments. The cantaloupe and watermelon were at the1 to early 2-leaf stage of growth and Palmer amaranth was the predominant weed at the 4 to 5 leaf stage. The air temperature was 94'F, the sky was clear, and there was no wind during the POST applications. Crop safety and weed control were visually evaluated at 2 weeks after treatment (WAT) for the PREE treatments and I WAT for the POST treatments. Acceptable weed control was measured as better than 80% control and acceptable crop safety was measured as less than 30% injury. The safe rate for each herbicide on cantaloupe and watermelon and effective weed control rate was calculated from distances that were measured between the beginning of each plot to the point of observed crop safety or weed control.

In the PREE test, azafenidin, flufenacet, thiazopyr, isoxaben, dithiopyr, and thifensulfuron exhibited safety on cantaloupes and watermelon at rates higher than rates required for effective weed control. MKH-6561 and CGA-362622 applied PREE were not safe on the melons at rates that provided acceptable weed control. In the POST test, the difference in rates that were safe on melons and rates that gave acceptable weed control was small for MKH-6561, flufenacet, and thifensulfuron. Azafenidin, thiazopyr, isoxaben, and pyrithiobac did not demonstrate adequate melon safety at rates required for acceptable weed control. These 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	Start Rate	Safe Rate* (<30% injury) cantaloupe	Safe Rate* (<30% injury) watermelon	Weed Control Rate (>80%)
	lb/A			
Azafenidin	0.05	0.025	0.025	0.012
MKH-6561	0.04	0.009	0.009	0.03
Flufenacet	0.6	0.25	0.25	<0.06
Thiazopyr	1.0	0.25	0.22	0.14
CGA-362622	0.03	<0.003	<0.003	0.004
Isoxaben	1.0	0.79	0.84	0.4
Dithiopyr	0.25	0.07	0.07	0.05
Thifensulfuron	0.002	0.002	0.002	0.0017

Table 2. Postemergence herbicide screening test for cantaloupe and watermelon

Herbicide	Start Rate	Safe Rate* (<30% injury) cantaloupe	Safe Rate* (<30% injury) watermelon	Weed Control Rate (>80%)
	lb/A			
Azafenidin	0.05	0.005	0.009	0.01
MKH-6561	0.04	0.008	0.004	0.004
Flufenacet	0.6	0.5	0.19	0.4
Thiazopyr	1.0	0.37	0.25	0.76
CGA-362622	0.03	<0.003	<0.003	<0.003
Isoxaben	1.0	0.46	0.46	0.83
Thifensulfuron	0.002	0.0005	0.0005	0.0003
Pyrithiobac	0.094	<0.01	<0.01	0.017

Herbicides for weed control in green pea. Timothy W. Miller and Carl R. Libbey. Washington State University, Mount Vernon, WA 98273. Several herbicides were tested for efficacy and crop safety to green peas in 2000 at the WSU Mount Vernon Research and Extension Unit. 'Charo' green peas were used for two herbicide studies. The first study evaluated efficacy and crop safety of new and currently-registered herbicides. The second study evaluated the effect of several herbicides on *Polygonum* species (pale smartweed and prostrate knotweed). Weed species in all plots included henbit, common chickweed, common groundsel, shepherd's-purse, Powell amaranth, common lambsquarters, prostrate knotweed, and pale smartweed.

Herbicide trial. Plots measured 10 by 20-ft and were seeded May 24. Preemergence (PRE) and postemergence (POST) treatments were applied June 1 and June 17, respectively. Pea plants were at the 5-leaf stage at the time of the POST application. All herbicide treatments were applied using a tractor-mounted sprayer delivering 29.7 gpa at 15 psi (Table 1). Crop injury and general weed control was visually estimated July 6 and August 8. A 1-m^2 quadrat was placed within each plot August 9, and pea plants in the quadrat were counted, and yield components determined. Plots with < 50% weed control were not harvested. 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.

Table 1. Application data, herbicide trial.

Date:	7:50 a.m., June 1, 2000	6:00 a.m., June 17, 2000
Type:	Broadcast, preemergence	Broadcast, postemergence
Crop stage:	—	4 to 5 leaves
Weed stage:	—	4 to 6 in.
Cloud cover:	10%	75%
Winds:	2 to 4 mph from NE	0 to 2 mph from S
Air temp.:	14 C	17 C
Soil temp (4"):	13 C	16 C
Relative humidity:	89%	85%
Comments:	No dew; soil wet	Dew present; soil damp

Polygonum trial. Plots measured 10 by 20-ft and were seeded June 2. PRE and POST treatments were applied June 10 and July 8, respectively. Pea plants were at the 9-leaf stage at the time of the POST application. All herbicide treatments were applied using a tractor-mounted sprayer delivering 29.7 gpa at 15 psi (Table 2). Crop injury and general weed control was visually estimated July 6 and August 8. A 1-m^2 quadrat were placed within each plot August 11, and pea plants in the quadrat were counted, and yield components determined. Plots with < 50% weed control were not harvested. 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.

Table 2. Application data, *Polygonum* trial.

Date:	8:45 a.m., June 2, 2000	7:15 a.m., June 10, 2000	9:30 a.m., July 8, 2000
Type:	Broadcast, preplant incorporated	Broadcast, preemergence	Broadcast, postemergence
Crop stage:	—	—	8 to 9 leaves
Weed stage:	—	—	to 12 in.
Cloud cover:	100%, overcast	75%	100%, overcast
Winds:	2 to 3 mph from SE	5 to 7 mph from S	0 to 2 mph from S
Air temp.:	14 C	12 C	18 C
Soil temp (4"):	14 C	14 C	9 C
Relative humidity:	86%	80%	84%
Comments:	No dew; soil wet	No dew; soil wet	No dew; soil damp

Results.

Herbicide trial. Crop injury from these herbicides was generally low, with three exceptions: pyrithiobac, flumioxazin, and chloransulam, which caused severe injury to peas (Table 3). Of products appearing safe for peas, weed control was maximized by metribuzin + flufenocet (PRE), which was still providing 95% weed control in early August. Early-season weed control and crop safety was good for flumetsulam, metribuzin + flufenocet (POST), imazamox + bentazon + 32-0-0, and bentazon + acifluorfen.

Polygonum trial. Late-season weed control and crop safety from clomazone + metribuzin, pendimethalin, pronamide, and metribuzin + bentazon (PRE + POST) was excellent (Table 4). Control of *Polygonum* species by these treatments was also excellent. Other products with good to excellent early-season weed control were flumetsulam + S-metolachlor, lactofen, and isoxaben, although lactofen caused 24% injury to treated peas. Yield was maximized by clomazone + metribuzin and pronamide.

Table 3. Crop injury and weed control in green peas treated with several herbicides and herbicide combinations.

Treatment[a]	Timing[b]	Rate	Crop injury	Weed control 7/6	Weed control 8/8	Plant pop.[c]	Pods/ plant	Yield
		lb/a	%	%	%			tons/a
metribuzin + flufenocet	PRE	0.75	13	100	95	1.92	5.3	2.7
flumetsulam	PRE	0.055	8	88	60	1.34	5.4	1.7
chloransulam	PRE	0.032	29	89	43	—	—	—
dimethenamid	PRE	1	8	50	3	—	—	—
flumioxazin	PRE	0.07	59	100	98	1.06	5.9	1.7
metribuzin + flufenocet	POST	0.5	3	84	65	1.46	5.9	2.0
imazamox + bentazon	POST	0.032 + 0.25	4	76	35	—	—	—
+ 32-0-0 + nis	POST	+ 1% + 0.25%						
imazamox + bentazon	POST	0.032 + 0.25	0	84	58	1.98	5.9	2.9
+ 32-0-0	POST	+ 1%						
imazamox + 32-0-0	POST	0.032 + 1%	4	73	39	—	—	—
imazamox + nis	POST	0.032 + 0.25%	9	71	38	—	—	—
bentazon + 32-0-0	POST	0.25 + 1%	0	53	9	—	—	—
bentazon + acifluorfen	POST	0.25 + 0.11	5	80	49	—	—	—
pyrithiobac	POST	0.0638	81	94	26	—	—	—
flumiclorac	POST	0.0806 + 1.25%	0	14	3	—	—	—
Untreated check	—	—	0	0	0	1.57	5.7	2.0
$LSD_{0.05}$	—	—	9	12	18	0.26	ns	0.9

[a]metribuzin + flufenocet prepackaged mixture, 13.6% + 54.4%; 32-0-0 = liquid fertilizer (URAN), nis = nonionic surfactant (R-11).
[b]PRE = preemergence; POST = postemergence.
[c]Pea plants per acre (x 100,000).

Table 4. Crop injury and weed control in green peas treated with several herbicides and herbicide combinations.

Treatment	Timing[a]	Rate	Crop injury	Weed control 7/6	Weed control 8/8	*Polygonum* control	Plant pop.[b]	Pods/ plant	Yield
		lb/a	%	%	%	%			tons/a
clomazone + bentazon	PPI + POST	0.125 + 0.5	0	43	70	89	2.35	3.9	2.1
clomazone + metribuzin	PPI + POST	0.125 + 0.125	0	38	89	93	2.81	4.5	2.9
trifluralin	PPI	0.75	1	78	61	74	—	—	—
ethalfluralin	PRE	0.75	1	56	40	44	2.15	3.3	1.2
pendimethalin	PRE	0.75	1	97	97	100	2.28	4.3	2.0
flumetsulam + S-metolachlor	PRE	0.0328 + 0.0765	11	100	71	68	2.67	3.2	1.9
alachlor	PRE	2	4	80	36	46	—	—	—
lactofen	PRE	0.2	24	94	76	85	2.03	4.0	1.2
napropamide	PRE	2	0	63	35	40	—	—	—
pronamide	PRE	1	0	94	88	100	2.31	4.8	2.8
isoxaben	PRE	0.4	8	84	56	56	2.37	3.5	1.4
trifluralin + isoxaben	PRE	0.5 + 0.124	0	56	34	30	—	—	—
metribuzin + bentazon	PRE + POST	0.2 + 0.5	0	100	99	100	2.27	4.9	2.3
metribuzin + bentazon	POST	0.125 + 0.25	0	14	79	96	1.86	3.7	2.1
Untreated check	—	—	0	0	0	0	1.57	3.2	1.7
$LSD_{0.05}$	—	—	4	15	18	21	0.94	1.0	0.9

[a]PPI = preplant-incorporated; PRE = preemergence; POST = postemergence.
[b]Pea plants per acre (x 100,000).

Potato vine desiccation, Dawson, ND. Scott A. Fitterer and Richard K. Zollinger. (Department of Plant Sciences, North Dakota State University, Fargo, ND 58105). An experiment was conducted to evaluate potato vine desiccation from labeled and experimental herbicides. 'Russet Burbank' potato was planted May 12, 2000. Herbicides to desiccate potato vines were applied September 6 at 12:00 noon with 80 F, 54% RH, no cloud cover, no dew, and 5-10 mph SE wind to vines at the beginning of natural senescence (BNS). Sequential treatments were applied on September 13 at 10:00 am with 60 F, 68% RH, 100% cloud cover, light mist, and 3-5 mph NW wind seven days after the BNS applications (BNS+7 DAT). Treatments were applied to the center two rows of the four row 12 by 25 ft plots with a back-pack sprayer 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 study was terminated on September 24 due to a 24 F freeze. Diquat at 0.25 lb/A applied on a 7 day split is considered a standard vine kill treatment. Treatments which were not as effective as the diquat standard included glufosinate, F8426, GX-550, GX-685, and GX-471. The addition of fungicides, with the exception of propanocarb plus chlorothalonil, tended to decrease the effectiveness of glufosinate. F8426 performance was improved with the addition of Scoil compared to Silwet. The addition of endothall helped to increase the desiccation of the F8426 treatment. GX-550 and GX-685 were not antagonized by the addition of triphenyltin hydroxide.

Treatments which were as effective as the standard two applications of diquat include endothall and paraquat. Endothall at 0.75 lb/A with the addition of AMS and LI-700 or Scoil increased the initial speed of desiccation. Following endothall with a sequential application of diquat at 0.375 lb/A equalized all treatments. The edition of linuron or carfentrazone did not enhance the performance of paraquat.

Yields were not significantly different compared to the mechanically topped treatment. No stem end discoloration was found for any treatments at harvest. Field and hedge bindweed was found throughout the trial at time of treatment application. Bindweed populations did not effect herbicide performance. Endothall provided excellent desiccation of field and hedge bindweed (data not included).

Table. Potato vine desiccation, Dawson, ND.

		Desiccation														
		Sept 7		Sept 9		Sept 11		Sept 13		Sept 17		Sept 19		Sept 21		Oct 4
Treatment[a]	Rate	Stem	Leaf	Stem	Leaf	Stem	Leaf	Stem	Leaf	Stem	Leaf	Stem	Leaf	Stem	Leaf	Yield
	lb/A	%														cwt/A
BNS[b]																
Glufosinate+AMS	0.375	3	0	7	1	20	7	38	17	60	33	67	40	76	53	473
Glufosinate+AMS+Propanocarb& Chlorthalonil	0.375+1.82	2	0	6	1	23	7	40	17	67	38	72	52	81	60	479
Glufosinate+AMS+Triphenyl hyrdoxide	0.375+0.162	2	0	6	1	15	6	32	12	48	25	52	32	57	38	462
Glufosinate+AMS+Mancozeb	0.375+1.0	1	0	6	2	11	4	27	8	38	13	55	28	62	33	502
F8426+Scoil	0.025	2	0	6	4	12	5	22	9	33	14	37	20	37	20	508
F8426+Silwet	0.025	2	0	5	2	9	5	16	7	25	10	25	10	25	10	505
F8426+Scoil	0.0375	2	0	6	2	14	7	28	11	35	16	38	21	43	22	476
F8426+Silwet	0.0375	2	0	6	4	10	6	17	8	25	12	28	13	30	15	534
F8426+Scoil	0.05	3	0	8	3	15	5	25	11	35	14	35	14	35	14	534
F8426+Silwet	0.05	2	0	6	6	12	6	22	9	27	13	28	12	28	12	517
F8426+endothall+Scoil	0.025+0.25	2	0	7	3	15	5	25	12	40	19	52	32	52	33	491
F8426+endothall+Scoil	0.0375+0.25	3	0	7	4	14	6	23	10	40	17	48	25	50	25	485
F8426+endothall+Scoil	0.05+0.25	4	0	10	5	20	8	32	14	47	27	60	35	65	42	505
BNS/BNS+7 DAT																
Endothall/diquat+Act 90	0.75/0.375	2	0	7	2	13	5	22	8	72	45	87	58	95	75	468
Endothall+AMS/diquat+Act 90	0.75/0.375	4	0	11	4	23	8	33	12	87	60	92	70	98	91	427
Endothall+AMS+LI 700/diquat+Act 90	0.75/0.375	4	0	13	4	28	10	47	22	90	63	94	75	98	90	517
Endothall+AMS+Scoil/diquat+Act 90	0.5/0.375	2	0	9	2	17	8	27	12	82	47	88	68	98	82	508
Endothall+AMS+Scoil/diquat+Act 90	0.75/0.375	4	1	12	6	23	10	43	17	90	65	96	83	99	91	430
Diquat+Act 90/diquat+Act 90	0.375/0.375	4	0	11	5	25	8	40	15	73	43	90	60	96	80	450
Diquat+Act 90/diquat+Act 90	0.25/0.25	3	0	8	3	17	7	27	13	68	42	82	57	97	77	552
Paraquat+Act 90/paraquat+Act 90	4.63/4.63	2	0	9	5	27	12	40	18	82	50	90	73	98	88	468
Paraquat+linuron+Act 90/ paraquat+linuron+Act 90	4.63+0.0625/ 4.63+0.0625	4	0	10	5	30	13	45	22	83	50	93	78	97	95	418
Paraquat+carfentrazone+Act 90/ paraquat+carfentrazone+Act 90	4.63+0.01/ 4.63+0.01	3	1	11	5	37	12	50	23	90	63	96	85	99	94	491
GX-550+Herbimax/GX-550+Herbimax	0.021/0.021	3	1	8	4	15	6	25	10	45	20	65	40	73	43	462
GX-550+Herbimax+SuperTin/ GX-550+Herbimax+SuperTin	0.021+0.187/ 0.021+0.187	2	0	6	3	15	6	23	10	45	17	63	30	72	35	470
GX-685+Herbimax/GX-685+Herbimax	0.021/0.021	3	1	9	5	20	7	32	13	67	35	82	58	89	70	462
GX-685+Herbimax+SuperTin/ GX-685+Herbimax+SuperTin	0.21+0.187/ 0.21+0.187	3	1	8	5	18	6	30	13	67	38	82	52	89	67	491
GX-471/GX-471	38.5/38.5	0	0	0	0	6	1	11	4	27	11	43	22	57	33	418
Mechanically topped[c]		0	0	0	0	0	0	100	100	100	100	100	100	100	100	488
Untreated[d]		0	0	0	0	0	0	0	0	0	0	0	0	0	0	537
LSD (0.05)		2	1	4	3	5	5	7	7	9	8	8	10	10	11	120

[a]AMS = ammonium sulfate at 3 lb/A with glufosinate and 5 lb/A with endothall; Scoil is a methylated seed oil at 1 qt/A with F8426 and 24 oz/100 gal with endothall; Silwet is a surfactant with silicone at 1 pt/A; Act 90 = Activator 90 is a non ionic surfactant at 0.25% v/v; LI-700 is a non ionic surfactant at 32 oz/100 gal; and Herbimax is a petroleum oil at 0.5% v/v. Fungicide: Propanocarb&Chlorthalonil = Tattoo C, Triphenyl hydroxide = SuperTin, and Mancozeb = mancozeb.

[b]BNS = beginning of natural senescence.

[c]Plots were mechanically topped on September 13 to completely remove vines.

[d]Unntreated plots were mechanically topped just prior to harvest on October 4.

Potato vine desiccation with ET-751, Dawson, ND. Scott A. Fitterer and Richard K. Zollinger. (Department of Plant Sciences, North Dakota State University, Fargo, ND 58105). An experiment was conducted to evaluate potato vine desiccation from ET-751. 'Red Norland' potato was planted May 16, 2000. Herbicides that desiccate potato vines were applied August 17 at 10:00 am with 59 F, 97% RH, 100% cloud cover, dew present, and 5-10 mph NW wind to vines which were at the beginning of natural senescence (BNS). Sequential treatments were applied on August 23 at 10:30 am with 74 F, 40% RH, no cloud cover, no dew, and 2-4 mph SW wind seven days after the BNS applications (BNS+7 DAT). Treatments were applied to the center two rows of the four row 12 by 25 ft plots with a back-pack sprayer delivering 34 gpa at 40 psi through 8004 flat fan nozzles. The experiment had a randomized complete block design with three replicates per treatment.

Hedge and field bindweed infested the entire trial. ET-751gave complete control of bindweed. Diquat did not desiccate bindweed and reduced the overall activity as a vine desiccant. ET-751 applied at 0.009/0.009 lb/A had greater leaf and stem dessication than other treatments on August 28 and at later rating dates. Harvest is typically targeted for 10-14 days after vine kill treatment. For harvest 14 DAT (Sept. 6), stem desiccation was not complete and would interfere with harvest. Further vine desiccation did not increase on September 11 except diquat at 0.123 lb/A. In generally, leaf and stem dessication was not significantly different for ET-751 regardless of rate or application method when evaluated 14 days after application. However, speed of desiccation was faster and more effective when treatments were evaluated in 1998.

Table. Potato vine desiccation with ET-751.

		Desiccation											
		August 24		August 26		August 28		August 30		September 6		September 11	
Treatment[a]	Rate	Leaf	Stem	Leaf	Stem	Leaf	Stem	Leaf	Stem	Leaf	Stem	Leaf	Stem
	lb/A	%											
BNS/BNS+7 DAT													
ET-751/ET-751	0.0045/0.009	33	5	43	7	55	17	60	22	90	72	93	85
ET-751/ET-751	0.009/0.009	47	7	57	10	72	25	77	28	94	88	98	92
ET-751/diquat	0.0045/0.123	30	7	35	7	42	15	45	15	87	78	88	80
ET-751/diquat	0.009/0.123	37	7	43	8	53	17	57	22	82	73	88	78
BNS+7 DAT													
ET-751	0.018	10	0	33	5	55	12	63	18	93	85	96	90
Diquat	0.245	12	2	25	5	33	10	33	10	90	80	93	87
Diquat	0.123	7	0	12	3	17	5	18	5	47	48	72	55
Untreated		0	0	0	0	0	0	0	0	0	0	0	0
LSD (0.05)		7	3	8	5	9	9	8	7	8	10	9	11

[a]ET-751 was applied with Herbimax a petroleum oil at 1% v/v; diquat was applied with R-11 a non ionic surfactant at 1.5 pt/A.

Perennial weed control options for red raspberry. Diane Kaufman and Gina Koskela. (North Willamette Research and Extension Center, Oregon State University, 15210 N.E. Miley Rd., Aurora, OR 97002). Common and false dandelions can be serious weeds in red raspberries with a perennial grass strip between rows. Although dichlobenil provides effective control, grower concerns over cost and potential damage to plant vigor have necessitated the search for other control options for dandelions and other perennial weeds. The following herbicides were applied to an eight year old planting of 'Meeker' red raspberry in early April 2000: azafenidin; dichlobenil; dimethenamid; isoxaben; metolachlor; terbacil + napropamide (chemical control); and thiazopyr. Application was made with a CO_2 pressurized backpack sprayer, mounted with a single TeeJet, flat fan 8002 nozzle at 40 psi. Treatments were randomized in a complete block design with four replications. The objectives of the trial were to evaluate crop tolerance to selected herbicides at different rates and to evaluate herbicide effectiveness for control of common and false dandelion in the berry row.

Plant vigor was assessed by monitoring the growth of primocanes throughout the season; the number of primocanes per plant (five plants/plot) was recorded on May 2, 2000 and again after training on September 27, 2000. Herbicide effectiveness was assessed by counting the number of false and common dandelion plants in the berry row twice during the growing season.

Both rates of azafenidin and thiazopyr burned back primocanes present at the time of application and resulted in delayed primocane growth in May. However, there were no differences among treatments in the final number of primocanes produced.

Table. Herbicide effects on primocanes and weed control.

Treatment	Rate	Primocanes		False and common dandelion	
		5/2/2000	9/27/2000	5/2/2000	7/14/2000
	lb/A	——no./plant ——		—— plants/plot ——	
Azafenidin	0.2	2.55	6.81	0.12	0.75
Azafenidin	0.4	1.33	8.10	0.12	0.25
Dichlobenil	4	3.23	6.98	1.25	1.5
Dimethenamid	1	4.05	6.16	10.37	2.5
Dimethenamid	1.25	4.11	8.28	7.62	6.25
Isoxaben	0.75	4.64	7.42	8.37	1.25
Isoxaben	1	3.85	6.48	2.37	1.25
Metolachlor	1.33	5.71	6.15	3.62	4.5
Terbacil + napropamide	1.6 + 4	4.39	6.71	0.12	0
Thiazopyr	0.75	2.23	7.70	3.12	1.25
Thiazopyr	1	1.92	8.84	1.87	0.75
Significance	-	***	ns	***	***
LSD (0.05)	-	0.91	-	2.30	1.35

***, ns = Significance at $P < 0.001$, not significant, respectively.

Azafenidin, terbacil + napropamide, and the high rates of isoxaben and thiazopyr provided the best control. Dichlobenil (usually applied during winter), provided an intermediate level of control when applied in early April. Both dimethenamid and metolachlor provided little control.

Tolerance of snap beans (*Phaseolus vulgaris*) to flumioxazin and azafenidin. R. E. Peachey and R. D. William (Horticulture Department, Oregon State University, Corvallis, OR 97331).

A field study was conducted to determine margin of crop safety for snap beans with the herbicides flumioxazin and azafenidin. The soil was a silt loam with a pH of 6.7, 6.07 % OM, and CEC of 30.7 meq/100 g soil. The soil was tilled approximately 2 weeks before planting. Snap beans (OR91G) were planted on June 8 with 350 lbs of 12-29-10 fertilizer banded at planting. Plots were 10 by 30 ft and treatments applied in a RCBD with four replications. PES herbicides were applied on June 9. Roundup was applied to the stale-seedbed to kill emerged weeds on June 14 before the snap beans emerged. The plots were cultivated to reduce possible weed competition. The azafenidin plots were not harvested because of poor weed control that reduced snap bean growth.

Snap bean emergence was unaffected by flumioxazin or azafenidin. Phytotoxicity and crop growth reduction from flumioxazin were noted at 19 and 24 DAP beginning at the rate of 0.141lb ai/A. Phytotoxicity and crop growth reduction were noted with both rates of azafenidin. There was no evidence statistically (LSD) that there were differences in yield even at alpha 0.2. It is likely that the low yield at 0.047 was due to resource competition from surviving weeds and that the slightly lower yield at 0.188 lb ai/A was due to flumioxazin injury on the snap beans.

Table 1. Effect of flumioxazin on snap bean emergence and growth, Corvallis, 2000.

Herbicide	Rate	Obs.	Snap bean emergence	Obs.	27-Jun (19 DAP)		2-Jul (24 DAP)	
					Phytotoxicity	Growth	Phytotoxicity	Growth
			no/m of row		1-10	% reduction	1-10	% reduction
1 Flumioxazin	0.047	8	24	4	0.5	5.0	0.8	7.5
2 Flumioxazin	0.094	8	21	4	1.5	5.0	0.5	3.8
3 Flumioxazin	0.141	8	24	4	3.9	13.8	3.3	30.0
4 Flumioxazin	0.188	8	22	4	5.8	20.0	6.8	65.0
5 Azafenidin	0.05	8	22	4	0.5	6.3	0.3	7.5
6 Azafenidin	0.1	8	20	4	1.8	7.5	1.3	17.5
7 Metolachlor Lactofen	1 0.125	8	23	4	0.1	2.5	0.0	7.5
8 Check		8	22	4	0.0	0.0	0.0	0.0
$FPLSD_{0.05}$			ns		2.5	8.3	2.0	22

Table 2. Effect of flumioxazin on snap bean yield and weed control, Corvallis, 2000.

	Herbicide	Rate	No.	Plant stand	Biomass	Avg. plant wt	Pod yield	Grade	Weed control rating
		lb ai/A		no/A	t/A	g	t/A	% 1-4 sieve	1-10
1	Flumioxazin	0.047	4	110000	15.8	131.5	8.7	42%	5.5
2	Flumioxazin	0.094	4	103500	17.0	153.0	9.6	37%	5.8
3	Flumioxazin	0.141	4	101300	16.9	153.8	9.5	41%	7.3
4	Flumioxazin	0.188	4	100700	15.0	133.6	8.6	43%	8.5
7	Metolachlor	1	4	108400	17.6	146.9	10.2	40%	9.0
	Lactofen	0.125							
	$FPLSD_{0.05}$			ns	ns	ns	ns	ns	

Field evaluation of herbicides in winter squash and cucumber. Gina Koskela, Chris Cornwell, Karen Cornwell, Robert B. McReynolds and Marija Arsenovic. (North Willamette Research and Extension Center, Oregon State University, Aurora, OR 97002) The objectives of these trials were to evaluate herbicides applied preemergence to winter squash and cucumber for the control of broadleaf weeds and crop safety. The trials were part of a nationwide effort organized by the IR-4 Project to identify potential herbicides to pursue for registration.

Two field trials were established on June 26, 2000. Golden Delicious squash and Pioneer cucumber were directed seeded at NWREC into a Quatama silt loam soil with 4% organic matter. Both trials included the same treatments in randomized complete block designs with four replications. Ethalfluralin was included as the industry standard. Weeds present in the trials included; dock, pigweed, knotweed, lambsquarter, dogfennel, shepherdspurse, ladysthumb, fireweed, and some grasses. Weed control was evaluated by counting the number of weeds in a random five-foot square area of each plot. Squash and cucumber stands were counted in a five-foot length of row. The results from weed densities, plant populations, and yields were analyzed in order to compare the herbicide effects with the standard treatment.

The squash was planted in two-row plots with 45 inches between rows. Each treated plot was 15 feet wide and 20 feet long. Treatments were applied June 29, using a CO_2 system adapted for an Allis Chalmers G tractor equipped with a 12-nozzle boom (TeeJet 8003) delivering 30 gallons per acre at 30 psi. The trial was sprinkler irrigated with approximately 0.75 inches of water following the herbicide applications. Squash populations were recorded and weed control effectiveness was evaluated on July 24 (25 DAT). Phytotoxicity was evaluated at the same time and periodically during the early period of plant growth. All squash in each plot were harvested on Oct. 27.

The cucumbers were seeded in two-row plots with 30 inches between rows. Treated plots were 5 feet wide and 20 feet long. Treatments were applied June 28 using a CO_2 backpack sprayer equipped with a 3-nozzle boom (TeeJet 8002) set to deliver 41 gallons per acre with a tank pressure of 40 psi. All treatments were incorporated with sprinkler irrigation following applications with approximately 0.5 to 0.75 inches of water. The trial was irrigated twice weekly until harvest. Cucumber populations were recorded on July 11(13 DAT). Weed control effectiveness and phytotoxicity were evaluated on Aug 2 (35 DAT). Yield was collected from a 5-foot length of both rows on August 30.

The only treatment in the squash trial that significantly reduced plant populations and yields in comparison to both the ethalfluralin standard and the untreated plot was pyrithiobac. There were no significant reductions in weed densities among treatments in the squash trial. Pyrithiobac also significantly reduced cucumber yields, but not plant populations. Among cucumber treatments, ethalfluralin had a significantly higher plant population than all other treatments and the s-metolachlor had significantly fewer plants than the ethalfluralin, but not less than the other treatments. Although not significant, the treatment with the highest yields of both squash and cucumber was halosulfuron. All treatments provided acceptable levels of weed control. Generally, with the exception of pyrithiobac, winter squash showed greater tolerance to all the herbicides than did cucumber. Cucumber tolerance to halosulfuron, the low rate of sulfentrazone and ethalfluralin was good.

Table. Effects of preemergence herbicides on plant populations, weed densities and yields of Golden Delicious winter squash and Pioneer cucumber

Treatments	Rate	Number of plants		Number of weeds		Yield		Phytotoxicity[a]		Efficacy	
		Squash	Cuc[b]	Squash	Cuc	Squash	Cuc	Squash	Cuc	Squash	Cuc
	lb/A	no./5 ft of row		no./5ft^2		kg/plot		%		%	
Halosulfuron	0.024	4	23	3.5	7	74.8	6.55	3.75	1.5	6.25	3.75
Flufenacet	0.45	6	15.5	0.25	3.5	59.47	3.71	0.75	4.5	8.75	5
Flufenacet	0.9	5.5	16	1	0.5	56.86	1.22	1	7.9	8.25	8.4
Flumioxazin	0.025	7	20	1	1	56.98	3.97	1	5.5	8.75	6.5
Pyrithiobac	0.054	0.75	19.75	0	4.25	15.32	0	9.75	9.4	8.75	8.4
S-dimet[b]	0.66	4.25	18.25	1	2	34.96	2.04	2.25	8.1	8.5	8.4
S-dimeth[b]	1.32	3.5	14	0	0.25	60.04	0.98	4.25	8.4	9.25	8.5
S-metolachlor	1.16	5	12.75	3	4.75	51.53	3.84	0.5	5.3	7.25	5.25
Sulfentrazone	0.10	3.5	19.25	1.25	1.5	58.57	5.01	2.3	2.5	8.75	3.75
Sulfentrazone	0.20	4.5	19.75	0.75	1.75	62.20	3.84	1	6.3	9	7.8
Ethalfluralin	1.125	4	32.5	0.5	1.25	61.63	4.69	2.25	0.75	7	5.25
Untreated		5	21.25	5.25	20.5	54.93	4.34	0	0	0	0
LSD		2.29	9.14	ns	6.84	25.02	3.59	---	---	---	---

[a] Phyto scale: 0=no crop injury, 10=crop destruction. Efficacy scale: 0=no weed control, 10=total weed control.
[b] Cuc=cucumber. S-dimeth=S-dimethenamid.

Herbicides for weed control in spinach grown for seed. Timothy W. Miller and Carl R. Libbey. Washington State University, Mount Vernon, WA 98273. Several herbicides were tested for efficacy and crop safety to spinach grown for seed in 2000 at the WSU Mount Vernon Research and Extension Unit. The first study evaluated efficacy and crop safety of new and currently-registered herbicides. The second study screened several herbicides not previously tested for use in spinach. Weed species in all plots included henbit, common chickweed, common groundsel, shepherd's-purse, Powell amaranth, common lambsquarters, prostrate knotweed, and pale smartweed.

Plots measured 7 by 20 ft and spinach was seeded May 8 (two rows/plot). Preplant incorporated (PPI), preemergence (PRE), and postemergence (POST) herbicides were applied May 8, May 13, and June 16, respectively. All herbicide treatments were applied using a tractor-mounted sprayer delivering 29.7 gpa at 15 psi (Table 1). Weed control and spinach injury were estimated June 9 and August 2. Female plants in the herbicide trial were counted August 20, and five representative female plants were cut, dried in the greenhouse, and seed threshed October 3. Due to low stand counts in the new herbicide trial, no spinach plants were harvested. The experimental design for both trials 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.

Table 1. Application data.

Date:	9:00 a.m., May 8, 2000	6:30 a.m., May 13, 2000	6:00 a.m., June 16, 2000
Type:	Broadcast, preplant incorporated	Broadcast, preemergence	Broadcast, postemergence
Crop stage:	—	—	4 to 6 leaves
Weed stage:	—	—	6 to 8 in.
Cloud cover:	100%, overcast	100%, overcast	Clear
Winds:	2 to 3 mph from NW	3 to 5 mph from NE	1 to 3 mph from N
Air temp.:	10 C	11 C	15 C
Soil temp (4"):	12 C	11 C	15 C
Relative humidity:	97%	92%	86%
Comments:	No dew; soil damp	No dew; soil wet	Heavy dew; soil damp

Results.

Herbicide trial. Six treatments in the herbicide trial were still providing >80% weed control by August 2 (Table 2): cycloate (PPI) followed by pyrazon or phenmedipham (POST), S-metolachlor (PRE) followed by pyrazon (POST), pyrazon + dimethenamid (PRE), or pyrazon (PRE) followed by dimethenamid or phenmedipham (POST). None of these treatments caused more than slight crop injury by June 9 or significantly reduced crop stands. Treatments causing moderate crop injury were S-metolachlor + ethofumesate, ethofumesate + dimethenamid, cycloate + dimethenamid, and cycloate + ethofumesate, but only S-metolachlor + ethofumesate and pyrazon + pyrithiobac significantly reduced spinach stand count. All treatments in the herbicide trial except pyrazon + pyrithiobac produced statistically as much seed as the handweeded check.

New herbicide screen. All PRE herbicide treatments caused excessive injury to spinach, killing most to all spinach plants (Table 3). POST treatments also caused foliar injury (data not shown), but, with the exception of sulfentrazone, did not kill the plants. Based on these data, none of these herbicides are likely candidates for further testing.

Table 2. Weed control from several herbicide combinations used in spinach seed.

Treatment[a]	Timing[b]	Rate	Crop injury[c]	Weed control 6/9	Weed control 8/2	Crop density	Seed yield
		lb/a	%	—— % ——		no./plot	lbs/a
cycloate + S-metolachlor	PPI + PRE	1 + 0.5	6	90	78	44	1912
cycloate + pyrazon	PPI + POST	1 + 1	1	78	83	56	1918
cycloate + ethofumesate	PPI + PRE	0.75 + 0.25	10	91	75	56	1742
cycloate + dimethenamid	PPI + PRE	1 + 0.75	14	96	78	48	1381
ethofumesate + pyrazon	PRE + POST	0.25 + 0.75	4	70	66	46	1257
ethofumesate + dimethenamid	PRE	0.25 + 0.75	19	96	66	50	1475
S-metolachlor + pyrazon	PRE + POST	0.5 + 1	3	85	87	50	2137
S-metolachlor + ethofumesate	PRE	0.5 + 0.75	23	96	74	42	904
S-metolachlor + dimethenamid	PRE	0.5 + 0.75	8	91	66	49	1999
pyrazon + dimethenamid	PRE	1 + 0.75	8	97	91	52	2128
cycloate + dimethenamid	PPI + POST	1 + 0.5	1	73	66	49	943
cycloate + phenmedipham	PPI + POST	1 + 0.5	1	76	84	60	2424
cycloate + pyrazon	PPI + POST	1 + 0.5	0	81	75	56	2229
ethofumesate + dimethenamid	PRE + POST	0.25 + 0.5	1	75	79	56	1721
ethofumesate + phenmedipham	PRE + POST	0.25 + 0.5	3	55	46	46	1091
ethofumesate + pyrazon	PRE + POST	0.25 + 0.5	0	74	68	55	1973
pyrazon + dimethenamid	PRE + POST	1 + 0.5	0	83	86	57	1975
pyrazon + phenmedipham	PRE + POST	1 + 0.5	0	81	95	50	2281
S-metolachlor + dimethenamid	PRE + POST	0.5 + 0.5	0	71	58	52	1024
S-metolachlor + phenmedipham	PRE + POST	0.5 + 0.5	0	74	73	53	2194
S-metolachlor + pyrazon	PRE + POST	0.5 + 0.5	1	79	68	50	1507
phenmedipham + dimethenamid	POST	0.5 + 0.5	-	0	75	51	1789
phenmedipham + pyrazon	POST	0.5 + 0.5	-	0	48	45	1782
pyrazon + pyrithiobac	POST	0.5 + 0.064	-	0	51	12	—
handweeded check	—	—	0	100	100	53	1633
$LSD_{0.05}$	—	—	5	10	24	11	1100

[a]pyrithiobac treatment applied with nonionic surfactant (0.25 %, v:v).
[b]PPI = preplant incorporated; PRE = preemergence; POST = postemergence.
[c]On this date (6/9), POST treatments had not yet been applied.

Table 3. Weed control from several new herbicides used in spinach seed.

Treatment[a]	Timing[b]	Rate	Crop injury[c]	Weed control 6/9	Weed control 8/2	Crop density
		lb/a	%	—— % ——		pl./plot
azafenidin	PRE	0.25	100	99	99	0
thiazopyr	PRE	0.5	89	99	97	2
sulfentrazone	PRE	0.25	100	94	83	0
isoxaflutole	PRE	0.094	100	99	76	0
chloransulam	PRE	0.032	78	96	84	6
flumetsulam	PRE	0.055	83	98	88	1
thiazopyr	POST	0.5	-	0	28	36
sulfentrazone	POST	0.25	-	0	25	2
flumiclorac	POST	0.04	-	0	13	36
fomesafen	POST	0.375	-	0	25	33
weedy check	—	—	0	0	0	22
$LSD_{0.05}$	—	—	4	2	10	9

[a]fumiclorac treatment applied with crop oil concentrate (1 pt/a).
[b]PRE = preemergence; POST = postemergence.
[c]On this date (6/9), POST treatments had not yet been applied.

Evaluation of new herbicides for use in strawberries. Diane Kaufman, Joe DeFrancesco, Gina Koskela, Ed Peachey. (North Willamette Research and Extension Center, Oregon State University, 15210 NE Miley Rd., Aurora, OR 97002). Two field trials were established at the North Willamette Research and Extension Center (NWREC) 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 and a rate of 20 gallons of water per acre.

1. Establishment Trial. 'Totem' strawberries were planted in raised beds on May 22, 2000. Plots four rows wide and 25 feet long were arranged in a randomized complete block design with four replications. Plants were irrigated after planting. Herbicide treatments were applied on May 23, 2000 and followed with 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 many herbicides began to lose effectiveness by late summer, all plots received a maintenance herbicide application of simazine (1 lb ai/A) on September 28, 2000, after being hoed free of weeds.

Weed control was evaluated approximately every 20 days beginning one month after treatment application. Plots were hand-weeded after each evaluation. Phytotoxicity was evaluated two days after herbicide applications and periodically throughout the growing season. Plant vigor was evaluated July 18, 2000. Yield data will be collected in summer 2001.

Table 1. Treatments in establishment trial.

Treatments	Rate at planting	Winter rate
	lb/A	lb/A
Azafenidin	0.1	0.3
Azafenidin	0.2	0.3
Dimethenamid	1	1.25
Ethofumesate	1	Ethofumesate (2) + Flumioxazin (0.0625)
Ethofumesate	2	2
Fluamide + isoxaben	0.25 + 0.75	0.25 + 0.75
Fluamide + sulfentrazone	0.25 + 0.125	0.25 + 0.25
Flumioxazin	0.0625	0.0625
Flumioxazin	0.0925	0.0925
Isoxaben	0.75	1
Oxyfluorfen	0.2	0.2
Sulfentrazone	0.125	0.25
Sulfentrazone	0.25	0.25
Thiazopyr	0.5	----
Hand-weeded control[a]	----	----
Weedy control[a]	----	----

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

Table 2. Dominant weeds present during growing season, 2000.

Date	Primary Weeds	Other Weeds
June 19 (28 DAT) and July 7 (45 DAT)	Pigweed, shepherdspurse, pineappleweed, barnyardgrass	Nightshade, henbit
July 31 (67 DAT)	Pigweed, shepherdspurse, pineappleweed, sowthistle, crabgrass	Henbit, chickweed, barnyardgrass, annual bluegrass
August 22 (89 DAT)	Pigweed, shepherdspurse, pineappleweed, crabgrass, annual bluegrass	Henbit, sowthistle
September 25 (122 DAT)	Annual bluegrass	Pigweed, shepherdspurse, pineappleweed, groundsel, henbit, sowthistle, chickweed, dandelions, clover/vetch

All herbicides provided excellent broadleaf weed control through early July, with the exception of ethofumesate, which provided inadequate control of broadleaf weeds at both rates (Table 3). Most herbicides continued to provide excellent broadleaf weed control through August. Isoxaben and sulfentrazone provided little control of grasses when used alone. However, in mixture with fluamide, both isoxaben and sulfentrazone performed well. There were no statistically significant differences among treatments in number of leaves, number of runners, or overall plant size (Table 4).

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, plants treated with oxyfluorfen showed no signs of phytotoxicity. Plants treated with azafenidin and flumioxazin had a few red spots on newly emerged leaves, but subsequent growth was normal.

Plants treated with the high rate of ethofumesate had some blackening of margins on newly emerged leaves until mid-June. The remaining herbicide treatments did not cause phytotoxicity.

Table 3. Weed control in establishment trial on four dates.

Treatment	Rate	Broadleaf weed control [a]				Grass weed control [a]			
		6/19	7/6	7/31	8/22	6/19	7/6	7/31	8/22
	lb /A	-----%				-----%			
Azafenidin	0.1	100	98.1	99.0	95.0	98.7	95.0	95.4	93.1
Azafenidin	0.2	98.0	99.1	98.1	98.3	96.2	91.2	97.5	98.7
Dimethenamid	1	96.3	92.5	85.0	84.6	97.2	96.2	96.7	90.6
Ethofumesate	1	77.2	57.2	73.3	35.8	90.0	82.5	86.7	85.0
Ethofumesate	2	86.9	76.6	82.5	62.5	91.9	96.2	95.4	95.0
Flua[b] + Isox	0.25 + 0.75	97.0	99.1	96.2	96.2	97.5	92.5	99.2	96.9
Flua[b] + Sulfen	0.25 + 0.125	96.9	97.8	96.2	95.8	95.0	95.0	94.2	92.5
Flumioxazin	0.0625	99.1	99.4	97.8	96.7	83.2	81.2	87.1	85.0
Flumioxazin	0.0925	99.0	99.6	99.6	96.2	92.5	96.25	95.0	91.2
Isoxaben	0.75	96.5	98.0	95.4	92.9	86.2	90.0	86.7	78.7
Oxyfluorfen	0.2	99.0	99.4	94.8	92.5	97.5	88.7	90.4	96.2
Sulfentrazone	0.125	94.5	95.6	96.7	90.0	78.2	72.5	77.9	68.7
Sulfentrazone	0.25	95.5	97.5	94.6	95.8	91.2	90.0	80.8	65.7
Thiazopyr	0.5	98.7	98.4	96.2	95.0	98.7	96.2	100	100
Significance [c]		***	***	***	***	ns	ns	**	***
LSD		2.4	4.4	3.0	4.9	-	-	5.6	7.6

[a] Expressed as percent control compared to the weedy check plots
[b] Flua = fluamide, Isox = isoxaben, Sulfen = sulfentrazone.
[c] ** *** = significance at P≤ 0.01, 0.001, respectively

Table 4. Strawberry plant vigor evaluated 7/18/00.

Treatment	Rate	Number leaves per plant	Number runners per plant	Plant size
	lb ai/A			cm
Azafenidin	0.1	9.21	3.07	502.98
Azafenidin	0.2	10.25	3.21	557.60
Dimethenamid	1	9.10	3.18	547.5
Ethofumesate	1	9.72	3.39	634.99
Ethofumesate	2	10.39	3.53	621.16
Flua[a] + Isox	0.25 + 0.75	8.64	3.32	483.38
Flua[a] + Sulf	0.25 + 0.125	9.57	3.46	573.80
Flumioxazin	0.0625	9.43	3.07	494.90
Flumioxazin	0.0925	8.11	2.86	467.44
Isoxaben	0.75	9.96	3.10	552.30
Oxyfluorfen	0.2	9.08	2.93	518.63
Sulfentrazone	0.125	9.36	2.89	571.29
Sulfentrazone	0.25	9.36	3.03	500.89
Thiazopyr	0.5	9.18	3.61	515.57
Hd-weed comb		9.61	2.89	659.78
Weedy control		9.93	2.96	571.03
Significance		ns	ns	ns

[a] Flua=fluamide, Isox=isoxaben, Sulfen=sulfentrazone. -Hand-weeded control.

2. Fall Timing Trial. This planting was also established on raised beds at NWREC on May 22, 2000 and will be used to evaluate herbicide treatments made in the fall. Plots four rows wide and 25 feet long were arranged in a randomized complete block design with four replications. Napropamide at 4 lb ai/A was applied to all plots immediately after planting, followed by one inch of irrigation. Herbicide treatments were made on October 4, 2000 and followed by one inch of irrigation. Treatments included: azafenidin (0.2 lb/A); dimethenamid (1.25 lb/A); ethofumesate (2 lb/A); flumioxazin (0.0625 lb/A); isoxaben(1 lb/A); sulfentrazone (0.25 lb/A); and simazine (1 lb/A) + napropamide (2 lb/A).

As of late October weed control was good, with the exception of some annual bluegrass in the isoxaben and sulfentrazone plots. Azafenidin and flumioxazin treated plants exhibited some red discoloration on leaves and considerable burn of young runner plants. Simazine + napropamide and dimethenamid-treated plants showed very little red spotting on leaves and no runner plant damage. Weed control and strawberry plant vigor will be evaluated again in the winter and during the next growing season.

Herbicides for weed control in table beets grown for seed. Timothy W. Miller and Carl R. Libbey. Washington State University, Mount Vernon, WA 98273. Several herbicides were tested for efficacy and crop safety to table beets grown for seed in 2000 at the WSU Mount Vernon Research and Extension Unit. The first study evaluated efficacy and crop safety of new and currently-registered herbicides. The second study screened several herbicides not previously tested for use in table beets. Weed species in all plots included henbit, common chickweed, common groundsel, shepherd's-purse, Powell amaranth, common lambsquarters, prostrate knotweed, and pale smartweed.

Plots measured 7 by 20 ft and table beet stecklings were planted April 21 (two rows/plot). Preplant incorporated (PPI), preemergence (PRE), and postemergence (POST) herbicides were applied April 21, May 1, and June 1, respectively. All herbicide treatments were applied using a tractor-mounted sprayer delivering 29.7 gpa at 15 psi (Tables 1 and 2). Weed control and beet injury were estimated June 9 and August 2. On October 4, plants in each plot were counted and three representative plants were cut. These were dried in the greenhouse and the seed threshed November 6. The experimental design for both trials 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.

Table 1. Application data, herbicide trial.

Date:	3:30 p.m., April 21, 2000	9:00 a.m., May 1, 2000	6:15 a.m., June 2, 2000
Type:	Broadcast, preplant incorporated	Broadcast, preemergence	Broadcast, postemergence
Crop stage:	---	—	Early bolting
Weed stage:	—	A few seedlings, < ½ in.	2 to 4 in.
Cloud cover:	100%, overcast	100%, overcast	100% , overcast
Winds:	2 to 5 mph from N	3 to 7 mph from S	3 to 5 mph from S
Air temp.:	13 C	9 C	12 C
Soil temp (4"):	12 C	5 C	15 C
Relative humidity:	87%	94%	97%
Comments:	No dew; soil damp	Dew; soil wet	Dew; soil wet

Table 2. Application data, new herbicide screen.

Date:	12:30 p.m., June 1, 2000	10:45 a.m., June 1, 2000
Type:	Broadcast, preemergence	Broadcast, postemergence
Crop stage:	---	6 in. to early bolting
Weed stage:	A few seedlings, < ½ in.	1 to 2 in.
Cloud cover:	80%	10%
Winds:	2 to 7 mph from S	6 to 7 mph from NE
Air temp.:	13 C	17 C
Soil temp (4"):	5 C	13 C
Relative humidity:	82%	83%
Comments:	No dew; soil wet	No dew; soil wet

Results.

Herbicide trial. No treatment caused visible foliar injury (data not shown). Seven treatments were still providing >85% weed control by August 2 (Table 3): ethofumesate (PRE) followed by pyrazon (POST), S-metolachlor (PRE) followed by phenmedipham/desmedipham, phenmedipham/desmedipham/ethofumesate, or pyrazon (POST), dimethenamid (PRE) followed by pyrazon (POST), or pyrazon at 3.7 lbs/a (POST) followed by phenmedipham/desmedipham/ethofumesate or dimethenamid (POST).

New herbicide screen. Most herbicides caused severe injury to developing foliage, with the exception of thiazopyr and sulfentrazone applied PRE (Table 4). These treatments initially resulted in excellent weed control, but control had dropped to 75 and 69% by August 2. Additional testing of these products at lower rates in tank mixtures with other products is warranted based on these data.

No treatment in either trial significantly reduced stand counts or seed yield from handweeded table beets (data not shown).

Table 3. Weed control from several herbicide combinations used in table beet seed.

Treatment[a]	Timing[b]	Rate	Weed control 6/9	Weed control 8/2
		lb/a	—— % ——	
cycloate + dimethenamid	PPI + PRE	2 + 1	88	60
cycloate + clopyralid + triflusulfuron	PPI + POST + POST	3 + 0.094 + 0.0156	53	36
cycloate + pyrazon	PPI + POST	3 +1.5	68	76
S-metolachlor + ethofumesate	PRE	1 + 1	93	79
S-metolachlor + dimethenamid	PRE	1 + 1	91	81
ethofumesate + dimethenamid	PRE	1 + 1	96	72
ethofumesate + triflusulfuron	PRE + POST	1.5 + 0.0156	81	56
ethofumesate + clopyralid + triflusulfuron	PRE + POST + POST	1.5 + 0.094 + 0.0156	85	80
ethofumesate + pyrazon	PRE + POST	1.5 + 1.5	85	90
S-metolachlor + phen/des	PRE + POST	1.5 + 0.5	94	85
S-metolachlor + phen/des/etho	PRE + POST	1.5 + 0.5	96	93
S-metolachlor + pyrazon	PRE + POST	1.5 + 1.5	86	88
dimethenamid + pyrazon	PRE + POST	1 + 1.5	91	90
pyrazon + phen/des	PRE + POST	2.5 + 0.5	92	79
pyrazon + phen/des/etho	PRE + POST	2.5 + 0.5	97	90
pyrazon + dimethenamid	PRE + POST	2.5 + 1	91	90
pyrazon + dimethenamid	PRE + POST	1.5 + 1	55	44
phen/des + dimethenamid	POST	0.5 + 1	0	71
phen/des/etho + dimethenamid	POST	0.5 + 1	0	51
pyrazon + triflusulfuron	POST	1.5 + 0.0156	0	68
dimethenamid + pyrazon	POST	1 + 1.5	0	68
handweeded check	—	—	100	100
weedy check	—	—	0	0
$LSD_{0.05}$	—	—	8	25

[a]Triflusulfuron treatments applied with nonionic surfactant (0.25% , v/v); phen/des = phenmedipham + desmedipham; phen/des/etho = phenmedipham + desmedipham + ethofumesate.
[b]PPI = preplant incorporated; PRE = preemergence; POST = postemergence.

Table 4. Weed control from several new herbicides used in table beet seed.

Treatment[a]	Timing[b]	Rate	Crop injury	Weed control 6/9	Weed control 8/2	Crop density
		lb/a	%	—— % ——		pl./plot
azafenidin	PRE	0.2	43	96	93	9
thiazopyr	PRE	0.5	18	99	75	8
sulfentrazone	PRE	0.25	13	79	69	9
isoxaflutole	PRE	0.094	80	99	78	7
chloransulam	PRE	0.032	53	98	94	4
flumetsulam	PRE	0.055	44	98	97	6
thiazopyr	POST	0.5	20	8	18	8
sulfentrazone	POST	0.25	93	92	74	6
flumiclorac	POST	0.04	68	26	13	7
fomesafen	POST	0.375	58	33	71	7
weedy check	—	—	0	0	13	8
$LSD_{0.05}$	—	—	25	13	27	ns

[a]fumiclorac treatment applied with crop oil concentrate (1 pt/a).
[b]PRE = preemergence; POST = postemergence.

Screening of low-rate herbicides for vegetable crop tolerance and weed control. R. Edward Peachey and Carol Mallory Smith (Horticulture and Crop Science Departments, Oregon State University, Corvallis, OR 97331). The objective of this study was to identify potential new low-rate herbicides for vegetable crops. Vegetable crops were planted on July 15 on 30 inch rows with a Gaspardo precision or John Deere Max-emerge planter in 250 by 5 ft plots with three replications. Crops and varieties included: snap beans (OR91G), broccoli (Emperor), cauliflower (Snowman), cabbage (Market victor), carrots (Prospector), red beets (Detroit Dark Red), sweet corn (Golden Jubilee), processing squash *Cucurbita maxima* (Golden Delicious) and cucumbers (Pioneer). Domestic red millet was seeded in one row. Herbicides were applied perpendicular to the crop rows in a strip-plot design. Herbicides were applied with a backpack sprayer and boom with 5-8003 flat fan nozzles spaced 20 in apart. Each split-plot was 5 by 10 ft. Preemergence herbicides (PES) were applied on July 18 at 17 gpa with air temperature at 62 F, 85 % RH, 100% cloud cover, and no wind. Postemergence herbicides were applied on August 4 when crops were 1-3 leaf at 17 gpa, air temperature 66 F, 80 % RH, clear skies and no wind. Crop oil concentrate (0.5%) was added to all postemergence applications. Crop emergence, growth, and herbicide injury, and weed control ratings were visually estimated on August 17.

Preemergence Powell amaranth and nightshade control was excellent with imazapic, flumioxazin, and ZA1296. MKH 6561 controlled Powell amaranth but had no effect on nightshade. Flufenpyr-ethyl had no soil activity. Flumioxazin also controlled Powell amaranth and nightshade when applied postemergence. Bensulfuron methyl and s-dimethenamid did not control weeds postemergence. BAS 620 controlled domestic red millet.

Of the herbicides with acceptable preemergence weed control, only imazpic on snap beans, MKH 6562 on cabbage, and flumioxazin on sweet corn had acceptable injury levels. Postemergence herbicides with acceptable weed control and crop safety included MKH 6562 on carrots, flufenpyr-ethyl on beans, carrots, and sweet corn, fluthiacet-methyl on snap beans, carrots, and sweet corn, and BAS 662 on sweet corn.

Table 1. Herbicide rate, timing and weed control ratings in vegetable screening trial.

Herbicide	Timing	Rate	Weed control		
			Powell amaranth	Nightshade	Millet
		lb/A	%		
Bensulfuron	PES	0.017	0	0	7
Flufenpyr-ethyl	PES	0.009	0	0	0
Flumioxazin	PES	0.095	100	93	0
Imazapic	PES	0.062	100	100	57
MKH 6561	PES	0.027	100	0	0
MKH 6562	PES	0.027	100	40	23
ZA1296	PES	0.094	100	98	7
BAS 620	POST	0.1	0	0	93
BAS 662	POST	0.088	97	90	20
Bensulfuron	POST	0.017	0	0	0
Flufenpyr-ethyl	POST	0.009	90	88	3
Flumioxazin	POST	0.095	100	100	47
Fluthiacet-methyl	POST	0.006	93	83	7
Fluthiacet-methyl + sethoxydim	POST	0.006	97	87	72
Imazapic	POST	0.048	100	98	93
MKH 6561	POST	0.027	97	77	23
MKH 6562	POST	0.013	98	83	27
Pyribenzoxium	POST	0.07	97	97	90
S-dimethenamid	POST	0.563	0	0	0
ZA1296	POST	0.045	100	100	30
Check	-	0	0	0	0
$FPLSD_{0.05}$			6	13	16

Table 2. Effect of herbicides on vegetable crop emergence (E), growth (GR), and herbicide injury symptoms (P).

Herbicide	Timing	Snap beans			Broccoli			Cauliflower			Cabbage			Carrot			Beets			Sweet corn			Cucumbers			Processing squash		
		E[a]	GR[b]	P[c]	E	GR	P	E	GR	P	E	GR	P	E	GR	P	E	GR	P	E	GR	P	E	GR	P	E	GR	P
Bensulfuron	PRE	100	0	1	100	0	0	93	0	0	100	0	0	100	0	0	100	0	0	100	3	0	55	0	0	83	20	0
Flufenpyr-ethyl	PRE	100	0	0	100	0	0	100	0	0	100	0	0	100	0	0	100	0	0	100	0	0	100	0	0	100	0	0
Flumioxazin	PRE	83	43	1	0	100	-	0	100	-	0	100	-	10	57	0	0	100	-	90	0	0	0	100	-	40	33	1
Imazapic	PRE	97	23	1	0	100	-	0	100	-	0	67	0	33	100	-	0	100	-	2	100	-	5	100	103	93	27	1
MKH 6561	PRE	100	33	2	0	100	-	0	97	9	0	100	-	100	0	0	0	100	-	0	100	-	10	50	0	100	47	1
MKH 6562	PRE	100	80	9	33	50	0	30	60	3	100	17	0	100	7	0	2	97	0	0	100	-	0	50	0	70	70	1
ZA1296	PRE	77	67	1	0	100	-	0	100	-	0	100	-	7	67	0	0	100	-	100	0	0	0	100	-	17	77	1
BAS 620	POST	100	0	0	100	0	1	100	0	0	100	0	0	100	0	0	100	7	0	67	93	9	100	0	0	100	13	0
BAS 662	POST	100	80	10	100	57	1	100	63	9	100	47	9	100	17	1	100	37	10	100	3	1	100	50	6	100	50	10
Bensulfuron	POST	100	67	9	67	97	-	100	93	8	100	80	10	67	53	6	100	37	4	100	57	3	50	85	4	100	83	7
Flufenpyr-ethyl	POST	100	10	2	100	30	2	100	47	5	100	27	3	100	0	0	100	53	7	100	0	1	100	50	3	100	23	3
Flumioxazin	POST	100	90	8	100	98	-	100	100	-	100	100	-	77	57	2	100	100	-	100	33	3	100	100	-	100	98	10
Fluthiacet + seth[d]	POST	100	17	3	100	47	0	40	90	10	100	47	4	100	20	0	100	87	6	100	30	6	65	60	4	83	30	3
Fluthiacet-methyl	POST	100	7	2	100	47	1	100	83	4	100	57	2	100	0	0	100	72	3	100	7	2	100	40	4	100	40	4
Imazapic	POST	100	67	7	100	93	-	100	90	10	100	100	-	100	100	-	100	100	-	100	83	10	100	100	-	100	90	10
MKH 6561	POST	100	63	8	100	97	-	100	95	10	100	90	10	100	53	5	100	80	10	100	97	10	100	75	9	100	83	10
MKH 6562	POST	100	77	10	100	77	1	100	82	8	100	83	10	100	27	1	100	73	10	100	60	5	100	80	8	100	53	7
Pyribenzoxium	POST	100	90	10	100	100	-	100	100	-	100	100	-	100	93	10	100	100	-	100	93	10	100	60	9	100	92	10
S-dimethenamid	POST	100	0	0	100	0	0	67	0	0	100	0	0	100	33	0	100	13	0	100	23	3	100	15	0	100	0	0
ZA1296	POST	100	67	10	100	90	0	80	90	10	100	100	-	67	97	10	100	100	-	100	7	0	100	95	10	100	77	10
$FPLSD^{0.05}$		16	30	2	20	20	1	31	21	3	0	26	2	34	30	3	1	22	3	18	25	4	43	44	3	25	35	3

[a] Emergence (E): estimated percent emergence compared to untreated check.
[b] Growth reduction (GR): estimated percent growth reduction caused by herbicide.
[c] Phytotoxicity (P): severity of herbicide injury symptoms; 0=none, 10 = severe. Phytotoxicity ratings are not presented for treatments that killed the crop.
[d] Fluthiacet + seth = fluthiacet methyl + sethoxydim.

Screening of low rate pre- and postemergence herbicides in vegetable crops. Steven A. Fennimore and Grant Manning. (Department of Vegetable Crops and Weed Science, University of California-Davis, Salinas, CA, 93905). All indications are that pesticide use cancellations, as a 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 'Minicor', iceberg lettuce 'Sharp Shooter', romaine lettuce 'Green Towers', yellow onion 'Takii T-433', spinach 'Spinnaker', 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 (Pre) herbicides and rates tested in lb/A were: BAS 656 08H at 0.66 and 1.00, S-metolachlor at 0.63 and 0.95, azafenidin at 0.025 and 0.050, quinclorac at 0.14 and 0.25, prometryn at 1.0 and 1.6. Postemergence (Post) herbicides included: S-3153 at 0.018, 0.027 and 0.054, pyrithiobac at 0.014 and 0.027, clopyralid at 0.047 and 0.094, fluroxypyr at 0.024 and 0.047, flumiclorac at 0.03 and 0.04, quinclorac at 0.14 and 0.25 and prometryn at 1.0 and 1.6. Crop oil concentrate was added at 0.63% v/v with S-3153, 1% v/v with flumiclorac and 1.25% v/v with quinclorac. Non-ionic surfactant was added at 0.25% v/v with pyrithiobac . The planting date was June 7, 2000. Preemergence treatments were applied June 9. Postemergence treatments were applied when most crop species were at two to three leaves, on June 29. Phytotoxicity ratings were recorded 33 and 47 days after preemergence treatment (DAT) and at 14 and 28 days after postemergence treatment. Stand counts were also taken 28 DAT, and crop biomasses (dry weight) were collected 29 DAT. Mean separation was performed using Fisher's protected LSD (α=0.05).

Iceberg lettuce was not sufficiently tolerant to any of the herbicides tested (Table 1). Herbicides that were found acceptable by crop, where rates in lb/A are identified in parentheses, were: romaine lettuce treated with pyrithiobac (0.014) and fluroxypyr (0.024 and 0.047); carrot treated with S-3153 (0.018), fluroxypyr (0.024, 0.047) and postemergence prometryn (1.0, 1.6) (Table 2); onion treated with S-3153 (0.018, 0.027), fluroxypyr (0.024, 0.047), flumiclorac (0.03, 0.04), pre- and postemergence quinclorac (0.14, 0.25), azafenidin (0.025) and preemergence quinclorac (0.14, 0.25); processing tomato treated with fluroxypyr (0.024) and S-metolachlor (0.63) (Table 3); broccoli treated with clopyralid (0.047), fluroxypyr (0.024), pre- and postemergence quinclorac (0.14, 0.25), S-metolachlor (0.63, 0.95) and azafenidin (0.025); spinach treated with clopyralid (0.047, 0.094), fluroxypyr (0.024), postemergence quinclorac (0.14, 0.25) and S-metolachlor (0.63) (Table 4). All combinations not previously mentioned resulted in unacceptable crop injury.

Table 1. Phytotoxicity, stand count and crop biomass for iceberg and romaine lettuce.

			Iceberg Lettuce				Romaine Lettuce			
Herbicide	Stage	Rate	Phytotoxicity[a]		Stand	Biomass[b]	Phytotoxicity[a]		Stand	Biomass[b]
		lb A^{-1}			m^{-1}	g m^{-1}			m^{-1}	g m^{-1}
S-3153	Post	0.018	6.5	7.8	3.8	6.2	5.5	5.8	6.0	11.4
S-3153	Post	0.027	3.3	3.3	11.3	26.7	3.3	2.5	11.3	32.1
S-3153	Post	0.054	5.8	6.5	4.3	7.3	6.3	5.8	9.7	12.9
Pyrithiobac	Post	0.014	0.8	3.0	7.5	30.7	0.3	2.0	10.0	43.3
Pyrithiobac	Post	0.027	2.3	5.8	5.5	19.9	0.8	3.5	14.5	34.8
Clopyralid	Post	0.047	2.3	5.0	15.5	19.3	2.3	4.5	11.5	29.4
Clopyralid	Post	0.094	5.5	8.5	5.3	3.1	5.3	8.5	2.5	2.6
Fluroxypyr	Post	0.024	1.8	2.8	7.0	32.5	1.0	1.8	10.0	47.2
Fluroxypyr	Post	0.047	1.8	2.3	17.0	35.8	1.0	0.8	15.3	41.3
Flumiclorac	Post	0.030	7.3	7.3	4.0	4.6	8.8	8.5	1.5	1.5
Flumiclorac	Post	0.040	8.5	8.3	2.8	2.6	8.5	8.0	3.0	3.4
Ouinclorac	Post	0.140	3.0	4.5	9.3	24.6	2.5	4.3	7.5	35.9
Ouinclorac	Post	0.250	3.8	6.5	13.8	13.0	2.5	6.3	13.8	14.9
Prometryn	Post	1.000	10.0	10.0	0.0	0.0	10.0	10.0	0.0	0.0
Prometryn	Post	1.600	10.0	10.0	0.0	0.0	10.0	10.0	0.0	0.0
BAS 656 08H	Pre	0.660	9.8	9.8	0.3	0.3	10.0	10.0	0.0	0.0
BAS 656 08H	Pre	1.000	10.0	10.0	0.0	0.0	10.0	10.0	0.0	0.0
S-metolachlor	Pre	0.630	7.5	7.3	5.3	6.5	8.8	8.5	2.5	2.5
S-metolachlor	Pre	0.950	10.0	9.8	0.0	0.0	10.0	9.8	0.0	0.0
Azafenidin	Pre	0.025	7.8	8.3	1.8	10.2	9.8	10.0	0.0	0.0
Azafenidin	Pre	0.050	9.8	9.8	0.5	0.3	10.0	9.5	0.5	0.1
Ouinclorac	Pre	0.140	8.0	5.5	4.3	3.8	8.5	7.3	2.0	4.7
Ouinclorac	Pre	0.250	9.5	9.3	1.0	0.1	9.3	8.8	2.5	0.3
Prometryn	Pre	1.000	10.0	10.0	0.0	0.0	10.0	10.0	0.0	0.0
Prometryn	Pre	1.600	10.0	10.0	0.0	0.0	10.0	10.0	0.0	0.0
Handweeded Check	-	-	0.0	0.3	12.5	61.1	0.0	0.3	7.0	49.9
Untreated Check	-	-	0.0	0.0	15.5	61.0	0.0	0.0	15.8	57.0
LSD (0.05)			1.8	2.1	4.2	13.9	1.7	1.9	4.3	12.6
Days after preemergence treatment			33	47	47	48	33	47	47	48
Days after postemergence treatment			14	28	28	29	14	28	28	29

[a]Crop phytotoxicity 0 = no injury, 10 = death
[b]Crop biomass (dry weight)

Table 2. Phytotoxicity, stand count and crop biomass for carrot and onion.

			Carrot				Onion			
Herbicide	Stage	Rate	Phytotoxicity[a]		Stand	Biomass[b]	Phytotoxicity[a]		Stand	Biomass[b]
		lb A^{-1}			m^{-1}	g m^{-1}			m^{-1}	g m^{-1}
S-3153	Post	0.018	1.0	1.0	70.0	42.4	0.8	1.3	14.8	5.8
S-3153	Post	0.027	0.5	0.8	71.3	40.6	0.3	0.0	12.5	6.1
S-3153	Post	0.054	1.8	3.0	56.5	20.3	3.0	3.5	12.3	3.7
Pyrithiobac	Post	0.014	4.3	4.5	59.0	10.2	7.8	9.8	6.0	0.2
Pyrithiobac	Post	0.027	5.0	6.0	59.3	7.8	8.8	10.0	2.0	0.0
Clopyralid	Post	0.047	1.0	2.5	49.3	27.8	2.0	3.8	6.5	2.4
Clopyralid	Post	0.094	1.5	3.5	53.0	18.0	2.0	3.3	12.0	3.1
Fluroxypyr	Post	0.024	0.0	0.8	53.8	42.0	1.0	0.5	15.5	6.1
Fluroxypyr	Post	0.047	0.0	0.5	54.0	50.9	0.5	0.3	9.5	2.8
Flumiclorac	Post	0.030	2.8	2.5	54.8	19.4	1.8	1.3	12.3	5.0
Flumiclorac	Post	0.040	1.5	2.5	60.5	20.6	1.8	3.0	9.0	3.1
Ouinclorac	Post	0.140	0.3	1.0	56.8	32.9	0.5	0.3	14.3	6.4
Ouinclorac	Post	0.250	2.8	5.5	35.8	6.8	0.5	1.5	11.0	5.5
Prometryn	Post	1.000	0.0	1.0	56.3	44.3	9.8	10.0	0.0	0.0
Prometryn	Post	1.600	0.8	1.8	65.3	44.1	10.0	10.0	0.0	0.0
BAS 656 08H	Pre	0.660	5.3	6.0	38.5	6.6	3.0	3.8	15.7	3.3
BAS 656 08H	Pre	1.000	7.5	7.3	24.5	4.0	5.5	6.5	10.0	1.8
S-metolachlor	Pre	0.630	0.5	1.0	61.5	38.3	6.0	6.8	4.0	0.4
S-metolachlor	Pre	0.950	0.8	1.3	60.3	38.7	6.3	6.3	4.3	0.8
Azafenidin	Pre	0.025	1.3	2.0	40.5	33.7	0.8	0.8	12.8	7.1
Azafenidin	Pre	0.050	2.8	4.3	30.0	20.4	3.5	5.3	8.3	1.4
Ouinclorac	Pre	0.140	8.0	7.3	15.8	2.5	0.5	3.3	13.5	8.2
Ouinclorac	Pre	0.250	8.8	9.3	4.3	0.7	1.0	1.3	11.3	5.3
Prometryn	Pre	1.000	0.5	0.8	50.3	37.2	9.5	7.5	0.5	0.2
Prometryn	Pre	1.600	0.3	1.5	53.8	40.7	10.0	10.0	0.5	0.0
Handweeded Check	-	-	0.0	0.0	56.0	56.0	0.0	1.0	11.5	5.8
Untreated Check	-	-	0.0	0.3	59.3	48.9	0.0	0.0	8.5	2.5
LSD (0.05)			1.6	1.6	14.9	13.5	2.1	2.8	4.8	3.4
Days after preemergence treatment			33	47	47	48	33	47	47	48
Days after postemergence treatment			14	28	28	29	14	28	28	29

[a]Crop phytotoxicity 0 = no injury, 10 = death
[b]Crop biomass (dry weight)

Table 3. Phytotoxicity, stand count and crop biomass for processing tomato and broccoli.

Herbicide	Stage	Rate	Processing Tomato Phytotoxicity[a]		Processing Tomato Stand	Processing Tomato Biomass[b]	Broccoli Phytotoxicity[a]		Broccoli Stand	Broccoli Biomass[b]
		lb A^{-1}			m^{-1}	g m^{-1}			m^{-1}	g m^{-1}
S-3153	Post	0.018	7.0	8.5	5.5	2.1	5.3	4.0	18.5	62.4
S-3153	Post	0.027	7.3	7.0	22.5	20.2	3.8	3.5	17.5	107.7
S-3153	Post	0.054	10.0	9.3	0.0	0.0	6.8	4.8	12.0	17.7
Pyrithiobac	Post	0.014	9.3	9.5	4.3	0.4	7.0	8.0	14.0	10.2
Pyrithiobac	Post	0.027	10.0	10.0	0.3	0.2	8.0	9.0	13.8	2.5
Clopyralid	Post	0.047	3.3	6.0	27.5	8.9	0.3	0.8	18.8	151.4
Clopyralid	Post	0.094	5.5	7.5	35.5	10.8	1.5	2.3	13.5	113.3
Fluroxypyr	Post	0.024	1.3	1.5	56.8	62.3	0.3	0.0	21.3	161.7
Fluroxypyr	Post	0.047	2.5	3.8	22.5	16.1	1.0	1.0	17.3	133.0
Flumiclorac	Post	0.030	7.3	7.3	15.5	6.2	3.0	1.0	17.3	127.7
Flumiclorac	Post	0.040	9.3	9.0	5.0	0.4	3.5	2.0	18.3	120.3
Quinclorac	Post	0.140	3.5	6.3	60.5	29.7	0.3	0.0	19.5	110.0
Quinclorac	Post	0.250	4.5	8.5	31.0	7.4	0.0	0.3	20.8	152.3
Prometryn	Post	1.000	10.0	10.0	0.0	0.0	8.0	8.5	6.8	13.1
Prometryn	Post	1.600	10.0	10.0	0.0	0.0	9.3	9.5	0.5	0.0
BAS 656 08H	Pre	0.660	5.8	6.3	54.8	21.7	5.5	6.3	19.8	19.4
BAS 656 08H	Pre	1.000	6.5	7.3	26.0	6.6	6.0	7.3	14.0	8.0
S-metolachlor	Pre	0.630	1.8	2.8	35.5	45.7	0.8	0.3	19.5	171.0
S-metolachlor	Pre	0.950	3.8	5.3	19.5	17.2	2.0	1.8	19.8	146.9
Azafenidin	Pre	0.025	8.3	8.5	7.8	6.3	1.0	0.5	17.0	151.5
Azafenidin	Pre	0.050	9.8	9.5	0.5	0.3	5.0	4.8	10.3	68.9
Quinclorac	Pre	0.140	7.0	8.8	41.0	4.8	0.5	2.3	19.3	180.7
Quinclorac	Pre	0.250	7.5	8.5	35.0	2.1	0.3	0.0	17.0	187.4
Prometryn	Pre	1.000	10.0	9.3	0.0	0.0	10.0	10.0	0.0	0.0
Prometryn	Pre	1.600	9.8	9.5	2.3	2.0	10.0	10.0	0.0	0.0
Handweeded Check	-	-	0.0	1.5	34.5	48.2	0.0	0.0	19.8	183.2
Untreated Check	-	-	0.0	0.0	42.3	40.3	0.0	0.0	21.8	154.7
LSD (0.05)			2.5	2.0	23.0	21.9	1.7	2.4	6.5	47.0
Days after preemergence treatment			33	47	47	48	33	47	47	48
Days after postemergence treatment			14	28	28	29	14	28	28	29

[a]Crop phytotoxicity 0 = no injury, 10 = death
[b]Crop biomass (dry weight)

Table 4. Phytotoxicity, stand count and crop biomass for spinach.

Herbicide	Stage	Rate	Spinach Phytotoxicity[a]		Spinach Stand	Spinach Biomass[b]
		lb A^{-1}			m^{-1}	g m^{-1}
S-3153	Post	0.018	5.3	3.3	62.3	67.0
S-3153	Post	0.027	4.8	4.3	77.8	62.8
S-3153	Post	0.054	7.8	5.5	46.3	18.5
Pyrithiobac	Post	0.014	6.3	9.3	6.7	6.5
Pyrithiobac	Post	0.027	7.0	9.8	0.8	0.5
Clopyralid	Post	0.047	1.8	3.0	80.8	60.5
Clopyralid	Post	0.094	0.8	1.8	111.8	87.6
Fluroxypyr	Post	0.024	1.0	0.8	122.3	81.7
Fluroxypyr	Post	0.047	2.0	2.8	97.3	56.8
Flumiclorac	Post	0.030	4.3	2.8	93.5	68.5
Flumiclorac	Post	0.040	4.0	3.5	101.5	53.5
Quinclorac	Post	0.140	1.0	1.0	122.0	106.2
Quinclorac	Post	0.250	0.8	3.3	91.5	73.2
Prometryn	Post	1.000	8.3	7.5	22.0	33.1
Prometryn	Post	1.600	9.8	9.8	0.5	1.9
BAS 656 08H	Pre	0.660	7.0	6.8	102.5	33.8
BAS 656 08H	Pre	1.000	7.0	6.8	74.8	19.7
S-metolachlor	Pre	0.630	0.8	2.0	67.3	115.3
S-metolachlor	Pre	0.950	2.3	1.8	73.0	67.6
Azafenidin	Pre	0.025	6.0	3.8	37.8	44.9
Azafenidin	Pre	0.050	8.5	7.5	4.0	6.7
Quinclorac	Pre	0.140	3.8	6.5	84.0	72.3
Quinclorac	Pre	0.250	5.8	6.8	57.3	43.8
Prometryn	Pre	1.000	9.8	9.5	0.3	0.1
Prometryn	Pre	1.600	9.5	9.5	1.8	1.8
Handweeded Check	-	-	0.0	1.0	106.3	83.0
Untreated Check	-	-	0.0	0.0	69.5	72.9
LSD (0.05)			1.9	2.7	33.7	44.6
Days after preemergence treatment			33	47	47	48
Days after postemergence treatment			14	28	28	29

[a]Crop phytotoxicity 0 = no injury, 10 = death
[b]Crop biomass (dry weight)

PROJECT 3: WEEDS OF AGRONOMIC CROPS

Bob Stougaard, Chair

Broadleaf weed control in spring-seeded alfalfa. Richard N. Arnold and D. Smeal. (New Mexico State University Agricultural Science Center, Farmington, NM 87499) Research plots were established on May 17, 2000 at the Agricultural Science Center, Farmington, New Mexico to evaluate the response of spring-seeded alfalfa (var. Legend) and annual broadleaf weeds to postemergence application of AC 299-263 and imazethapyr applied alone or in combination. Soil type was a Wall sandy loam with a pH of 7.8 and an organic matter content of less than 1%. The experimental design was a randomized complete block with three replications. Individual plots were 10 by 30 ft in size. Treatments were applied with a compressed air backpack sprayer calibrated to deliver 30 gal/A at 30 psi. Treatments were applied on June 12 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 12. Alfalfa was harvested on August 1, using a self-propelled Almaco plot harvester.

No crop injury was observed in any of the treatments. Bromoxynil applied at 0.25 lb/A gave poor control of redroot and prostrate pigweed. Russian thistle control was good to excellent with all treatments except Imazamox and imazethapyr applied at 0.032 and 0.047 lb/A and the check. Common lambsquarters and black nightshade control were good to excellent with all treatments except the check. The weedy check had significantly higher yields as compared to herbicide treatments. This is possibly attributed to the high weed content when harvested.

Table. Broadleaf weed control in spring-seeded alfalfa.

Treatments	Rate	Weed Control					Alfalfa
		SOLNI	AMARE	AMABL	SASKR	CHEAL	yield
	lb/A	%					t/A
Imazamox[a]	0.032	100	100	100	70	89	2.0
Imazamox[a]	0.04	100	100	100	92	94	1.9
Imazamox[a]	0.047	100	100	100	97	96	2.0
Imazamox[b]	0.032	100	100	100	95	100	1.8
Imazamox[b]	0.04	100	100	100	100	100	1.9
Imazamox[b]	0.047	100	100	100	95	99	2.0
Imazethapyr[b]	0.047	100	100	100	70	83	2.2
Imazethapyr + clethodim[b]	0.047+0.094	100	100	100	85	98	1.9
Imazethapyr[b]	0.064	100	100	100	92	95	2.1
Imazethapyr + clethodim[b]	0.064+0.094	100	100	100	98	98	1.9
Imazamox + clethodim[b]	0.032+0.094	100	100	100	83	98	2.0
Imazamox + sethoxydim[b]	0.032+0.19	100	100	100	95	100	1.9
Imazethapyr + sethoxydim[b]	0.047+0.19	100	100	100	98	84	2.1
Imazethapyr + sethoxydim[b]	0.064+0.19	100	100	100	95	93	2.2
Bromoxynil[a]	0.25	100	40	65	100	95	2.6
Weedy check		0	0	0	0	0	3.7
LSD 0.05		1	12	8	6	7	0.8

[a] Treatments were applied with X-77 surfactant and 32-0-0 at 0.25% and 1.0% v/v.

[b] Treatments were applied with MSO and 32-0-0 at 1.0% v/v.

Rotational crop response to simulated postemergence application of clopyralid to sugarbeets. John Roncoroni and Robert Norris (Weed Science Program, Vegetable Crops Department, University of California, Davis, CA 95616). Clopyralid is used for postemergence control of several weeds in sugarbeets. The herbicide can persist in the soil following the harvest of the sugarbeets. This trial evaluated impact of clopyralid residues in the soil on crops that are typically grown in rotation in California following sugarbeet harvest. The trial was established at the University of California research farm at Davis. Clopyralid was applied as a 10 inch wide band along each bed at 2.0 , 4.0 and 8.0 oz/A on June 30, 1999 to 20 ft wide (eight 30 inch center beds) by 50 feet long plots replicated four times. The soil type is a Yolo fine sandy loam. The field was then maintained as a simulated sugarbeet field to derive the 'worst case' scenario. No actual beets were planted to the field but it was irrigated on a typical 2-week schedule. Glyphosate was used to control weeds that germinated. The field was disked in a direction along the beds only on October 6. Thirty-inch beds were made on October 15. Alfalfa (cv. CUF 011) and lettuce (cv Parria Island Cos) were planted using a pull behind sled fitted with Planet Jr. planters on October 22, 1999. Irrigation was applied by sprinkler. A visual rating of percent germination was taken on November 22. Plants were counted on December 20,1999. In April 2000 the plots were rotovated lengthways, and bedded up for 30 inch center beds. The plots were planted to 2 rows each of cantaloupe (cv. Hybrid Challenger), tomato (cv. Hybrid La Rossa) and lettuce (cv Parria Island Cos) on June 6, 2000. Plant vigor and stand were assessed on August 9, 2000.

Lettuce and alfalfa planted in the fall approximately 5 months after the applications of clopyralid were severely damaged by the herbicide. The impact of the herbicide was evident at all rates evaluated, and increased with increasing rate. Alfalfa was particularly sensitive to the herbicide. Lettuce, tomatoes and cantaloupes planted in the spring approximately 12 months after the clopyralid application did not show any visible injury. There was no consistent affect of the herbicide on the stand of tomato or cantaloupe. There was a trend for decrease in lettuce stand (linear regression on treatment means significant at $P = 0.028$, $R^2 = 0.94$). Plant-back restrictions following use of clopyralid in sugarbeets should be observed.

Table. Rotational crop response to simulated postemergence application of clopyralid to sugarbeets.

Clopyralid	Lettuce		Alfalfa		Lettuce	Cantaloupe	Tomato
	Cover 11/22/99	Stand 12/20/99	Cover 11/22/99	Stand 12/20/99	Stand 8/9/00	Stand 8/9/00	Stand 8/9/00
(oz/A)	(%)	(plants/3 m)	(%)	(plants/3 m)	(plants/16 m)		
Untreated	92.3±3.0	50.5±6.5	66.3±12.8	20.0±1.5	38.5±16.5	59.8±20.6	57.5±5.7
2	70.0±8.9	40.5±8.7	5.5±1.7	3.6±2.4	36.0±4.1	27.5±5.2	78.8±20.4
4	58.8±17.1	24.5±6.6	5.5±3.3	1.3±1.3	34.5±9.4	40.0±16.6	116.8±14.8
8	30.0±21.7	12.9±11.1	3.8±3.8	0.0±0.0	29.8±9.3	43.0±22.8	83.5±24.6

All data are means of 4 replications ± standard error.

Broadleaf weed control in established Kentucky bluegrass. Jerry Swensen and Donn Thill. (Plant Science Division, University of Idaho, Moscow, ID 83844-2339) Experimental plots were established in one year old 'Marquis' Kentucky bluegrass near Rockford, Washington, to evaluate broadleaf weed control and crop injury with prosulfuron alone and in combination with 2,4-D, in comparison with tribenuron methyl. The experimental design was a randomized complete block with three replications. Herbicides were applied March 25, 2000, when rosettes of mayweed chamomile and fiddleneck tarweed were 2 inches in diameter. All herbicides were applied with a CO_2 pressurized backpack sprayer calibrated to deliver 10 gpa at 32 psi and 3 mph. Environmental conditions at the time of application were as follows; air temperature 50 F, relative humidity 73%, wind 0 to 3 mph, sky cloudy, and soil temperature 45 F at 4 inches. Crop injury and control of mayweed chamomile and fiddleneck tarweed were evaluated 53 and 97 days after treatment.

No herbicide treatments injured Kentucky bluegrass (data not shown). Control of mayweed chamomile ranged from 57 to 100% 53 DAT (Table). Prosulfuron at 0.0088 lb/A and tribenuron methyl at both rates controlled mayweed chamomile significantly less than higher rates of prosulfuron or prosulfuron plus 2,4-D amine (Table). At 53 DAT, fiddleneck tarweed control ranged from 83 to 100%. The lowest rates of prosulfuron and tribenuron methyl controlled fiddleneck tarweed significantly less than other treatments. By 97 DAT, mayweed chamomile and fiddleneck tarweed control ranged from 43 to 100%. Excellent control of mayweed chamomile and fiddleneck tarweed was maintained with prosulfuron applied at 0.0246 lb/A or greater. Poor mayweed chamomile and fiddleneck tarweed control was observed in stands treated with tribenuron methyl and prosulfuron at rates below 0.0246 lb/A.
Kentucky bluegrass seed yield were not measured due to extreme weediness of the site.

Table. Percent control of mayweed chamomile (ANTCO) and fiddleneck tarweed (AMSLY).

		53 DAT		97 DAT	
Treatment	rate	ANTCO	AMSLY	ANTCO	AMSLY
	lb/A	%			
Untreated check	-	-	-	-	-
Prosulfuron + NIS[a]	0.0088	87	87	67	70
Prosulfuron + NIS	0.0176	97	95	87	77
Prosulfuron + NIS	0.0246	100	97	100	97
Prosulfuron + NIS	0.0353	100	100	100	100
Tribenuron + NIS	0.0077	57	83	43	47
Tribenuron + NIS	0.0155	77	93	57	63
Prosulfuron + 2,4-D-amine[b] + NIS	0.0176 + 0.49	98	97	100	70
Prosulfuron + 2,4-D-amine[b] + NIS	0.0353 + 0.49	100	100	100	100
$LSD_{(0.05)}$		13	8	48	52

[a] NIS=90% nonionic surfactant (R-11) added at 0.025% v/v.
[b] acid equivalent rate for 2,4-D

Annual grass control in established Kentucky bluegrass with pendimethalin. Jerry Swensen, Traci Rauch, and Donn Thill. (Plant Science Division, University of Idaho, Moscow, ID 83844-2339) Experimental plots were established in ten year old 'Newport' Kentucky bluegrass near Gifford, Idaho, to evaluate crop injury and control of annual grasses with fall applied pendimethalin alone and in combination with fall applied flufenacet and spring applied oxyflourfen and diuron. The experiment was a randomized complete block design with four replications. All herbicides were applied with a CO_2 pressurized backpack sprayer calibrated to deliver 10 gpa at 32 psi and 3 mph (Table 1). Crop injury and percent cover were evaluated visually on April 19, 2000. Bulbous bluegrass (POABU) stand density and downy brome (BROTE) control were evaluated visually on May 22, 2000.

Table 1. Application information.

	September 9, 1999	March 8, 2000
Bluegrass growth stage	vegetative, 1-2 in. tall	vegetative, 2-3 in. tall
POABU and BROTE growth stage	preemergence	2 leaf
Air temp (F)	72	65
Relative humiditdy (%)	41	60
Wind (mph)	3	2
Sky (% cloud cover)	25	10
Soil temp at 4 in. (F)	60	52

No herbicide treatments injured Kentucky bluegrass (data not shown) which ranged in percent cover from 76 to 81% (Table 2). Bulbous bluegrass cover ranged from 7 to 15 %, and was not affected by herbicide treatment. No treatment controlled downy brome. Kentucky bluegrass seed yield ranged from 170 to 209 lb/A, and did not differ with herbicide treatment.

Table 2. Percent cover of Kentucky bluegrass and bulbous bluegrass (POABU), percent control of downy brome (BROTE),and bluegrass seed yields following application of four herbicide treatments.

Treatment	Rate	Application timing	Kentucky bluegrass	POABU	BROTE control	Kentucky bluegrass yield
	lb/A		% cover		%	lb/A
Untreated check	-	-	76	14	-	170
Pendimethalin	2.06	Fall	81	13	3	209
Pendimethalin	2.89	Fall	76	15	1	166
Pendimethalin +	2.06	Fall	80	8	1	159
flufenacet	0.425	Fall				
Pendimethalin +	2.06	Spring	81	7	2	176
oxyflourfen +	0.062	Spring				
diunon	1.20	Spring				
$LSD_{(0.05)}$			NS	NS	NS	NS

Imazapic for turf growth reduction in Kentucky bluegrass. Jerry Swensen, Janice Reed, and Donn Thill. (Plant Science Division, University of Idaho, Moscow, ID 83844-2339) Two studies, one with 8 and another with 16 Kentucky bluegrass varieties, were established under dryland conditions near Moscow, Idaho, to evaluate reduced turf growth with a single spring application of imazapic. The 8 and 16 variety studies were spring seeded in 1997, and 1992, respectively. Main plots were varieties, and subplots were imzazapic treated, or untreated check. On April 27, 2000, canopy height of each variety in both studies was measured, after which plots were mowed to a uniform height of 2 inches (Tables 1 and 3). Imazapic was applied at 0.06 lb ai/A on May 11, 2000, using a tractor-mounted sprayer calibrated to deliver 30 gpa at 40 psi and 5 mph. Environmental conditions at application were as follows: air temperature 52 F, relative humidity 70%, wind 3 mph, cloud cover 90%, and soil temperature 52 F at 4 inches. Canopy height in the 8 and 16 variety studies was measured May 23 and 24, 2000, 26 and 27 days after mowing (DAM), respectively, and again June 16, 2000, 50 DAM. After the last height measurement the plots were again mowed to a uniform height of 2 inches, and the clippings collected, dried and weighed.

In the 8 variety study, canopy height 26 and 50 DAM varied with variety (Table 1). Regrowth in varieties Caliber and Award was less than Blue Chip, South Dakota, and Odyssey. Weight of regrowth collected 50 DAM was greatest in Odyssey and least in Caliber. Imazapic reduced canopy height and regrowth weight 19% and 46%, respectively, 50 DAM (Table 2).

In the 16 variety study, canopy height 27 and 50 DAM varied with variety (Table 3). Regrowth was least in varieties Ram I, Baron, Glade, Cheri, and Midnight, while the greatest regrowth was in varieties Argyle, Kenblue, Huntsville, South Dakota, Wabash, and Adelphi. Weight of regrowth was lowest in Midnight, Glade, and Cheri. By 50 DAM, imazapic had reduced canopy height and regrowth weight by 32% and 69%, respectively.

Table 1. Canopy height of eight Kentucky bluegrass varieties prior to mowing (PTM) and 26 and 50 days after mowing (DAM), and dry weight of regrowth 50 DAM. Values are means of treated and untreated plots.

	Canopy height			Regrowth weight
Variety	PTM	26 DAM	50 DAM	50 DAM
	inches			lb/A
Award	3.5	3.7	4.2	424
Blue Chip	7.5	4.7	6.0	418
Caliber	2.8	3.0	4.2	384
Classic	3.6	3.7	5.1	675
NuBlue	4.8	4.4	5.0	538
Odyssey	4.1	4.4	5.9	791
Palouse	2.8	3.6	4.7	348
South Dakota	6.9	5.1	5.9	444
$LSD_{(0.05)}$	1.4	0.6	1.2	361

Table 2. Effects of imazapic on Kentucky bluegrass canopy height 26 and 50 days after mowing (DAM), and regrowth weight 50 DAM. Values are means of eight varieties.

	Canopy height		Regrowth weight
Treatment	26 DAM	50 DAM	50 DAM
	inches		lb/A
Untreated check	4.4	5.7	651
Imazapic	3.7	4.6	354
$LSD_{(0.05)}$	0.3	0.5	145

Table 3. Canopy height of 16 Kentucky bluegrass varieties prior to mowing (PTM), and 27 and 50 days after mowing (DAM), and dry weight of regrowth measured 50 DAM. Values are means of treated and untreated plots.

Variety	Canopy height			Regrowth weight
	PTM	27 DAM	50 DAM	50 DAM
	inches			lb/A
Adelphi	2.7	4.7	6.2	590
Argyle	4.3	7.1	7.2	736
Baron	2.7	5.9	4.8	471
Cheri	2.6	3.8	4.6	256
Eclipse	2.7	4.3	5.7	437
Glade	2.3	3.3	4.7	298
Huntsville	4.6	6.7	6.7	667
Julia	2.6	5.9	5.6	656
Kenblue	4.3	6.5	7.1	753
Liberty	2.6	4.3	5.2	466
Midnight	2.3	3.5	4.1	412
Newport	4.2	5.8	6.1	723
Ram I	2.3	4.7	4.9	538
South Dakota	4.9	6.9	6.5	691
Suffolk	2.9	4.7	5.3	671
Wabash	4.5	5.9	6.3	654
$LSD_{(0.05)}$	0.6	1.1	1.1	324

Table 4. Effects of imazapic on Kentucky bluegrass canopy height 27 and 50 days after mowing (DAM), and regrowth weight 50 DAM. Values are means of 16 varieties.

Treatment	Canopy height		Regrowth weight
	27 DAM	50 DAM	50 DAM
	inches		lb/A
Untreated check	4.4	5.7	651
Imazapic	3.7	4.6	354
$LSD_{(0.05)}$	0.3	0.5	166

Reduced lodging in established Kentucky bluegrass with trinexapac-ethyl. Jerry Swensen, Janice Reed, and Donn Thill. (Plant Science Division, University of Idaho, Moscow, ID 83844-2339) A study was established in four year old 'Palouse' Kentucky bluegrass near Nezperce, Idaho, to evaluate crop injury and reduced lodging with trinexapac-ethyl, applied at three times and three concentrations. The experiment was a randomized complete block design with four replications. Treatments were applied May 1, May 12, and May 26, using a CO_2 pressurized backpack sprayer calibrated to deliver 10 gpa at 32 psi and 3 mph (Table 1). Crop injury and canopy height were measured June 2, 2000. Lodging was evaluated visually June 21, 2000. Plots were swathed at maturity and panicle density and seed yield were determined.

Table 1. Application information.

	May 1, 2000	May 12, 2000	May 26, 2000
Bluegrass stage	late boot	10% heading	50% heading
Air temp (F)	70	53	62
Relative humidity (%)	54	72	74
Wind (mph)	2	2	2
Cloud cover (%)	5	90	95
Soil temp at 4 in. (F)	55	47	52

No treatments injured Kentucky bluegrass (data not shown). Canopy height ranged from 28 to 33 inches and was greatest in the untreated check (Table 2). The two highest rates of trinexapac-ethyl reduced canopy height about 12%, while application timing had no effect on canopy height. All treatments reduced lodging of Kentucky bluegrass 77 to 100% compared to the untreated check. The lowest rate reduced lodging 77 to 88%, while the two higher rates reduced lodging 95 to 100%. Panicle density ranged from 212 to 372 panicles per square foot, and did not differ between treatments. Seed yields ranged from 166 to 265 lb/A, and did not vary significantly among treatments.

Table 2. Effects of trinexapac-ethyl applied at three dates and three rates, on Kentucky bluegrass canopy height, percent lodging, panicle density and seed yield.

Treatment	Rate	Application Timing	Canopy height	Lodging	Panicle density	Seed yield
	lb/A		inches	%	no/ft ^{2}	lb/A
Untreated check	-	-	33.8	83	372	254
trinexapac-ethyl	0.176	Late boot	32.0	16	295	265
trinexapac-ethyl	0.353	Late boot	31.3	1	212	239
trinexapac-ethyl	0.529	Late boot	29.8	0	304	200
trinexapac-ethyl	0.176	10% head	31.8	10	220	166
trinexapac-ethyl	0.353	10% head	30.3	1	234	215
trinexapac-ethyl	0.529	10% head	28.0	0	241	238
trinexapac-ethyl	0.176	50% head	32.5	19	221	240
trinexapac-ethyl	0.353	50% head	30.3	3	295	211
trinexapac-ethyl	0.529	50% head	29.5	4	303	177
$LSD_{(0.05)}$			2.0	12	NS	NS

Weed control in herbicide resistant canola. Joan Campbell and Donn Thill. (Department of Plant, Soil, and Entomological Sciences, University of Idaho, Moscow, ID 83844-2339) Weed control in herbicide resistant canola was evaluated at the University of Idaho farm near Moscow, Idaho. Three varieties (Hyola, SWRiderR, and DKL 27-20) of glyphosate resistant canola, two varieties (Phoenix and Invigor 2373) of glufosinate resistant canola (Glu-R), and one variety (46A76) of imidazolinone resistant canola (Imi-R) were seeded in experiment one. Glu-R 'Invigor 2373' canola was seeded in experiment two and Imi-R '46A76' canola was seeded in experiment three. All three experiments were seeded on May 7, 2000. Soil type was a loam with 4.64% organic matter, 39 cmol/kg CEC, and 4.3 pH. Also, the first experiment was repeated (experiment 4) in an adjacent field, which was evaluated for volunteer barley control, but the canola seed was not harvested. Treatments were applied with a CO_2 pressurized backpack sprayer calibrated to deliver 10 gal/A at 32 psi (Table 1). The Imi-R experiment was sprayed at the canola 3 leaf growth stage on June 6. Canola seed was harvested with a small plot combine from a 4.5 by 27 ft area. The Gly-R experiment was harvested on August 31, and the Glu-R and Imi-R experiments were harvested on September 7.

Table 1. Application data.

Experiment	1,2,3	4	1, 4	2, 3	1, 2, 4
Application date	May 5	May 22	June 5	June 6	June 9
Growth stage					
Canola	PPI	PPI	1-2 leaf	3 leaf	5-6 leaf
Common lambsquarters (CHEAL)	PPI	--	3 leaf	3-6 leaf	4-6 leaf
Wild oat (AVEFA)	PPI	--	2-3 leaf	2-4 leaf	2-3 inch tall
Mayweed chamomile (ANTCO)	PPI	--	0.5-1 inch diameter	0.5 inch diameter	1-2 inch diameter
Volunteer barley (HORVX)	--	PPI	2 leaf	--	3 leaf
Air temperature (F)	48	61	80	76	62
Soil temperature (F)	55	70	60	60	60
Relative humidity (%)	80	55	54	56	64
Wind velocity (mph)	3 West	0	0	1 West	2 NW
Cloud cover (%)	100	0	100	90	50

In the first experiment, all glyphosate treatments controlled all weeds (Table 2). Glufosinate controlled common lambsquarters in both 'Phoenix' and 'Invigor 2373'. Wild oat control was 97% with glufosinate in 'Phoenix', but only 75% in 'Invigor 2373". Likely, poor control in 'Invigor 2373' was an artifact of inconsistent wild oat population across the experiment. Volunteer barley control was control was 96% in 'Invigor 2373' and 70% in 'Phoenix'. Poor control in 'Phoenix' was likely due to glyphosate sprayer contamination injury in this experiment. Imazamox did not control any weed species because spray additives were inadvertently omitted from the treatment. Canola seed yield did not differ among treatments.

Weed control (CHEAL, AVEFA, ANTCO) was 100% with all treatments in the Imi-R and Glu-R experiments (Table 3 and 4). Canola seed yield was low due to shattering and seed yield did not differ among treatments.

Table 2. Weed control and seed yield in herbicide resistant canola.

Treatment[a]	Variety	Application growth stage	Rate[b]	Weed control[c] ANTCO	CHEAL	AVEFA	HORVX	Canola seed yield
		canola leaf no.	lb/A	%	%	%	%	lb/A
Glyphosate	Hyola	5-6	0.375	100	100	100	100	1214
Glyphosate	SWRideR	5-6	0.375	100	100	100	100	1269
Glyphosate	DKL 27-20	5-6	0.375	100	100	100	100	1583
Glyphosate +	Hyola	1-2	0.375	100	100	100	100	1673
glyphosate		5-6	0.375					
Check	Hyola		--	--	--	--	--	1549
Glyphosate +	SWRideR	1-2	0.375	100	100	100	100	1592
glyphosate		5-6	0.375					
Check	SWRideR		--	--	--	--	--	1525
Glyphosate +	DKL 27-20	1-2	0.375	100	100	100	100	1597
glyphosate		5-6	0.375					
Check	DKL 27-20		--	--	--	--	--	1638
Glufosinate	Phoenix	5-6	0.443	50	100	97	70	1264
Check	Phoenix			--	--	--	--	1368
Glufosinate	Invigor 2373	5-6	0.443	100	100	75	96	1486
Check	Invigor 2373		0	0	0	0	0	1724
Imazamox	46A76	5-6	0.31	63	13	55	39	1467
Check	46A76		--	--	--	--	--	1328
Trifluralin +	Hyola	5-6	0.75	75	75	100	100	1857
quizalofop +			0.055					
NIS			0.25 % v/v					
LSD (0.05)				NS	25	24	13	NS
Density (plants/ft²)				2	4	1-2	15	

[a] Glyphosate was applied with Ammonium sulfate (Bronc) at 17 lb/100 gal.

[b] Glyphosate rate is acid equivalent. Other rates are active ingredient.

[c] ANTCO, CHEAL, and AVEFA data are from experiment 1 and HORVX data are from experiment 4.

Table 3. Glufosinate resistant canola yield.

Treatment	Rate	Time of application	Canola yield
		canola leaf no.	lb/A
Untreated	0	--	636
Trifluralin glufosinate[a]	0.75 0.357	PPI 5-6	648
Glufosinate[a] glufosinate[a]	0.268 0.268	3 5-6	618
Quizalofop[b] glufosinate[a]	0.048 0.357	3 5-6	540
Glufosinate[a]	0.446	5-6	562
Quizalofop + glufosinate[a]	0.033 0.357	5-6	524
Sethoxydim + glufosinate[a]	0.164 0.357	5-6	542
Trifluralin quizalofop[b]	0.75 0.048	PPI 5-6	507
Quizalofop[b] + clopyralid	0.048 0.187	5-6	490
Glufosinate[a] glufosinate[a]	0.357 0.223	3 5-6	559
Glufosinate[a] glufosinate[a]	0.446 0.223	3 5-6	575
Glufosinate[a] glufosinate[a]	0.357 0.268	3 5-6	551
Glufosinate[a] glufosinate[a]	0.446 0.268	3 5-6	588
LSD(0.05)			NS

[a] Ammonium sulfate (Bronc) added at 15 lb/100 gal
[b] Nonionice surfactant (R-11) added at 0.25% v/v

Table 4. Imidazolinone resistant canola yield.

Treatment	Rate	Canola yield
	lb/A	lb/A
Untreated	0	351
Imazamox + seed oil COC[a] + AMS[b]	0.0313	410
Imazamox + petroleum COC[c] + AMS	0.0313	396
Imazamox[a] + nonionic surfactant[c] + AMS	0.0313	352
Imazamox[a] + seed oil COC[a]	0.0313	358
Imazamox + petroleum COC[c] +	0.0313	318
Imazamox + nonionic surfactant[d]	0.0313	485
Imazamox + AMS	0.0313	322
Trifluralin	0.75	362
Trifluralin + quizalofop + nonionic surfactant[c]	0.75 0.055	321
Trifluralin	0.75	332
Imazamox + nonionic surfactant[d] + AMS	0.0313	344
LSD(0.05)		NS

[a] Sun-itII applied at 2% v/v
[b] Ammonium sulfate (Bronc) applied at 15 lb/100 gal
[c] Moract applied at 2% v/v
[d] R-11 applied at 0.25% v/v

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. An experiment was conducted near Genesee, Idaho to compare 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 above-ground biomass, 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.

In monocultures yellow mustard yielded 30% more than canola and seed yield of both crops was independent from density. Wild oat had no effect on yellow mustard yield at any density, while canola yield was reduced on average by 40% for all wild oat/canola proportions. Wild oat seed production was reduced 64% by canola and 90% by yellow mustard on average compared to wild oat in monoculture. Wild oat seed production tended to increase with increasing wild oat density in wild oat/canola proportions. Yellow mustard decreased wild oat seed production independently from wild oat density. Greater competitive ability of yellow mustard with wild oat compared to canola also was observed previously in interference experiments in greenhouse.

Table. Effect of wild oat/canola and wild oat/yellow mustard interference on crop yield and wild oat seed production in the field near Genesee, ID in 2000.

Weed/crop proportion [a]	Wild oat/canola		Wild oat/yellow mustard	
	Crop yield	Wild oat seed production	Crop yield	Wild oat seed production
plants/m²	kg/ha	seed/m²	kg/ha	seed/m²
0/75	511	-	625	-
0/150	385	-	691	-
0/225	568	-	697	-
0/300	409	-	643	-
75/0	-	51,040	-	57,889
75/75	327	16,966	455	3,147
75/150	259	10,306	501	3,114
75/225	300	16,690	514	6,011
75/300	296	9,808	721	2,800
150/0	-	61,810	-	69,428
150/75	283	35,630	524	9,608
150/150	200	29,056	370	4,992
150/225	271	15,008	398	4,742
150/300	186	15,848	574	3,126
225/0	-	78,968	-	86,312
225/75	295	39,030	573	8,406
225/150	236	36,814	694	5,728
225/225	285	26,664	492	7,202
225/300	314	20,177	689	6,672
300/0	-	80,056	-	75,154
300/75	406	32,560	480	22,374
300/150	228	34,938	629	8,268
300/225	350	24,964	517	10,694
300/300	275	26,180	695	7,528

[a] Wild oat density always listed first.

Rates of yellow mustard, canola and wild oat development in 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. In a greenhouse interference experiment conducted in 1999, yellow mustard var. "Idagold' reduced above-ground biomass and panicle production of wild oat 35 and 60%, respectively, while canola var. 'Sunrise' had no effect on wild oat biomass and panicle production. Rapid early development of yellow mustard was suggested to be responsible for its greater competitive ability with wild oat compared to canola. Thus, a greenhouse experiment was conducted in 2000 to compare plant height and biomass accumulation by yellow mustard, canola and wild oat over a 7 week period. Monocultures of yellow mustard, canola and wild oat were grown at 75 plants m^{-2} (16 randomly spaced plants per 45 by 45 cm, 19 L pots). Heights and above-ground biomass were determined by harvesting four plants of each species at 1, 3, 4, 5 and 7 weeks after emergence (WAE) from different pots.

Biomass of the three species did not differ at 1 WAE (Table 1). A 66% increase in yellow mustard biomass accumulation occurred at 3 WAE, while a 37 and 42% increase in wild oat and canola biomass accumulation, respectively, took place at 4 WAE. At 3 WAE, flowering stems of yellow mustard had begun to elongate, while canola plants were still in a rosette stage, resulting in 39% taller yellow mustard plants compared to canola. Linear models describing biomass accumulation by the three species were developed: yellow mustard biomass (g) = 1.94 WAE - 3.84, canola biomass (g) = 1.35 WAE - 2.87, and wild oat biomass (g) = 0.92 WAE - 2.03. Exponential models predicted that the rate of biomass accumulation by yellow mustard was superior to that of wild oat and marginally greater compared to canola, while the rates were similar between canola and wild oat (Table 2). Yellow mustard also had the greatest rate of plant elongation, followed by canola and wild oat (data not shown).

Table 1. Plant height and above-ground biomass of yellow mustard, canola and wild oat in a greenhouse experiment [a].

WAE [b]	Plant height			Biomass		
	yellow mustard	canola	wild oat	yellow mustard	canola	wild oat
		cm			g	
1	6	7	16	0.1	0.1	0.1
3	27	16	40	0.8	0.3	0.2
4	56	30	57	2.5	1.5	0.9
5	84	48	79	4.0	2.6	1.4
7	147	102	106	11.8	8.3	5.8

[a] All measurements are on per plant basis

[b] Weeks after emergence

Table 2. Contrasts of coincidence of the regression lines describing plant above-ground biomass accumulation over time for wild oat, yellow mustard and canola.

Statistic	Contrast		
	yellow mustard vs. canola	yellow mustard vs. wild oat	canola vs. wild oat
Sums of squares	2.6	8.4	1.7
F-value	3.0	9.6	1.9
Pr > F	0.05	0.0003	0.2

Evaluation of injury to imidazolinone-tolerant canola seeded into sulfonylurea-treated soil. Brian M. Jenks, Denise M. Markle, Gary P. Willoughby, and Kent McKay. (North Central Research Extension Center, North Dakota State University, Minot, ND 58701) Herbicide treatments were applied May 21, 1999. One year later, imidazolinone-tolerant canola (46A76) was seeded May 17,2000 at 700,000 pls/A into 6-inch rows under a conventional tillage system. Individual plots were 10 by 60 ft and replicated three times. Canola was harvested August 22, 2000.

Table. Canola yield one year after herbicide application.

		Canola (2000)	
Treatment (1999)	Rate	Yield	Tst Wt
	lb ai/A	lb/A	lb/bu
Untreated		1637	50.6
Prosulfuron	0.009	1662	50.8
Triasulfuron	0.013	1662	50.7
Triasulfuron & dicamba (Na)	0.074	1601	50.8
Metsulfuron & chlorsulfuron	0.012	1658	50.8
Metsulfuron	0.0038	1812	50.7
LSD		NS	NS
CV		8	0.3

The plot area was not tilled in fall 1999. We disked the plot area twice in spring 2000 prior to seeding. Imazamox (0.031 lb) was applied postemergence over the entire plot. The only visible injury was a slight yellowing on one end of the study which was on a steeper slope. The pH and OM on the slope were 8.2 and 2.4%, respectively. The pH and OM for the rest of the plot area was 7.7 and 3.0%, respectively. Canola yields in the treated plots were not significantly different from the untreated.

Weed control in chickpea. Brian M. Jenks, Denise M. Markle, Gary P. Willoughby, and Kent McKay. (North Central Research Extension Center, North Dakota State University, Minot, ND 58701) Chickpeas ('Sanford') were planted April 28 into 6-inch rows at 150 lb/A in a conventional tillage system. Individual plots were 10 by 30 ft arranged in a RCBD with three replicates. Treatments were applied preplant incorporated (PPI) on April 26, preemergence (PRE) on May 3, or postemergence (POST) on June 5. PRE and PPI treatments were applied with a CO_2 pressurized bicycle sprayer with XR80015 flat fan nozzles delivering 20 gpa at 30 psi. All POST treatments were applied using XR8001 flat fan nozzles delivering 10 gpa at 40 psi. Pyridate was applied postemergence when chickpeas were about 5 to 6in tall. The primary weeds present were wild buckwheat, kochia, redroot pigweed, and yellow foxtail.

Table. Weed control and injury to chickpeas.

			Crop Injury		POLCO		KCHSC		AMARE	SETLU
Treatment[a]	Rate	Crop stand	May 25	Jul 15	Jul 15	Aug 21	Jul 15	Aug 21	Jul 15	Aug 21
	lb ai/A	pl/m of row	%		% Control					
Untreated		5.1	0	0	0	0	0	0	0	0
PPI										
Ethalfluralin	0.75	3.7	3	0	67	57	79	74	100	75
Trifluralin	1	—	5	0	60	68	70	57	98	79
Pendimethalin	1.5	—	1	0	73	80	75	65	94	85
Sulfentrazone[a]	0.125	5.3	4	0	42	45	77	80	73	58
Sulfentrazone[a]	0.25	4.8	3	0	83	78	93	95	85	80
Sulfentrazone[a]	0.5	4.0	7	2	91	92	99	99	97	85
PRE										
Isoxaflutole	0.047	4.9	0	0	0	0	98	95	100	80
Isoxaflutole	0.07	5.5	0	0	0	0	100	99	100	84
Isoxaflutole	0.14	5.0	0	0	0	0	100	99	100	89
Sulfentrazone[a]	0.125	3.8	0	0	48	53	84	73	83	58
Sulfentrazone[a]	0.25	4.5	2	0	81	86	100	99	93	72
Sulfentrazone[a]	0.5	4.4	5	3	95	92	100	100	99	88
Flumioxazin[a]	1	3.4	12	0	28	23	97	95	98	47
Flumioxazin[a]	1.5	3.5	18	3	48	43	92	86	97	72
Flumioxazin[a]	3	3.9	47	3	73	62	98	94	100	70
PPI/POST										
Handweeded check[b]		3.7	3	0	95	89	100	100	100	94
Trifluralin /	0.75 /	—	3	0	75	77	100	96	100	95
pyridate +	0.94 +									
quizalofop +	0.048 +									
NIS	0.25 %									
LSD			4	2	12	15	15	20	11	12
CV			39	196	13	17	11	14	7	10

[a] All sulfentrazone and flumioxazin treatments were followed by a POST application of quizalofop at 0.048 lb.
[b] Trifluralin (PPI) and pyridate + NIS (POST) were applied at 0.75 lb and 0.94 lb + 0.25% to aid handweeding.

We evaluated chickpea tolerance to several new herbicides as well as weed control with these new products compared to existing products. Sulfentrazone at 0.25 lb or higher provided good to excellent control of kochia, wild buckwheat, and redroot pigweed. Sulfentrazone at 0.125 lb did not provide adequate weed control. Isoxaflutole was effective on kochia and pigweed, but had no effect on wild buckwheat. Flumioxazin provided good to excellent kochia and pigweed control, but poor wild buckwheat control. Trifluralin/pyridate provided excellent control of kochia and pigweed, but only fair control of wild buckwheat. Chickpea yields are not presented due to the confounding nature of the wild buckwheat pressure and ascochyta that caused severe damage to the study. Treatments that did not effectively control wild buckwheat suffered severe or total yield loss as a result of the high wild buckwheat pressure.

Weed Control in Chickpeas. Joseph P. Yenish, John D. Toker, and Edward J. Scheenstra. (Washington State University, Pullman, WA 99164-6420). The study was conducted near Pullman, WA to evaluate determine common lambsquarters control and crop injury of labeled and nonlabeled herbicides in chickpeas. The study was designed as a randomized complete block with 4 replications. Application timings included PPI = preplant incorporated applied 4/29/00, PRE = preemergence applied 5/1/00, and POST = postemergence applied 6/5/00. All herbicides were applied using a CO_2 backpack sprayer calibrated to deliver 10 gallons per acre at 35 psi.

Common lambsquarters control was fair to excellent with greatest control with postemergence pyridate, pyridate plus quizalofop, and the higher rate of isoxaflutole. Postemergence 2,4-DB applications injured chickpeas the greatest. Chickpea yields were similar regardless of treatment.

Table. Common lambsquarters control and chickpea injury and yield.

			Common lambsquarters control		Chickpea	
Treatment	Rate	Timing	6/20/00	8/15/00	Injury 6/20/00	Yield
			---- % ----			lbs/a
Weedy check	lbs/a		0	0	0	2782
Imazethapyr	0.047	PPI	78	65	0	2761
Pendimethalin	0.75	PPI	91	74	1	2914
Imazethapyr + pendimethalin	0.047 + 0.63	PPI	90	88	0	2844
Flufenacet + metribuzin	0.4 + 0.1	PRE	74	65	0	3008
Sulfentrazone	0.25	PRE	69	84	0	3216
Sulfentrazone	0.19	PRE	80	71	0	3017
Metribuziun	0.25	PRE	69	65	0	2879
Chloransulam	0.032	PRE	65	58	0	2823
V-53482	0.078	PRE	90	76	0	2828
Isoxaflutole	0.06	PRE	88	80	2	2962
Isoxaflutole	0.094	PRE	95	89	0	3145
2,4-DB	0.25	POST	71	58	15	2812
Pyridate	0.94	POST	95	91	1	2893
Pyridate + quizalofop[a]	0.94 + 0.044	POST	94	91	0	2961
LSD (p=0.05)			25	15	2	ns

[a]applied with 0.25% v/v nonionic surfactant.

Broadleaf weed control in field corn with postemergence herbicides. Richard N. Arnold and D. Smeal. (New Mexico State University Agricultural Science Center, Farmington, NM 87499) Research plots were established on May 8, 2000 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. Field corn was planted with flexi-planters equipped with disk openers on May 8. Postemergence treatments were applied on June 6 when corn was in the 4th leaf stage and weeds were small. Black nightshade, prostrate and redroot pigweed, and common lambsquarters infestations were heavy and Russian thistle infestations were light throughout the experimental area. Treatments were evaluated on July 6.

DPX 79406 plus dicamba applied at 0.023 plus 0.25 lb/A had the highest injury level of 5. All treatments except the check gave good to excellent control of common lambsquarters, black nightshade, redroot and prostrate pigweed. Russian thistle control was good to excellent with all treatments except DPX 7946 applied alone at 0.023 lb/A or in combination with pyridate applied at 0.35 and 0.47 lb/A and the check.

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

Treatments[a,b]	Rate	Crop injury	Weed control				
			CHEAL	SOLNI	AMARE	AMABL	SASKR
	lb/A	%	%				
DPX 79406	0.023	0	100	100	100	100	82
DPX 79406 + atrazine	0.023+0.45	0	100	100	100	100	90
DPX 79406 + dicamba	0.023+0.125	3	100	100	100	100	100
DPX 79406 + dicamba	0.023+0.25	5	100	100	100	100	100
DPX 79406 + dicamba + atrazine (pm)	0.023+0.4	0	100	100	100	100	100
DPX 79406 + dicamba + atrazine (pm)	0.023+0.8	2	100	100	100	100	100
DPX 79405 + diflufenzopyr + dicamba (pm)	0.023+0.1	0	100	100	100	100	100
DPX 79406 + diflufenzopyr +dicamba (pm)	0.023+0.2	0	100	100	100	100	100
DPX 79406 + pyridate	0.023+0.35	0	93	88	91	91	72
DPX 79406 + pyridate	0.023+0.47	3	100	91	100	100	83
Weedy check		0	0	0	0	0	0

[a] pm equal packaged mix
[b] All treatments had MSO added at 1.0% v/v.

Broadleaf weed control in field corn with preemergence herbicides. Richard N. Arnold and D. Smeal. (New Mexico State University Agricultural Science Center, Farmington, NM 87499) Research plots were established on May 8, 2000 at the Agricultural Science Center, Farmington, New Mexico to evaluate the response of field corn (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 8. Treatments were applied on May 9 and immediately incorporated with 0.75 in of sprinkler applied water. Black nightshade, common lambsquarters, redroot and prostrate pigweed infestation were heavy and Russian thistle infestation were light throughout the experimental area. Crop injury evaluations were made on June 6 and weed control evaluations were made on July 6.

Flufenacet plus metribuzin plus isoxaflutole applied at 0.51 and 0.03 lb/A caused the highest injury of 64. All treatments except the check gave good to excellent control of common lambsquarters, Russian thistle, prostrate pigweed, and black nightshade. Redroot pigweed control was good to excellent with all treatments except atrazine applied at 1.5 lb/A and the check.

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

Treatments[a]	Rate	Crop injury	Weed control				
			CHEAL	SASKR	AMARE	AMABL	SOLNI
	lb/A	—%—	—%—				
Flufenacet + isoxaflutole (pm)	0.193	4	100	100	100	97	100
Flufenacet + isoxaflutole (pm) + atrazine	0.193+0.6	6	100	100	97	100	98
Flufenacet + isoxaflutole (pm)	0.29	15	100	100	100	100	100
Flufenacet + metribuzin (pm) + isoxaflutole	0.51+0.03	64	100	100	98	100	100
Flufenacet + metribuzin (pm) + isoxaflutole	0.28+0.047	42	100	100	100	100	100
Isoxaflutole	0.047	11	100	100	96	100	100
Atrazine	1.5	0	100	100	67	93	97
Weedy check		0	0	0	0	0	0

[a] pm equal packaged mix.

Broadleaf weed control in roundup ready field corn with preemergence herbicides followed by a sequential treatment of glyphosate. Richard N. Arnold and D. Smeal. (New Mexico State University Agricultural Science Center, Farmington, NM 87499) Research plots were established on May 9, 2000 at the Agricultural Science Center, Farmington, New Mexico to evaluate the response of Roundup Ready field corn (var. Dekalb 580RR) and annual broadleaf weeds to preemergence herbicides followed by a sequential treatment of Roundup. 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, 43 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 9. Preemergence treatments were applied on May 9 and immediately incorporated with 0.75 in of sprinkler applied water. Postemergence treatments were applied on June 6. Common lambsquarters, redroot and prostrate pigweed, and black nightshade infestations were heavy throughout the experimental area. Preemergence treatments were evaluated on June 7 before postemergence treatments were applied. Roundup treatments were evaluated on July 13.

Dimethenamid applied at 4.4 lb/A gave the highest injury rating of 67. All treatments applied preemergence gave excellent control of broadleaf weeds before Roundup was applied. Roundup applied at 1.0 lb/A showed no crop injury.

Table. Broadleaf weed control in Roundup Ready field corn with preemergence herbicides followed by a sequential treatment of Roundup.

Treatments[a]	Rate	Crop Injury	Weed control			
			SOLNI	AMARE	AMABL	CHEAL
	lb/A	——%——	——%——			
Acetochlor/ glyphosate	3.5/1.0	3	100	100	100	100
Metolachlor/ glyphosate	2.6/1.0	1	100	100	100	100
Dimethenamid/ glyphosate	2.2/1.0	8	100	100	100	100
Acetochlor/ glyphosate	7.0/1.0	47	100	100	100	100
Metolachlor/ glyphosate	5.2/1.0	7	100	100	100	100
Dimethenamid/ glyphosate	4.4/1.0	67	100	100	100	100
Acetochlor/ glyphosate	1.75/1.0	0	100	100	100	100
Metolachlor/ glyphosate	1.3/1.0	0	100	100	100	100
Dimethenamid/ glyphosate	1.1/1.0	0	100	100	100	100
Weedy check		0	0	0	0	0

[a] Roundup was applied with ammonium sulfate at 2% v/v.

Annual weed control in Liberty Link® corn. John O. Evans, Brent Beutler, and R.William Mace. (Department of Plants, Soils, and Biometeorology, Utah State University, Logan, Utah 84322-4820) Liberty Link® hybrid corn (Pioneer 34A55) was planted May 12, 2000 at the Utah State University Greenville Farm in North Logan, UT to compare several preemergence herbicides with some new postemergence treatments to control prostrate pigweed in corn. Individual treatments were applied to 10 by 40 foot plots with a CO_2 backpack sprayer using flatfan 8002 nozzles providing a 10 foot spray width calibrated to deliver 14 gpa at 39 psi. The soil was a Millville silt loam with 7.5 pH and OM content of less than 2%. Treatments were applied in a randomized block design, with four replications. Preemergence treatments were applied May 23. Postemergence treatments were applied June 8, when the corn was in the 4 -5 leaf stage and prostrate pigweed was 2-8 inches tall. Visual evaluations for weed control and crop injury were completed July 7 and July 28, 2000. Plots were harvested October 9.

There was no evidence of corn injury for either preemergence or postemergence treatments. Preemergence treatments did not preform as well as postemergence applications against prostrate pigweed. Weather and field conditions prevented immediate post-planting application of the preemergence herbicides and although seedling weeds were not visible at treatment, we suspect some may have germinated but not yet emerged. Metolachlor/atrazine was the best preemergence treatment while isoxaflutole, flufenacet/isoxaflutole, and thiafluimide/metribuzin/atrazine provide only marginal control of prostrate pigweed. Postemergence treatments of glufosinate and rimsulfuron/thifensulfuron were excellent controls for prostrate pigweed and nicoslufuron/rimsulfuron/atrazine provided good control. Yields were not significantly different among treatments except for the untreated and the acetochlor treatment which were approximately 3 T/A below the best yielding treatments. (Utah Agricultural Experiment Station, Logan, UT. 84322-4820)

Table. Annual weed control in Liberty Link® corn.

			Corn			Weed Control	
			Injury		Yield	AMABL	
Treatment	timing	Rate	7/7	7/28	10/9	7/7	7/28
		lb ai/A	—%—		T/A	—%—	
Untreated			0	0	6.2	0	0
Thiafluamide/metribuzin	PRE	0.54	0	0	8.8	10	55
Thiafluamide/metribuzin/atrazine	PRE	1.5	0	0	9.1	35	71
Isoxaflutole	PRE	0.059	0	0	8.7	65	59
Acetochlor	PRE	1.75	0	0	7.3	25	5
Metolachlor/atrazine	PRE	2.3	0	0	10.0	99	92
Flufenacet/isoxaflutole	PRE	0.22	0	0	9.2	60	20
Nicosulfuron/rimsulfuron/atrazine	POST	0.875	0	0	8.5	45	73
Rimsulfuron/thifensulfuron	POST	0.063	0	0	9.5	98	92
Glufosinate	POST	0.37	0	0	10.2	98	93
LSD(0.05)			0	0	1.1	18	20

Control of common lambsquarters in Roundup Ready® corn. John O. Evans, Paul Haderlie, and R.William Mace. (Department of Plants, Soils, and Biometeorology, Utah State University, Logan, Utah 84322-4820) Roundup Ready® corn (DeKalb RR626) was planted May 12, 2000 at the Utah State University Greenville Farm in North Logan, UT to evaluate several preemergence and postemergence herbicides to control common lambsquarters. Individual treatments were applied to 10 by 40 foot plots with a CO_2 backpack sprayer using flatfan 8002 nozzles providing a 10 foot spray width calibrated to deliver 14 gpa at 39 psi. The soil was a Millville silt loam with 7.5 pH and OM content of less than 2%. Treatments were applied in a randomized block design, with four replications. Preemergence treatments were applied May 25. Postemergence treatments were applied June 8, when the corn was in the 4 -5 leaf stage and lambsquarters was 2-8 inches tall. Visual evaluations for weed control and crop injury were completed July 7 and July 28, 2000. Plots were harvested October 9.

Thiafluamide/metribuzin/atrazine applied preemergent controlled 86 percent of common lambsquarters without corn injury. Isoxaflutole did not cause injury to corn but failed to provide acceptable lambsquarters control; whereas in past years it has been an excellent control treatment. All postemergence treatments provided excellent lambsquarters control except the low rate of ETK 2303. Corn yields correlated well with the level of weed control for the various treatments where the untreated and the lowest dosage of ETK 2303 were the lowest producers. (Utah Agricultural Experiment Station, Logan, UT. 84322-4820)

Table. Annual weed control in Roundup Ready® corn.

			Corn			Weed Control	
			Injury		Yield	CHEAL	
Treatment	timing	Rate	7/7	7/28	10/9	7/7	7/28
		lb/A	—%—		T/A	—%—	
Untreated			0	0	10.3	0	0
Thiafluamide/metribuzin/atrazine	PRE	1.5	0	0	13.3	75	86
Isoxaflutole	PRE	0.059	0	0	11.6	25	19
Glyphosate	POST	0.75	0	0	13.4	96	95
Sulfosate	POST	0.75	0	0	12.7	94	94
ETK 2303	POST	0.56	0	0	12.7	90	90
ETK 2303	POST	0.19	0	0	10.0	15	10
LSD(0.05)					2	20	22.1

Preemergence and postemergence control of green foxtail and redroot pigweed in Roundup Ready® corn. John O. Evans, Paul Haderlie, and Brent Beutler. (Department of Plants, Soils, and Biometeorology, Utah State University, Logan, Utah 84322-4820) Roundup Ready® corn (DeKalb RR626) was planted May 16, 2000 at the Jeff Gittins farm in Smithfield, UT to evaluate the effectiveness of controlling annual weeds with several herbicides. 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 Green Canyon gravelly loam with 7.9 pH and OM content of less than 2%. Treatments were applied in a randomized block design, with three replications. Preemergence treatments were applied May 20 without subsequent soil incorporation. Postemergence treatments were applied June 12 to corn 12 inches tall, redroot pigweed three inches tall, and green foxtail 6 inches tall. Visual weed control and crop injury evaluations were completed June 21, July 10, and July 28, 2000. Plots were harvested September 21.

Most preemergence treatments worked poorly at the beginning of the season, but after the first flood irrigation the redroot pigweed populations were reduced by some treatments to manageable levels. The thiafluamide/metribuzin treatment was acceptable by the last evaluation date. The green foxtail escaped all preemergence treatments but the metolachlor/atrazine combination. All postemergent treatments worked well on green foxtail but redroot pigweed recovered somewhat after mid July when treated with rimsulfuron/thifensulfuron or glyphosate. No observable corn injury occurred and the yields were not significantly different among treatments.(Utah Agricultural Experiment Station, Logan, UT. 84322-4820)

Table. Green foxtail and redroot pigweed control in Roundup Ready® corn.

			Corn			Weed Control				
			Injury		Yield	SETVI		AMARE		
Treatment	timing	Rate	7/7	7/28	10/9	6/21	7/10	6/21	7/10	7/28
		lb/A	%		T/A	%				
Untreated			0	0	18.6	0	0	0	0	0
Thiafluamide/metribuzin	PRE	0.54	0	0	17.4	0	0	0	0	87
Isoxaflutole	PRE	0.059	0	0	16.7	0	0	0	0	47
Flufenacet/isoxaflutole	PRE	0.22	0	0	15.1	0	0	0	0	50
Acetochlor	PRE	1.75	0	0	17.3	0	0	0	17	52
Metolachlor/atrazine	PRE	3.16	0	0	16.4	23	100	0	83	93
Nicosulf/rimsulf/atrazine [a]	POST	0.875	0	0	16.9	83	99	90	98	97
Rimsulf/thifensulf [a]	POST	0.063	0	0	17.2	80	100	83	100	92
Glyphosate	POST	0.75	0	0	14.6	60	100	77	83	88
LSD(0.05)					3.5	44.2	0.7	11.6	30	33

[a] Nitrogen added at 2% v/v and COC added at 1% v/v.

Effect of adjuvants on fluroxypyr efficacy. Phillip W. Stahlman and Patrick W. Geier. (KSU Agricultural Research Center, Hays, KS 67601). Effects of four adjuvants were compared on the efficacy of fluroxypyr alone and in combination with atrazine in corn near Hays, KS. 'Golden Harvest H9481Bt' field corn was seeded April 21, in rows 30 inches apart at 21,900 kernels per acre. The experiment was a randomized complete block with three replicates and plots were 10 by 32 ft. The weed population was dense: kochia, >50 plants/m^2; redroot pigweed, 5-10 plants/m^2; and Palmer amaranth, 5-20 plants/m^2. Treatments were applied with a tractor-mounted, compressed-air plot sprayer delivering 12 gpa at 24 psi and 3 mph on May 23, when corn was in the V4 stage and 8 to 12 inches high, kochia was 3 to 10 inches high, redroot pigweed was 2 to 8 inches high, and Palmer amaranth was 2 to 5 inches high. Air temperature and relative humidity at the time of treatment application were 74 F and 15%, respectively, and the sky was clear and there was no dew. Plants were growing rapidly.

Tank mixing with atrazine enhanced fluroxypyr efficacy more than any of the adjuvants evaluated. At 8 DAT, fluroxypyr plus atrazine plus any of four adjuvants controlled kochia, redroot pigweed, and Palmer amaranth by 97 or higher. In comparison, control of individual species with fluroxpyr plus adjuvants ranged from: kochia, 53 to 63%; redroot pigweed, 13 to 17%; and Palmer amaranth, 10 to 20%. At 69 DAT, control of each species had improved considerably. Redroot pigweed control was 100% for all treatments. However, shading and interspecific competition from the much taller kochia and Palmer amaranth probably contributed to redroot pigweed control in plots without atrazine. LI700 improved kochia control by fluroxypyr the most (23%) of the adjuvants evaluated, followed by either Activator 90 or MSO (13% improvement). Herbimax did not improve kochia control. Each of the adjuvants improved control of Palmer amaranth, LI700 more than MSO, which was similar to Activator 90 and Herbimax. Nontreated corn produced little grain because of weed interference. Corn sprayed with treatments including atrazine yielded more than corn sprayed with treatments without atrazine. Differences between treatments within groupings of with and without atrazine were not significant.

Table. Effect of adjuvants on the efficacy of fluroxypyr alone and in combination with atrazine and on corn yield, Hays, KS, 2000.

		Weed control[a]						
		8 DAT			69 DAT			Corn
Treatment	Rate	KCHSC	AMARE	AMAPA	KCHSC	AMARE	AMAPA	Yield
	lb/A	%						Bu/A[b]
Fluroxypyr	0.188	50	17	10	60	100	47	36.8
Fluroxypyr + Activator 90	0.188 + 0.5% v/v	60	17	17	73	100	60	32.9
Fluroxypyr + LI700	0.188 + 0.5% v/v	53	13	13	83	100	67	30.2
Fluroxypyr + Herbimax	0.188 + 1.0 qt	63	13	20	63	100	60	29.1
Fluroxyoyr + MSO[c]	0.188 + 1.0 qt	57	17	17	73	100	57	35.8
Fluroxypyr + atrazine + Activator 90	0.188 + 1.0 + 0.5% v/v	98	100	99	100	100	100	68.3
Fluroxypr + atrazine + LI700	0.188 + 1.0 + 0.5% v/v	97	99	98	100	100	100	74.3
Fluroxypyr + atrazine + Herbimax	0.188 + 1.0 + 1.0 qt	98	100	99	100	100	100	75.2
Fluroxypyr + atrazine + MSO	0.188 + 1.0 + 1.0 qt	99	100	99	100	100	100	79.9
Untreated		--	--	--	--	--	--	5.7
LSD (0.05)		7	8	8	9	NS	9	14.7

[a] DAT = days after treatment; KCHSC = kochia; AMARE = redroot pigweed; AMAPA = Palmer amaranth
[b] Adjusted to 15% moisture
[c] Methylated seed oil

Biennial wormwood control in dry beans. Brian M. Jenks, Denise M. Markle, and Gary P. Willoughby. (North Central Research Extension Center, North Dakota State University, Minot, ND 58701) Dry beans (Othello) were planted June 3 into 30-inch rows at 60 lb/A in a conventional tillage system. Individual plots were 10 by 30 ft arranged in a RCBD with three replicates. Treatments were applied preplant incorporated (PPI) on May 30, preemergence (PRE) on June 6, or postemergence on July 15 (POST) or July 21 (POST 2). PRE and PPI treatments were applied with a CO_2 pressurized bicycle sprayer with XR80015 flat fan nozzles delivering 20 gpa at 30 psi. All POST treatments were applied using XR8001 flat fan nozzles delivering 10 gpa at 40 psi. The primary weed of interest was biennial wormwood. Kochia, redroot pigweed, and common lambsquarters were also present. This site was in wheat in 1998 and fallow 1999.

Table. Weed control, crop injury, and dry bean yield.

		Dry beans		ARTBI		KCHSC		AMARE		CHEAL		
Treatment[a]	Rate	7-20	8-30	7-20	8-30	7-20	8-30	7-20	8-30	7-20	8-30	Yield
	lb ai/A	% Injury		% Control								lb/A
Untreated		0	0	0	0	0	0	0	0	0	0	754
PPI/POST												
Handweeded check[b]		2	0	100	99	100	98	99	100	100	100	2094
Flumetsulam & metolachlor / quizalofop	1.92 / 0.055	0	0	37	33	10	7	93	96	83	78	1481
Flumetsulam / quizalofop	0.05 / 0.055	0	0	42	37	15	0	69	82	55	47	1534
PRE/POST												
Sulfentrazone / quizalofop	0.125 / 0.055	0	1	92	90	93	89	87	93	97	95	2258
Sulfentrazone / quizalofop	0.25 / 0.055	2	1	99	100	97	97	97	93	100	100	2434
Sulfentrazone / quizalofop	0.5 / 0.055	8	6	100	100	100	100	99	100	100	100	2322
Metribuzin / quizalofop	0.25 / 0.055	4	3	100	98	92	92	84	84	98	93	1866
Flumioxazin / quizalofop	0.094 / 0.055	69	60	100	92	99	98	98	98	99	97	1170
POST/POST 2												
Bentazon / Bentazon + sethoxydim	0.5 / 0.5 + 0.2	0	0	77	91	92	88	60	70	68	70	1833
POST												
Bentazon + sethoxydim	1 + 0.2	0	0	89	80	95	89	73	60	92	73	2041
Fomesafen + imazamox	0.25 + 0.016	9	3	37	17	71	32	87	80	63	50	995
Bentazon + imazamox + 28% N	0.5 + 0.032 + 1 qt	0	0	79	70	89	63	89	83	88	77	1854
LSD		6	9	11	15	10	10	15	15	17	18	592
CV		48	93	9	12	8	9	11	11	12	14	20

[a] Sethoxydim and quizalofop were applied with COC at 1%, and imazamox was applied with NIS at 0.25%.
[b] Trifluralin at 0.75 lb (PPI) and quizalofop at 0.055 lb (POST) were applied to aid in handweeding.

We evaluated several registered and non-registered products for controlling biennial wormwood in dry beans. Soil pH at this site is 5.5 with 4.3% organic matter. Flumioxazin was the only product that caused significant crop injury. Flumetsulam plus metolachlor and flumetsulam did not control biennial wormwood. Sulfentrazone, metribuzin, and flumioxazin effectively controlled all weeds. A split application of bentazon was slightly more effective than a single application. Bentazon plus imazamox provided fair control of biennial wormwood and kochia. Fomesafen plus imazamox provided very poor biennial wormwood control.

Weed control in dry beans. Brian M. Jenks, Denise M. Markle, Gary P. Willoughby, and Kent McKay. (North Central Research Extension Center, North Dakota State University, Minot, ND 58701) Dry beans (Maverick) were planted at Underwood, ND on May 24 into 30-inch rows at 60 lb/A in a conventional tillage system. Individual plots were 10 by 22 ft arranged in a RCBD with four replicates. Pendimethalin, flumioxazin, and sulfentrazone were applied preemergence (PRE) on May 25. Postemergence (POST) treatments were applied on June 22 to 1 to 2 trifoliate dry beans. PRE treatments were applied with a CO_2 pressurized bicycle sprayer with XR80015 flat fan nozzles delivering 20 gpa at 30 psi. All POST treatments were applied using XR8001 flat fan nozzles delivering 10 gpa at 40 psi. The primary weeds present were wild mustard (2 to 4-lf, 1 to 2 per sq ft) and green/yellow foxtail (1 to 2in, 30 per sq ft).

Table. Weed control, crop injury, and dry bean yield.

		Dry bean injury			SINAR		Setaria spp.[a]		
Treatment	Rate	Jun 22	Jul 12	Jul 31	Jun 22	Jul 31	Jun 22	Jul 31	Yield
	lb ai /A	%			% Control				lb/A
Untreated			0	0		0		0	414
PRE/POST									
Pendimethalin / imazamox + NIS	1.5 / 0.032 + 0.25%	5	0	0	49	100	64	92	1477
Flumioxazin / sethoxydim + COC	0.078 / 0.2 + 1%	33	12	0	81	88	83	98	1458
Sulfentrazone / sethoxydim + COC	0.25 / 0.2 + 1%	15	29	20	78	82	81	97	1155
POST									
Imazamox + NIS	0.032 + 0.25%		0	0		95		86	1318
Imazamox + NIS + Zinc	0.032 + 0.25% + 1 qt		0	0		98		91	1404
Imazamox + bentazon + NIS + 28%N	0.032 + 0.125 + 0.25% + 1 qt		0	0		94		92	1325
Imazamox + Quad 7	0.032 + 1%		0	0		97		93	1573
Imazamox + bentazon + NIS + 28%N	0.032 + 0.25 + 0.25% + 1 qt		0	0		94		92	1522
Imazamox + fomesafen + MSO	0.032 + 0.125 + 1%		0	0		100		84	1285
Fomesafen + sethoxydim + MSO	0.25 + 0.2 + 1%		0	0		100		97	1519
Bentazon + sethoxydim + COC	1 + 0.2 + 1%		0	0		62		95	1159
LSD		10	5	3	26	14	7	5	389
CV		33	116	148	21	11	5	4	21

[a] Setaria spp. is a mix of yellow and green foxtail

We evaluated dry bean tolerance and weed control with four experimental herbicides. We observed no injury with imazamox or fomesafen. Imazamox provided good to excellent control of wild mustard and foxtail spp. Flumioxazin caused moderate initial injury, but the dry beans appeared to recover over time. Sulfentrazone caused significant injury throughout the season. The soil pH at the Underwood site is 7.5 and OM is 3.0%. Sulfentrazone caused almost no injury in studies at Minot where the pH is 5.5 and OM is 4.3%. Wild mustard control with bentazon was poorer than expected.

Evaluation of various herbicides in dry edible beans. Steven E. Salisbury, Don W. Morishita, and Michael J. Wille. (Twin Falls County Extension Office and Twin Falls Research and Extension Center, University of Idaho, Twin Falls, ID 83303). A study was conducted in furrow-irrigated dry edible bean ('UI 228') to evaluate several herbicides and herbicide combinations for control of various problem weeds in dry bean production. This study was conducted on the University of Idaho Research and Extension Center near Kimberly, ID. Soil type at this location was a Portneuf silt loam (5% sand, 56% silt, 39% clay) with an 8.3 pH, 1.45% organic matter, and a CEC of 25.5 meq/100 g soil. Liquid herbicide treatments were applied with a CO_2-pressurized bicycle-wheel sprayer calibrated to deliver 10 gpa using 11001 flat-fan nozzles. The herbicide-impregnated fertilizer treatment was applied with a drop-type fertilizer spreader. Additional application information is shown in Table 1. Experimental design was a randomized complete block with four replications, and each plot was 7.33 by 30 ft. Evaluations of crop injury and weed control were made 14 days after last postemergence application (July 21). The beans were cut and windrowed September 8, and harvested September 26 with a small-plot harvester.

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

Application date	5/16	6/12	6/16	7/6
Application timing	PPI	Pre/Post	1st trifoliate	3rd trifoliate
Air temperature (F)	63	65	60	58
Soil temperature (F)	72	64	60	58
Relative humidity (%)	38	62	63	56
Wind speed (mph)	4	1	6	2
Cloud cover (%)	30	100	5	40
Weed species/ft^2				
hairy nightshade			15	
common lambsquarters			14	
redroot pigweed			12	
common mallow			2	
barnyardgrass			3	
green foxtail			8	

Preplant incorporated treatments did not cause any crop injury (Table 2). Excessive crop injury (40%) with imazamox was due to an over-application. Other injury observed with the glyphosate treatments is attributed to some bean emergence at glyphosate application. All of the pre-plant incorporated treatments controlled all weed species 90 to 100% with the exception of EPTC and ethalfluralin + EPTC impregnated on fertilizer. EPTC controlled hairy nightshade, redroot pigweed, and green foxtail 79, 82, and 89%, respectively. Ethalfluralin + EPTC impregnated on fertilizer controlled common mallow 82%. Sequential postemergence applications following PPI treatments provided excellent control (92 to 100%) of all weed species. The postemergence applications of imazamox + bentazon followed by bentazon + sethoxydim controlled all weeds 81 to 95%. Bentazon + sethoxydim applied one time did not control weeds as well as the same treatment applied sequentially to imazamox + bentazon. All herbicide treatments yielded greater than the check. The highest yielding treatments were pendimethalin + EPTC (3306 lb/A), ethalfluralin (2865 lb/A), and dimethenamid followed by bentazon + imazamox and NIS + ammonium sulfate (2745 lb/A).

Table 2. Evaluation of preplant, preemergence, and postemergence herbicides for weed control in dry beans.

Treatment[b]	Application type	Rate	Crop injury	Weed control[a] CHEAL	AMARE	SOLSA	MALNE	SETVI	ECHCG	Yield
		lb/A	%							lb/A
Check			-	-	-	-	-	-	-	308
Ethalfluralin	PPI	1.5	0	100	100	100	95	100	100	2860
EPTC	PPI	4	0	93	82	79	95	89	100	2720
Pendimethalin	PPI	1.5	0	100	99	93	90	100	100	1520
Dimethenamid	PPI	1.0	0	94	99	94	93	99	100	2750
Ethalfluralin EPTC	PPI	0.75 3.5	0	100	100	93	98	100	100	1670
Ethalfluralin (impregnated) + EPTC (impregnated)	PPI	0.75 + 3.5	0	100	100	93	82	99	100	1800
Ethalfluralin + alachlor	PPI	0.75 + 2.6	0	100	100	99	93	100	100	1550
Pendimethalin + EPTC	PPI	0.75 + 3.5	0	100	100	92	99	100	100	3310
Pendimethalin Imazamox + AMS + NIS	PPI 3rd trifoliate	0.75 0.031 + 2.5 + 0.25% v/v	1	100	100	100	100	100	100	1830
Dimethenamid Bentazon + imazamox + AMS + NIS	PPI 3rd trifoliate	0.5 0.75 + 0.031 + 2.5 + 0.25% v/v	0	100	100	95	95	98	100	2750
Glyphosate Bentazon + imazamox + sethoxydim + AMS+ NIS	Pre/Post 3rd trifoliate	0.75 0.75+ 0.031+ 0.18+ 2.5+ 0.25% v/v	16	99	92	95	92	100	100	2000
Glyphosate + Bentazon + sethoxydim + MSO	Pre/Post 3rd trifoliate	0.75 0.8+ 0.18+ 2.0	17	100	97	94	88	100	100	1840
Imazamox+ bentazon+ MSO Bentazon+ sethoxydim+ MSO	unifoliate 3rd trifoliate	0.31+ 0.8+ 2.0 0.8+ 0.125+ 2.0	40	81	91	90	95	84	95	2040
Bentazon+ sethoxydim+ MSO	unifoliate	0.75+ 0.18+ 2.0	0	60	25	80	88	78	99	2700
LSD (0.05)			10	10	10	11	12	11	12	1980

[a]Weeds evaluated for control were common lambsquarters (CHEAL), redroot pigweed (AMARE), hairy nightshade (SOLSA), common mallow (MALNE), green foxtail (SETVI), and barnyardgrass (ECHCG).

[b]NIS = nonionic surfactant, MSO = methylated seed oil, AMS = ammonium sulfate.

Weed control in field peas. Brian M. Jenks, Denise M. Markle, Gary P. Willoughby, Kent McKay. (North Central Research Extension Center, North Dakota State University, Minot, ND 58701) 'Majoret' peas were seeded April 28 at 180 lb/A into 6 inch rows in a conventional tillage system. Individual plots were 10 by 30 ft arranged in a RCBD with three replicates. Preplant incorporated (PPI) treatments were applied April 26, preemergence (PRE) treatments were applied May 3, and postemergence (POST) treatments were applied on June 2. All treatments were applied with a CO_2 pressurized bicycle sprayer. PPI and PRE treatments were applied with XR80015 flat fan nozzles delivering 20 gpa at 30 psi. POST treatments were applied using XR8001 flat fan nozzles delivering 10 gpa at 40 psi. Field peas were harvested on August 1.

Table. Weed control, crop injury, and field pea yield.

		Pea			Control				
		Stand	Injury		POLCO	AMARE	KCHSC		
Treatment	Rate	May 26	May 25	Jul 15	Jul 15	Jul 15	Jul 15	Yield	Tst Wt
	lb ai/A	pl/m of row	%		%			lb/A	lb/bu
Untreated		8.9	0	0	0	0	0	3200	64.5
PPI									
Ethalfluralin	0.75	11.7	1	3	90	98	98	3580	64.9
Pendimethalin	1.5		1	0	88	98	98	3530	64.9
PPI/POST									
Sulfentrazone / quizalofop	0.125 / 0.048	13.4	3	0	70	100	100	3402	64.7
Sulfentrazone / quizalofop	0.25 / 0.048	12.2	5	2	90	100	100	3545	64.9
Sulfentrazone / quizalofop	0.5 / 0.048	10.1	9	7	95	100	100	3515	64.6
Pendimethalin / imazamox + NIS	0.124 / 0.031 + 0.25 %		0	3	93	100	98	3489	64.6
Handweeded check[a]		11.1	0	3	99	100	100	3356	64.6
PRE/POST									
Flumioxazin / quizalofop	0.063 / 0.048	11.8	10	4	55	100	100	2877	64.0
Flumioxazin / quizalofop	0.094 / 0.048	9.3	12	8	77	100	100	3169	64.5
Flumioxazin / quizalofop	0.188 / 0.048	7.7	63	20	87	100	100	3062	65.3
Sulfentrazone / quizalofop	0.125 / 0.048	10.5	2	1	73	100	100	3479	64.6
Sulfentrazone / quizalofop	0.25 / 0.048	12.1	8	4	93	100	100	3528	64.4
Sulfentrazone / quizalofop	0.5 / 0.048	11.4	20	7	95	100	100	3509	64.9
POST									
Imazamox + NIS	0.023 + 0.25 %			4	65	100	82	3286	64.6
Imazamox + NIS	0.031+ 0.25 %			3	80	100	88	3424	64.8
Imazamox + Quad 7	0.031 + 1 %			18	73	100	89	2214	62.3
Imazamox + bentazon + NIS + 28% N	0.031 + 0.25 + 0.25 % + 1 qt			3	89	100	93	3375	64.7
Imazamox + bentazon + NIS + 28% N	0.031 + 0.5 + 0.25 % + 1 qt			2	90	100	93	3464	64.6
Bentazon + sethoxydim	1+ 0.2			4	82	87	93	3332	64.3
Fluroxypyr + quizalofop + NIS	0.016 + 0.048 + 0.25 %			29	55	43	100	2633	64.2
Fluroxypyr + bentazon + sethoxydim	0.016 + 0.5 + 0.2			32	84	82	100	2652	64.4
LSD		3	5	6	14	4	4	459	NS
CV		16	29	50	11	3	3	9	1.2

[a] Trifluralin was applied at 0.75 lb (PPI), followed by quizalofop at 0.048 lb (POST) to aid handweeding.

We evaluated pea tolerance to sulfentrazone, flumioxazin, and imazamox compared to other herbicides. Sulfentrazone caused only slight injury at any rate or application timing and did not reduce crop yield. Flumioxazin caused moderate to severe injury at the high rate and reduced yield approximately 200-500 lbs. Imazamox plus Quad 7 caused moderate visible crop injury and a significant yield reduction.

Broadleaf weed control in durum wheat. Brian M. Jenks, Denise M. Markle, and Gary P. Willoughby. (North Central Research Extension Center, North Dakota State University, Minot, ND 58701) Durum (Ben) was seeded May 24 at 100 lb/A into 6 inch rows in a conventional tillage system. Individual plots were 10 by 30 ft arranged in a RCBD with three replicates. Treatments were applied with a CO_2 pressurized bicycle sprayer on June 23. XR8001 flat fan nozzles were used, delivering 10 gpa at 40 psi. The crop was harvested September 12.

Table. Broadleaf weed control and yield in durum wheat.

Treatment[a]	Rate	KCHSC Jul 20	KCHSC Aug 21	Yield	Tst Wt
	lb ai/A	% Control	% Control	bu/A	lb/bu
Fluroxypyr	0.016	74	78	42	57.2
Fluroxypyr	0.031	87	94	39	57.0
Fluroxypyr	0.062	96	100	43	58.0
Fluroxypyr	0.094	99	100	40	57.7
Fluroxypyr	0.126	100	100	45	57.4
Thifensulfuron & tribenuron + bromoxynil & MCPAe	0.014 + 0.5	100	100	42	57.7
Fluroxypyr & MCPA	0.67	98	100	41	57.8
Dicamba (dga salt)	0.125	63	50	40	57.3
Dicamba (dga salt) + MCPA ester	0.094 + 0.25	98	100	43	57.7
Bromoxynil & MCPAe	0.75	100	100	43	57.3
Carfentrazone	0.008	98	93	37	57.3
Carfentrazone + dicamba (dga salt)	0.008 + 0.094	100	100	39	57.2
Carfentrazone + fluroxypyr & 2,4-D	0.008 + 0.47	100	100	43	57.5
Carfentrazone + thifensulfuron & tribenuron	0.008 + 0.014	95	91	39	57
Untreated		0	0	42	57.6
LSD		7	11	NS	NS
CV		5	7	17	1.3

[a] Carfentrazone was applied with 0.25% Activator 90 and 1 qt 28% N.

We compared several rates of fluroxypyr and other herbicides for kochia control in durum wheat. Fluroxypyr at 0.031 lb or higher provided good to excellent kochia control. All other treatments except for dicamba alone also controlled kochia. Carfentrazone caused the typical speckling on the wheat leaves when applied alone or in combination with dicamba or fluroxypyr plus 2,4-D. However, the leaf speckling was not observed when combined with thifensulfuron and tribenuron.

Grass and broadleaf weed control with flucarbazone and various tankmixes. Brian M. Jenks, Denise M. Markle, and Gary P. Willoughby. (North Central Research Extension Center, North Dakota State University, Minot, ND 58701) Durum (Ben) was seeded May 19 into 6-inch rows at 100 lb/A in a conventional tillage system. Individual plots were 10 by 30 ft arranged in a RCBD with three replicates. Treatments were applied using XR8001 flat fan nozzles delivering 10 gpa at 40 psi. Postemergence treatments were applied on June 22 with a CO_2 pressurized bicycle sprayer. The primary weeds were wild oat, common lambsquarters, wild buckwheat, and redroot pigweed. The crop was harvested on August 30.

Table. Weed control, crop injury, and durum yield.

		Injury		AVEFA	CHEAL	POLCO	AMARE	
Treatment[a]	Rate	Jul 20	Aug 15	Jul 20				Yield
	lb ai/A	%		% Control				bu/A
Untreated		0	0	0	0	0	0	28
Clodinafop + DSV	0.05 + 0.5 %	1	0	95	0	0	0	36
Tralkoxydim + Supercharge	0.18 + 0.5 %	0	0	94	0	0	0	32
Fenoxaprop	0.083	1	0	95	0	0	0	37
Imazamethabenz + Activator 90	0.43 + 0.25 %	0	0	92	0	77	0	37
Flucarbazone + 2,4-D ester	0.027 + 0.5	8	2	92	99	93	94	41
Flucarbazone + MCPA ester	0.027 + 0.5	12	7	82	99	91	94	36
Flucarbazone + bromoxynil	0.027 + 0.25	9	4	89	88	90	91	38
Flucarbazone + bromoxynil & MCPAe	0.027 + 0.5	10	6	90	98	93	95	39
Flucarbazone + thifensulfuron + 2,4-D ester	0.027 + 0.023 + 0.5	8	3	91	99	99	99	38
Flucarbazone + fluroxypyr + 2,4-D ester	0.027 + 0.094 + 0.5	8	2	93	99	98	98	39
Flucarbazone + clopyralid & MCPA + 2,4-D ester	0.027 + 0.69 + 0.5	7	2	92	99	99	96	41
Flucarbazone + tribenuron	0.027 + 0.016	14	12	89	98	94	98	34
Flucarbazone + tribenuron + 2,4-D ester	0.027 + 0.008 + 0.5	8	5	91	98	96	96	39
Flucarbazone + carfentrazone + MCPA ester	0.027 + 0.008 + 0.25	10	4	89	96	92	95	35
Imazamethabenz + fenoxaprop + R-11	0.31 + 0.042 + 0.25 %	1	0	93	0	78	0	36
LSD		2	2	6	10	8	9	NS
CV		23	40	5	9	7	8	14

[a] All flucarbazone treatments were applied with Activator 90 at 0.25%.

All flucarbazone treatments caused slight crop stunting soon after application. Injury was somewhat higher with MCPA ester or tribenuron. Injury was generally lower where 2,4-D ester was included as a tankmix partner. Wild oat control with flucarbazone was good to excellent with most treatments.

Volunteer wheat control in fallow. Joan Campbell and Donn Thill. (Department of Plant, Soil, and Entomological Sciences, University of Idaho, Moscow, ID 83844-2339) Glyphosate is commonly used for volunteer wheat control in fallow. Alternative treatments are necessary for the incorporation of glyphosate resistant wheat in a cropping system. Volunteer wheat (not glyphosate resistant) control was evaluated with several herbicide treatments in a fallow field southeast of Lewiston, Idaho. Treatments were applied on April 3 and May 16, 2000. In a second experiment, sulfosate was evaluated for volunteer wheat control. Treatments were applied on April 10, 2000. Both experiments were randomized complete block designs with four replications and had 12 volunteer wheat plants/ft^2. Treatments were applied with a CO_2 pressurized backpack sprayer calibrated to deliver 10 gal/A at 32 psi (Table 1).

Table 1. Application data.

Application date	April 3	April 10	May 16
Wheat growth stage	5 leaf, 0 to 1 tiller	5 leaf, 1 to 2 tiller	jointing
Air temperature (F)	62	59	71
Soil temperature (F)	44	42	55
Relative humidity (%)	63	66	59
Cloud cover (%)	0	0	0
Wind velocity (mph)	0 to 5 East	2 to 6 Southeast	0 to 3 West

Two weeks after the 5 leaf application, glyphosate controlled volunteer wheat 100%, but other treatments only controlled volunteer wheat 86 to 88% (Table 2). On May 24, volunteer wheat control was excellent (99-100%) with all treatments applied at the 5 leaf stage. Volunteer wheat control was 93-94% with glyphosate and was not controlled with other treatments applied at the joint stage. By June 2, volunteer wheat control was 100% with all treatments applied at the 5 leaf stage and with glyphosate applied at the joint stage. Volunteer wheat control with other treatments applied at the joint stage ranged from 71 to 78%. Volunteer wheat control with all treatments in the second experiment was 100% at 14 and 28 days after treatment (Table 3.)

Table 2. Volunteer wheat control in fallow with glyphosate, quizalofop, clethodim and sethoxydim applied at the 5 leaf and joint stages of volunteer wheat.

Treatment[a]	Rate[e]	Time of application	Volunteer wheat control April 26	May 24	June 2
	lb/A		%	%	%
Glyphosate[b]	0.56	5 leaf	100	100	100
Quizalofop[c]	0.045	5 leaf	88	100	100
Quizalofop[c]	0.06	5 leaf	88	100	100
Quizalofop[c]	0.075	5 leaf	88	100	100
Glyphosate[b] + quizalofop[c]	0.56 0.045	5 leaf	100	100	100
Glyphosate[b] + quizalofop[c]	0.56 0.06	5 leaf	100	100	100
Glyphosate[b] + quizalofop[c]	0.56 0.075	5 leaf	100	100	100
Clethodim[c]	0.109	5 leaf	86	99	100
Sethoxydim[d]	0.375	5 leaf	88	100	100
Untreated	0	--	--	--	--
Glyphosate[b]	0.56	joint	--	94	100
Quizalofop[c]	0.045	joint	--	16	71
Quizalofop[c]	0.06	joint	--	9	73
Quizalofop[c]	0.075	joint	--	18	78
Glyphosate[b] + quizalofop[c]	0.56 0.045	joint	--	94	100
Glyphosate[b] + quizalofop[c]	0.56 0.06	joint	--	93	100
Glyphosate[b] + quizalofop[c]	0.56 0.075	joint	--	94	100
Clethodim[c]	0.109	joint	--	19	78
Sethoxydim[d]	0.375	joint	--	16	73
Untreated	0	--	--	--	--
LSD (0.05)			3	5	5

[a] Ammonium sulfate (Bronc) was added to all treatments at 17 lb/100 gal spray solution
[b] Roundup Ultra
[c] Petroleum crop oil concentrate (Moract) was added at 1% v/v
[d] Petroleum crop oil concentrate (Moract) was added at 2.5% v/v
[e] Glyphosate rate is acid equivalent. Other rates are active ingredient.

Table 3. Volunteer wheat control in fallow with sulfosate, glyphosate, and tank mix combinations with dicamba and 2,4-D.

Treatment[a]	Rate[b]	Volunteer wheat control
	lb/A	%
Sulfosate	0.375	100
Sulfosate	0.5	100
Sulfosate	0.625	100
Glyphosate	0.375	100
Glyphosate	0.5	100
Glyphosate	0.625	100
Sulfosate +	0.375	100
dicamba	0.125	
Sulfosate +	0.5	100
dicamba	0.125	
Sulfosate +	0.625	100
dicamba	0.125	
Glyphosate +	0.375	100
dicamba	0.125	
Sulfosate +	0.375	100
2,4-D ester	0.5	
Sulfosate +	0.5	100
2,4-D ester	0.5	
Sulfosate +	0.625	100
2,4-D ester	0.5	
Glyphosate +	0.375	100
2,4-D ester	0.5	
Untreated	0	--

[a] All treatments applied with 17 lb/100 gal ammonium sulfate (Bronc)

[b] 2,4-D rate is expressed as acid equivalent. Other rates are active ingredient.

Weed control in fallow with several glyphosate formulations. Joan Campbell and Donn Thill. (Department of Plant, Soil, and Entomological Sciences, University of Idaho, Moscow, ID 83844-2339) Glyphosate formulations were evaluated for volunteer wheat control in fallow near Lewiston, Idaho. Experiment one (1A through 1D) was repeated at four wheat growth stages (Table 1). Treatments in experiment two were applied at the same time as experiment 1D. The experimental design was a randomized complete block with four replications for all experiments. Treatments were applied with a CO_2 pressurized backpack sprayer calibrated to deliver 10 gal/A at 32 psi (Table 1). Weed control was evaluated visually.

Table 1. Application data.

Experiment	1A	1B	1C	1D and 2
Application date	April 19	May 1	May 12	May 18
Volunteer wheat growth stage	3 tiller, 4 to 16 in.	15 to 20 in.	joint to boot	heading
Air temperature (F)	66	70	59	70
Soil temperature (F)	48	55	60	60
Relative humidity (%)	54	41	70	59
Wind velocity (mph)	3 East	3 East	2 East	0
Cloud cover (%)	15	0	0	0

Volunteer wheat control was slowest 12 days after treatment (DAT) (May 1) with Engame/2,4-D in experiment 1A and fastest 11 DAT (May 12) with Engame in experiment 1B (Table 2). There were no differences in volunteer wheat control among Roundup Ultra and Roundup Original treatments. In the second experiment, volunteer wheat control was better with Engame (90%) 15 DAT (June 2) than Touchdown 5 (80%) or Roundup Ultra + quizalofop (81%) (Table 3). Volunteer wheat control did not differ among Roundup Ultra, Touchdown 5, or Touchdown treatments. Volunteer wheat was controlled 100% in all experiments by 4 wk after application (data not shown).

Table 2. Volunteer wheat control with different glyphosate formulations applied at four wheat growth stages.

		Volunteer wheat control							
		1A		1B		1C		1D	
Treatment	Rate	April 26	May 1	May 12	May 24	May 18	May 24	May 24	June 2
	lb ae/A	% of untreated control							
Roundup Ultra[a]	0.375	75	98	82	100	54	100	75	80
Roundup Original[ab]	0.375	68	98	80	100	55	100	68	82
Engame[bc]	0.375	72	100	89	100	66	100	75	91
Engame/2,4-D[bd]	0.75	70	94	82	100	60	100	80	85
Roundup Original[ab] + 2,4-D	0.375 + 0.375	70	97	81	100	52	100	72	84
LSD (0.05)		NS	3	5	NS	NS	NS	NS	NS

[a] Ammonium sulfate added at 17 lb/100 gal
[b] LI700 added at 0.5% v/v
[c] ETK2303, glyphosate acid
[d] ETK2350, glyphosate acid

Table 3. Volunteer wheat control with glyphosate and sulfosate.

		Volunteer wheat control	
Treatment	Rate	May 24	June 2
	lb ae/A	% of untreated control	
Roundup Ultra[a]	0.375	60	85
Touchdown 5[ab]	0.375	50	80
Engame[cd]	0.375	65	90
Touchdown[ae]	0.375	61	86
Roundup Ultra[a] + quizalofop[f]	0.375 + 0.045	44	81
LSD (0.05)		NS	6

[a] Ammonium sulfate added at 17 lb/100 gal
[b] Sulfosate
[c] LI700 added at 0.5% v/v
[d] ETK2303, glyphosate acid
[d] Glyphosate isopropylamine salt
[f] Crop oil concentrate (Moract) added at 1% v/v

Herbicidal control of volunteer winter wheat in the fallow season. John O. Evans, Brent Beutler, and R. William Mace. (Department of Plants, Soils, and Biometeorology, Utah State University, Logan, Utah 84322-4820). With the advent of herbicide-resistant crops, the ability to control volunteer plants in succeeding rotational crops may become particularly challenging. The purpose of this experiment was to evaluate several alternative herbicides to control volunteer grain as well as annual grassy and broadleaved weeds during fallow periods of a wheat-fallow rotation. 'Pioneer' winter wheat was planted September 12, 1999 at the USU Blue Creek Farm near Howell, UT. Individual treatments were applied to 10 by 30 foot plots with a CO_2 backpack sprayer using flat fan 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%. One-half of the plots received an early treatment May 2, 2000 and half received a late treatment May 17, 2000 in a randomized block design, with three replications. Wheat ranged in size from 10 inches tall at the early application date to 20 inches tall at the late application date. Visual evaluations of wheat control were completed June 18, 2000.

Two weeks after the May 2 application, any treatment containing glyphosate was recorded at 80% or higher volunteer wheat control whereas quizalofop, clethodim, and sethoxydim required four weeks to reach similar wheat control ratings. By the second evaluation all the treatments and both application timings proved very effective in stopping volunteer wheat except the lowest dosage of ETK 2303. (Utah Agricultural Experiment Station, Logan, UT. 84322-4820)

Table. Control of volunteer winter wheat in fallow.

Treatment		Winter wheat control (%)		
	Rate	5/16	6/18	
	lb/A	early	early	late
Untreated		0	0	0
Glyphosate[a]	0.56	83	100	100
Quizalofop-P-ethyl[b]	0.046	13	100	100
Quizalofop-P-ethyl[b]	0.061	23	100	100
Quizalofop-P-ethyl[b]	0.076	20	100	100
Glyphosate+ quizalofop-P-ethyl[b]	0.56+ 0.046	80	100	100
Glyphosate+ quizalofop-P-ethyl[b]	0.56+ 0.061	78	100	100
Glyphosate+ quizalofop-P-ethyl[b]	0.56+ 0.076	88	100	100
Clethodim[b]	0.109	20	100	100
Sethoxydim[b]	0.375	17	100	100
ETK 2303	0.56	90	100	100
ETK 2303	0.19	82	100	83
$LSD_{(0.05)}$		8.8	4.3	4.3

[a] N added at 2 qt/A rate.
[b] Scoil added at 1qt/A with N at 2 qt/A rate.

Control of volunteer winter wheat and downy brome in fallow. Phillip W. Stahlman and Patrick W. Geier. (KSU Agricultural Research Center, Hays, KS 67601). Alternatives to glyphosate will be needed to control volunteer plants of glyphosate-resistant winter wheat. An experiment was conducted near Hays, KS to evaluate and compare the effectiveness of quizalofop, clethodim, and sethyoxydim with glyphosate at two times of application for control of over-wintered volunteer winter wheat and downy brome plants. The experiment was a randomized complete block with three replicates and plots were 10 by 32 ft. Treatments were applied in water with a tractor-mounted, compressed-air plot sprayer delivering 8.3 gpa at 30 psi and 3 mph on dates indicated in Table 1.

Volunteer wheat and downy brome control with glyphosate alone or in mixture with quizalfop + Sun-It II occurred faster and consistently was higher compared with quizalfop, clethodim, or sethoxydim plus Sun-It II up to 30 DAT. Thereafter, control of volunteer wheat and downy brome with the earlier applications of quizalfop or clethodim plus Sun-It II was similar to control with glyphosate; sethoxydim was not as effective as the other herbicides. Glyphosate alone controlled both species completely, therefore, mixing quizalfop with glyphosate provided no benefit.

Table 1. Application data.

Date:	April 4, 2000	April 11, 2000
Air temp.	65 F	57 F
Relative humidity	20%	20%
Growth Stages:		
Volunteer wheat	10-15 tillers; 4-9" high	10-15 tillers; 4-10" high
Downy brome	8-15 tillers; 3-7" high	8-15 tillers; 3-7" high

Table 2. Control of over-winter volunteer winter wheat and downy brome, Hays, KS, 2000.

Treatment[a]	Rate	Appl. date	Volunteer wheat 4-25	5-3	5-9	Downy brome 4-25	5-3	5-9
	lb/A or % v/v		%					
Glyphosate	0.56	4-4-00	100	100	100	99	100	100
Quizalofop + Sun-It II	0.046 + 1.0%	4-4-00	78	92	99	77	88	98
Quizalofop + Sun-It II	0.061 + 1.0%	4-4-00	73	87	99	80	90	97
Quizalofop + Sun-It II	0.076 + 1.0%	4-4-00	77	88	99	77	87	98
Gly + quizalofop + Sun-It II	0.56 + 0.046 + 1.0%	4-4-00	100	100	100	100	100	100
Gly + quizalofop + Sun-It II	0.56 + 0.061 + 1.0%	4-4-00	99	100	100	99	100	99
Gly + quizalofop + Sun-It II	0.56 + 0.076 + 1.0%	4-4-00	100	100	100	100	100	100
Clethodim + Sun-It II	0.109 + 1.0%	4-4-00	80	92	99	77	90	98
Sethoxydim + Sun-It II	0.375 + 1.0%	4-4-00	70	70	90	77	73	73
Glyphosate	0.56	4-11-00	93	99	100	95	99	100
Quizalofop + Sun-It II	0.046 + 1.0%	4-11-00	50	70	90	53	73	87
Quizalofop + Sun-It II	0.061 + 1.0%	4-11-00	47	73	90	47	80	85
Quizalofop + Sun-It II	0.076 + 1.0%	4-11-00	47	70	95	53	73	92
Gly + quizalofop + Sun-It II	0.56 + 0.046 + 1.0%	4-11-00	93	100	100	93	97	100
Gly + quizalofop + Sun-It II	0.56 + 0.061 + 1.0%	4-11-00	85	98	100	88	95	100
Gly + quizalofop + Sun-It II	0.56 + 0.076 + 1.0%	4-11-00	88	98	100	87	93	100
Clethodim + Sun-It II	0.109 + 1.0%	4-11-00	57	70	93	60	77	90
Sethoxydim + Sun-It II	0.375 + 1.0%	4-11-00	60	70	92	60	73	70
LSD (0.05)			9	8	2	10	9	4

[a]All treatments included ammonium sulfate at 2% w/w (17 lb/100 gal); Glyphosate = Roundup Ultra; Gly = glyphosate;

Common mallow control. Brian M. Jenks, Denise M. Markle, and Gary P. Willoughby. (North Central Research Extension Center, North Dakota State University, Minot, ND 58701) We evaluated many registered herbicides for controlling common mallow. The study was established in a large patch of common mallow with no crop to provide competition. Individual plots were 10 by 30 ft arranged in a RCBD with three replicates. Treatments were applied using XR8001 flat fan nozzles delivering 10 gpa at 40 psi. Postemergence treatments were applied on June 5 with a CO_2 pressurized bicycle sprayer. Common mallow was 4 to 8 inches at application and 9 to 16 plants per sq ft.

Table. Common mallow control with various herbicides.

		MALNE
Treatment	Rate	Jun 20
	lb ai/A	% Control
Fluroxypyr	0.062	57
Fluroxypyr	0.126	70
Fluroxypyr + 2,4-D ester	0.126 + 0.5	78
Fluroxypyr + 2,4-D ester + thifensulfuron & tribenuron	0.062 + 0.5 + 0.014	82
Glufosinate + AMS	0.44 + 3 lb	98
Glufosinate + AMS	0.26 + 3 lb	89
Glyphosate + AMS	0.38 + 1 %	87
Glyphosate + glufosinate + AMS	0.38 + 0.13 + 1 %	89
Dicamba (dga salt)	0.063	8
Bromoxynil & MCPAe	0.5	45
Pyridate + NIS	0.94 + 0.25 %	40
Bentazon + COC	0.5 + 1 qt	32
Clopyralid & 2,4-D	0.6	38
Untreated		0
LSD		8
CV		8

Glufosinate at 0.44 lb effectively controlled common mallow. Glyphosate alone or glufosinate at 0.26 lb provided slightly less but still good control. A three-way mix of fluroxypyr plus 2,4-D plus thifensulfuron and tribenuron provided slightly better mallow control compared to fluroxypyr alone (full rate) or with 2,4-D. The half-rate of fluroxypyr was much weaker on mallow. From this and previous studies, we would recommend not reducing the fluroxypyr rate for mallow control and always include 2,4-D. Bromoxynil and MCPAe, pyridate, and bentazon caused slight stunting, but did not control the mallow. Dicamba had almost no effect on the mallow.

Comparison of imazethapyr and imazamox for broadleaf weed control. Don W. Morishita and Michael J. Wille. (Twin Falls Research and Extension Center, University of Idaho, Twin Falls, ID 83303-1827) Three rates each of imazethapyr and imazamox were compared for broadleaf weed control in crop-free conditions. Treatments were arranged in a randomized complete block design with four replications. Individual plots were 8 by 25 ft. All herbicides were applied May 27, 2000, with a CO_2-pressurized bicycle-wheel sprayer calibrated to deliver 10 gpa using 11001 flat fan nozzles. Weed species evaluated were common lambsquarters, kochia, and volunteer sugar beet at densities of 74, 4, and 2 plants/ft^2. Common lambsquarters and kochia heights ranged from 1 to 8-inches when herbicides were applied. Environmental conditions at application were as follows: air temperature 73 F, soil temperature 62 F, relative humidity 68%, wind speed 0 mph, and cloud cover 10%. Soil type at this location was a Portneuf silt loam (26% sand, 64% silt, and 10% clay) with 1.6% organic matter, 8.1 pH, and 16 meq/100 g soil CEC. Weed control was evaluated visually 13, 20, and 37 days after treatment (DAT).

Common lambsquarters control at 13 and 20 DAT was unacceptable, ranging from 40 to 68% with all rates of imazethapyr and imazamox. Imazamox at 0.047 lb/A controlled common lambsquarters better than any other treatment at 13 DAT. At 37 DAT, all imazamox rates controlled common lambsquarters better than the two lower imazethaypyr rates (0.047 and 0.0625 lb/A). Kochia control was unacceptable and equal between herbicides at all of the rates applied on all three evaluation dates. Volunteer sugar beet control 13 DAT ranged from 55 to 73% and from 50 to 90% 20 DAT. However, due to treatment variability no statistical differences were observed between herbicides or rates. By 37 DAT, volunteer sugar beet control ranged from 87 to 100% with all herbicide treatments. Overall poor weed control in this study is partly attributed to the variable weed size at application. These data suggest that imazamox may control common lambsquarters slightly better than imazethapyr, but kochia and volunteer sugar beet control is very similar between these two herbicides.

Table. Broadleaf weed control comparison with imazethapyr and imazamox, near Kimberly, Idaho.

		Weed control[a]								
		KCHSC			CHEAL			BEAVU		
Treatment	Rate	6/9	6/16	7/3	6/9	6/16	7/3	6/9	6/16	7/3
	lb/A	%								
Imazethapyr+ NIS + 28% UAN	0.047 + 0.25% v/v + 2.5% v/v	51	64	58	44	49	44	63	80	95
Imazethapyr + NIS + 28% UAN	0.0625 + 0.25% v/v + 2.5% v/v	60	66	55	43	55	46	60	66	95
Imazethapyr + NIS + 28% UAN	0.094 + 0.25% v/v + 2.5% v/v	49	58	36	40	53	58	65	78	100
Imazamox + NIS + 28% UAN	0.031 + 0.25% v/v + 2.5% v/v	40	49	31	45	59	75	73	90	98
Imazamox + NIS + 28% UAN	0.039 + 0.25% v/v + 2.5% v/v	40	54	46	58	56	79	56	70	87
Imazamox + NIS + 28% UAN	0.047 + 0.25% v/v + 2.5% v/v	54	61	48	68	68	73	55	50	100
LSD (0.05)		ns	ns	ns	15	ns	19	ns	ns	ns

[a]Weed evaluated for control were kochia (KCHSC), common lambsquarters (CHEAL), and volunteer sugar beets (BEAVU).

Control of volunteer glyphosate-resistant spring wheat and other weeds with glyphosate and grass 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 at the University of Idaho Kambitsch Research Farm to evaluate volunteer glyphosate-resistant spring wheat control with grass herbicides. Volunteers were simulated by seeding 'Bobwhite' glyphosate-resistant spring wheat at 25 lb/A with a grain drill on May 5, 2000. Plots were 8 by 30 ft arranged in a randomized complete block design with four replications. All herbicide treatments were applied with a CO_2 pressurized backpack sprayer calibrated to deliver 10 gpa at 32 psi and 3 mph (Table 1). Control was evaluated visually on June 22 and July 5, 2000. The study was terminated on July 5 to prevent the glyphosate-resistant spring wheat from producing seed.

Table 1. Application data.

Application date	June 1		June 9
Wheat growth stage	4 to 5 leaf		5 to 6 leaf
Air temp (F)	65		63
Relative humidity (%)	52		62
Wind (mph)	0 to 2		0
Soil temperature at 2 in (F)	64		55
pH		5.1	
OM (%)		2.4	
CEC (meq/100g)		21	
Texture		Silt loam	

On June 21, volunteer glyphosate-resistant wheat (TRIAS) control ranged from 83 to 97% for all treatments applied at the 3 to 4 leaf stage (Table 2), except glyphosate applied alone (0% control). Control ranged from 30 to 44% for all treatments applied at the 5 to 6 leaf stage, with the exception of glyphosate applied at 0.56 lb/A (0%). By July 5, all treatments, except glyphosate alone, controlled TRIAS 90 to 99%. Control was best (97% or better) with clethodim or sethoxydim applied at either timing. On July 5, wild oat (AVEFA) control ranged from 93 to 100% with all treatments. Common lambsquarters (CHEAL) and yellow mustard (SINAL) control ranged from 91 to 100% with all treatments containing glyphosate or MON 78195.

Table 2. Volunteer glyphosate-resistant wheat and weed control with glyphosate and grass herbicides near Genessee, ID in 2000.

			Weed control				
		Application	June 21	July 5			
Treatment[a]	Rate	timing	TRIAS[b]	TRIAS[b]	AVEFA	CHEAL	SINAL
	lb/A	leaf #	%				
Glyphosate	0.56	3-4	0	0	100	99	100
Quizalofop	0.03	3-4	83	90	100	0	0
Quizalofop	0.046	3-4	85	97	95	0	0
Quizalofop	0.061	3-4	88	95	94	0	0
Glyphosate + quizalofop	0.56 + 0.03	3-4	86	94	96	100	96
Glyphosate + quizalofop	0.56 + 0.04	3-4	88	95	95	99	96
Glyphosate + quizalofop	0.56 + 0.061	3-4	86	94	95	98	91
MON 78195	0.525	3-4	85	95	95	100	95
MON 78195	0.788	3-4	88	93	95	98	93
MON 78195	1.05	3-4	86	94	93	100	90
Clethodim	0.109	3-4	94	97	96	0	0
Sethoxydim	0.375	3-4	97	97	97	0	0
Glyphosate	0.56	5-6	0	0	95	95	93
Quizalofop	0.03	5-6	34	94	94	0	0
Quizalofop	0.046	5-6	31	94	97	0	0
Quizalofop	0.061	5-6	33	96	96	0	0
Glyphosate + quizalofop	0.56 + 0.03	5-6	33	93	94	95	95
Glyphosate + quizalofop	0.56 + 0.04	5-6	30	94	93	96	92
Glyphosate + quizalofop	0.56 + 0.061	5-6	36	95	95	92	95
MON 78195	0.525	5-6	35	94	95	91	95
MON 78195	0.788	5-6	35	95	94	96	95
MON 78195	1.05	5-6	31	94	95	96	96
Clethodim	0.109	5-6	43	99	96	0	0
Sethoxydim	0.375	5-6	44	97	95	0	0
Untreated control	--	--	--	--	--	--	--
LSD (0.05)			4	3	3	2	2

[a]All treatments contained ammonium sulfate (Bronc) at 5% v/v and all treatments, except glyphosate alone, were applied with a methylated seed oil (Sun-it II) at 1% v/v.

[b]Simulated volunteer glyphosate-resistant spring wheat.

Control of volunteer herbicide resistant wheat and canola. Curtis R. Rainbolt and Donald C. Thill. (Plant Science Division, University of Idaho, Moscow, ID 83844-2339) Studies were established near Moscow, ID at the University of Idaho Parker Research Farm and near Ralston, WA at the USDA Ralston Direct Seed Project site to evaluate control of volunteer herbicide resistant canola and wheat with various herbicides. Glyphosate-resistant spring wheat, glyphosate-resistant spring canola, imidazolinone-resistant wheat, imidazolinone-resistant spring canola, and glufosinate-resistant spring canola were seeded with a no-till drill at 20% of standard seeding rates at Ralston on April 31 and at Moscow on May 8, 2000. Plots were 2.4 by 3.8 m arranged in a randomized complete block-split block with four replications. Split blocks were crops and main plots were herbicide treatments. All herbicide treatments were applied with a CO_2 pressurized backpack sprayer calibrated to deliver 93 L/ha at 230kPa and 1.3 m/s on May 15 at Ralston and on June 11 at Moscow (Table 1). Control was evaluated visually at both locations 14 and 21 days after treatment (DAT). Above ground biomass was collected from a $0.25m^2$ area of each plot in the glyphosate-resistant spring wheat and imidazolinone-resistant wheat at Ralston and in all crops at Moscow 28 DAT. Canola biomass was not collected at Ralston due to inconsistent emergence and a poor stand. Both studies were terminated immediately after biomass collection to prevent seed production.

Table 1. Application data.

Location	Ralston, WA	Moscow, ID
Application date	May 15	June 11
Wheat growth stage	5 to 6 leaf	3 to 4 leaf
Canola growth stage	5 to 10 cm	5 to 8 inch
Air temperature (C)	13	5
Relative humidity (%)	64	85
Wind (m/s)	1 to 2	1 to 2
Soil temp at 2 in (C)	18	10
pH	7.3	5.4
OM (%)	2.1	3.2
CEC (meq/100g)	17	22
Texture	silt loam	silt loam

At Ralston, all treatments except the Roundup Ultra and Touchdown formulations of glyphosate applied alone, glyphosate/2,4-D, and glyphosate/dicamba reduced glyphosate-resistant wheat (RRW) biomass compared to the untreated control (Table 2). The best treatments were paraquat + diuron, paraquat, quizalofop, clethodim, glyphosate + clethodim, and glyphosate + quizalofop which reduced RRW biomass 92 to 96%. All herbicide treatments reduced biomass of imidazolinone-resistant wheat (CFW) compared to the untreated control. Biomass was reduced 89% or more by all treatments except glufosinate alone (49%). Volunteer crop control 14 DAT (data not shown) was similar to 21 DAT, with the exception of slightly higher control of RRW and CFW with treatments containing paraquat 14 DAT. By 21 DAT, RRW control was best (89 to 96%) with paraquat + diuron and treatments containing clethodim or quizalofop. CFW control was 88% or greater with all treatments except glufosinate (36%) and paraquat (83%). Control of glyphosate-resistant canola (RRC) was best with glyphosate + paraquat (98%) and paraquat + diuron (100%). Control of imidazolinone-resistant canola (CFC) and glufosinate-resistant canola (LLC) was 88% or better with paraquat, paraquat + diuron, and all treatments containing glyphosate.

At Moscow, all treatments containing glufosinate, paraquat, quizalofop, and clethodim reduced RRW biomass compared to the untreated control (Table 3). Quizalofop and clethodim treatments reduced biomass most (86 to 92%). CFW biomass was significantly reduced by all treatments compared to the untreated control, and was reduced 87% or more with all treatments containing glyphosate. RRC biomass was reduced by glyphosate/2,4-D (96%), glyphosate/dicamba (92%), paraquat (76%), glufosinate (67%), glyphosate + glufosinate (61%), glyphosate + paraquat (77%), and paraquat + diuron (100%). CFC biomass was reduced 89% or more by all treatments except quizalofop and clethodim. LLC biomass was reduced 82% or more by all treatments except glufosinate, quizalofop, and clethodim. Volunteer crop control 14 DAT (data not shown) was similar to 21 DAT, with the exception of slightly higher control of RRW and CW with treatments containing paraquat 14 DAT. By 21 DAT, RRW control was 91 to 95% with quizalofop, glyphosate + quizalofop, clethodim, and glyphosate + clethodim. CFW control was best (89 to 100%) with clethodim, quizalofop, and all treatments containing glyphosate, except glyphosate + paraquat. RRC was controlled 96 to 100% with paraquat + diuron, glyphosate/2,4-D, and glyphosate/dicamba. Control of CFC and LLC was 93% or better with paraquat + diuron and all treatments containing glyphosate, except glyphosate + glufosinate.

Table 2. Volunteer herbicide-resistant crop control and biomass in response to various herbicides at Ralston, WA.

Treatment[a]	Rate	Biomass (28 DAT)		Control (21 DAT)				
		RRW[b]	CFW	RRW	CFW	RRC	CFC	LLC
	kg/ha	g/m²		%				
Glyphosate[c] + AMS	0.43 + 5% v/v	314	22	0	93	0	98	95
Glyphosate/2,4-D + AMS	1.13 + 5% v/v	278	8	0	93	73	98	98
Glyphosate/dicamba + AMS	0.56 + 5% v/v	294	9	0	89	53	100	98
Paraquat + NIS	0.56 + 0.25% v/v	25	16	83	83	74	94	96
Glufosinate	0.49	196	236	73	36	54	51	0
Glyphosate[d] + AMS	0.43 + 5% v/v	211	22	0	95	0	96	100
Glyphosate[c] + glufosinate + AMS	0.43 + 0.49 + 5% v/v	192	48	71	88	91	88	89
Glyphosate[c] + paraquat + AMS + NIS	0.43 + 0.56 + 5% v/v + 0.25% v/v	84	7	55	97	98	100	95
Paraquat + diuron + NIS	0.56 + 0.28 + 0.25% v/v	26	6	89	97	100	99	99
Quizalofop + NIS	0.062 + 0.25% v/v	21	10	93	95	0	0	0
Glyphosate[c] + quizalofop + AMS + NIS	0.43 + 0.062 + 5% v/v + 0.25% v/v	13	3	95	98	0	98	99
Clethodim + COC	0.104 + 1% v/v	19	11	96	95	0	0	0
Glyphosate[c] + clethodim + AMS+ COC	0.43 + 0.104 + 5% v/v + 1% v/v	14	5	94	97	0	98	98
Untreated control	--	346	461	--	--	--	--	--
LSD (0.05)		144	104	6	6	3	5	3

[a]Glyphosate/2,4-D and glyphosate/dicamba were applied as the commercial formulations, AMS is ammonium sulfate, NIS is 90% non-ionic surfactant (R-11), and COC is crop oil concentrate (Moract).
[b]RRW is glyphosate-resistant spring wheat, CFW is imidazolinone-resistant wheat, RRC is glyphosate-resistant spring canola, CFC is imidazolinone-resistant canola, and LLC is glufosinate-resistant canola.
[c]Roundup Ultra formulation of glyphosate.
[d]Touchdown formulation of glyphosate (isopropylamine salt).

Table 3. Volunteer herbicide-resistant crop control and biomass in response to various herbicides at Moscow, ID.

Treatment[a]	Rate	Biomass (28 DAT)					Control (21 DAT)				
		RRW[b]	CFW	RRC	CFC	LLC	RRW	CFW	RRC	CFC	LLC
	kg/ha	g/m²					%				
Glyphosate[c] + AMS	0.43 + 5% v/v	108	1	80	5	0	0	100	0	100	99
Glyphosate/2,4-D + AMS	1.13 + 5% v/v	116	4	4	2	7	0	99	97	100	100
Glyphosate/dicamba + AMS	0.56 + 5% v/v	105	7	9	2	5	0	93	96	99	100
Paraquat + NIS	0.56 + 0.25% v/v	49	17	27	13	32	20	30	53	50	81
Glufosinate	0.49	33	57	37	8	173	49	13	13	45	0
Glyphosate[d] + AMS	0.43 + 5% v/v	114	4	82	3	18	0	100	0	98	93
Glyphosate[c] + glufosinate + AMS	0.43 + 0.49 + 5% v/v	52	14	42	8	23	41	90	18	80	88
Glyphosate[c] + paraquat + AMS + NIS	0.43 + 0.56 + 5% v/v + 0.25% v/v	35	6	25	16	13	30	50	43	55	93
Paraquat + diuron + NIS	0.56 + 0.28 + 0.25% v/v	58	24	0	0	0	51	76	100	100	100
Quizalofop + NIS	0.062 + 0.25% v/v	19	9	126	98	101	91	94	0	0	0
Glyphosate[c] + quizalofop + AMS + NIS	0.43 + 0.062 + 5% v/v + 0.25% v/v	17	0	77	4	5	95	100	0	97	99
Clethodim + COC	0.104 + 1% v/v	14	5	119	154	113	91	89	0	0	0
Glyphosate[c] + clethodim + AMS+ COC	0.43 + 0.104 + 5% v/v + 1% v/v	11	1	119	4	17	93	100	0	96	100
Untreated control	--	139	102	110	123	172	--	--	--	--	--
LSD (0.05)		48	32	41	64	90	23	15	22	11	11

[a]Glyphosate/2,4-D and glyphosate/dicamba were applied as the commercial formulations, AMS is ammonium sulfate, NIS is 90% non-ionic surfactant (R-11), and COC is crop oil concentrate (Moract).

[b]RRW is glyphosate-resistant spring wheat, CFW is imidazolinone-resistant wheat, RRC is glyphosate-resistant spring canola, CFC is imidazolinone-resistant canola, and LLC is glufosinate-resistant canola.

[c]Roundup Ultra formulation of glyphosate.

[d]Touchdown formulation of glyphosate (isopropylamine salt).

Field bindweed control in fallow with imazapyr and imazapic. Traci A. Rauch and Donald C. Thill. (Plant Science Division, University of Idaho, Moscow, ID 83844-2339) Two studies were established in chemical fallow near Tammany, ID to examine field bindweed control with imazapyr and imazapic. In both experiments, plots were 12 by 20 ft arranged in a randomized complete block design with four replications. All herbicide treatments were applied with a CO_2 pressurized backpack sprayer at 3 mph (Table 1). The entire plot areas were treated with glyphosate at 0.38 lb ae/A on April 10 and flay mowed on April 28, 2000. Field bindweed density and weed control were evaluated on May 12, June 27, July 27, August 9, and September 12, 2000.

Table 1. Application and soil data for experiment one and two.

	Experiment one			Experiment two
Application date	September 22, 1999	March 8, 2000	July 13, 2000	July 13, 2000
Field bindweed growth stage	bloom (post-harvest)	preemergence	12 in. runners	12 in. runners
Gpa	20	20	10	10
Psi	40	40	30	30
Air temperature (F)	82	48	80	80
Relative humidity (%)	40	80	39	39
Wind (mph, direction)	1, NW	1, SW	1, NW	1, NW
Cloud cover (%)	0	80	20	20
Soil temperature at 2 in (F)	60	38	68	68
pH			5.9	
OM (%)			2.5	
CEC (meq/100g)			22	
Texture			silt loam	

In experiment one, field bindweed density was lowest with glyphosate/2,4-D (July 27) and bloom-stage applied imazapyr at 0.50 lb/A (July 27 and September 12); however, density did not differ among treatments at either evaluation date (Table 2). On July 27, glyphosate/2,4-D and imazapyr applied at bloom-stage controlled field bindweed better (98 to 99%) than both rates of imazapyr and imazapic at 0.128 lb/A applied preemergence (35 to 50%). On September 12, field bindweed control was best with bloom-stage applied imazapyr at 0.50 lb/A (98%) and lowest with both rates of imazapyr and imazapic at 0.128 lb/A applied preemergence (18 to 47%).

In experiment two, field bindweed density on August 9 ranged from 1 to 9 plants/240 ft^2 and did not differ among treatments or from the untreated check (Table 3). On September 12, all treatments, except imazapyr at 0.125 lb/A, had less field bindweed than the untreated check. Field bindweed density in the glyphosate/2,4-D treatment was 82% lower than the 0.125 lb/A imazapyr treatment. Imazapyr at 0.25 lb/A and glyphosate/2,4-D controlled field bindweed 88 and 93%, respectively, on August 9. By September 12, glyphosate/2,4-D controlled field bindweed better (82%) than both rates of imazapic and imazapyr at 0.125 lb/A (18 to 52%).

Table 2. Field bindweed density and control with imazapyr and imazapic in experiment one.

			Field bindweed			
		Application	Density		Control	
Treatment[a]	Rate[b]	timing	July 27	September 12	July 27	September 12
	lb/A		plants/240 ft^2		%	
Imazapyr	0.25	bloom	1	2	98	90
Imazapyr	0.50	bloom	0	0	99	98
Imazapic	0.128	bloom	1	2	77	78
Imazapic	0.192	bloom	5	6	54	60
Imazapyr	0.25	preemergence	4	8	35	39
Imazapyr	0.50	preemergence	4	9	49	18
Imazapic	0.128	preemergence	7	9	50	48
Imazapic	0.192	preemergence	1	2	82	75
Glyphosate/2,4-D	1.0	12 in. runners	0	2	98	90
Untreated check	--	--	5	11	--	--
LSD (0.05)			NS	NS	47	43

[a]A 90% nonionic surfactant (R-11) was applied at 0.25 % v/v with all postemergence imazapyr and imazapic applications.
[b]Rate is in lb ae/A.

Table 3. Field bindweed density and control with imazapyr and imazapic in experiment two.

Treatment[a]	Rate[b]	Field bindweed			
		Density		Control	
		August 9	September 12	August 9	September 12
	lb/A	——plants/240 ft^2——		——%——	
Imazapyr	0.125	5	11	64	18
Imazapyr	0.25	2	6	88	68
Imazapic	0.128	4	8	49	52
Imazapic	0.192	6	6	48	52
Glyphosate/2,4-D	1.0	1	2	93	82
Untreated check	--	9	16	--	--
LSD (0.05)		NS	7	14	27

[a]A 90% nonionic surfactant (R-11) was applied at 0.25 % v/v with all imazapyr and imazapic treatments.
[b]Rate is in lb ae/A.

Quackgrass control with glyphosate formulations. Traci A. Rauch and Donald C. Thill. (Plant Science Division, University of Idaho, Moscow, ID 83844-2339) A study was established near Bonners Ferry, ID in a field waste area to examine quackgrass, volunteer wheat, and toad rush control with glyphosate and ETK2303. Plots were 8 by 30 ft arranged in a randomized complete block design 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). Weed control was evaluated visually on May 16 and 24, and June 6 and 26, 2000.

Table 1. Application and soil data.

Application date	May 8, 2000	May 24, 2000
Quackgrass growth stage	6 to 8 in	10 to 12 in
Volunteer wheat growth stage	12 to 16 in	boot stage
Toad rush growth stage	1 in	2 to 3 in
Air temperature (F)	62	80
Relative humidity (%)	39	40
Wind (mph, direction)	6, W	1, W
Cloud cover (%)	85	50
Soil temperature at 2 in (F)	60	65
pH	7.3	
OM (%)	10.0	
CEC (meq/100g)	25	
Texture	loam	

On May 16, volunteer wheat control was greater with ETK2303 at 0.75 lb/A (94%) than ETK2303 at 0.65 lb/A (89%), but by June 6 all treatments at both timings controlled volunteer wheat 99%. On May 16 and June 6, all treatments controlled toad rush 99%. Toad rush regrowth decreased control by June 26 to 65% or less for the early timing and 86% or less for the later timing. Quackgrass was slower to display symptoms. On May 16, all treatments had only suppressed quackgrass (72 to 79%), but by May 24 both ETK2303 treatments controlled above-ground quackgrass shoots 91 and 96%. By June 6, quackgrass in the early timing treatments was starting to regrow and control decreased to 62 to 65%. The same trend occurred in the later timing treatments on June 26.

Table 2. Quackgrass, volunteer wheat, and toad rush control with glyphosate and ETK2303.

Treatment[a]	Rate[b]	Application timing[c]	Volunteer wheat control		Toad rush control			Quackgrass control			
			May 16	June 6	May 16	June 6	June 26	May 16	May 24	June 6	June 26
	lb/A		--%--								
Glyphosate	0.75	6 to 8 in	91	99	99	99	60	72	76	62	60
ETK2303	0.65	6 to 8 in	89	99	99	99	65	78	91	64	65
ETK2303	0.75	6 to 8 in	94	99	99	99	65	79	96	65	64
Glyphosate	0.75	10 to 12 in	--	99	--	99	86	--	--	98	86
ETK2303	0.65	10 to 12 in	--	99	--	99	85	--	--	99	86
ETK2303	0.75	10 to 12 in	--	99	--	99	86	--	--	99	85
Untreated check		--	--	--	--	--	--	--	--	--	--
LSD (0.05)			5	NS	NS	NS	4	5	6	4	4
Density (plts/ft^2)			9			112			46		

[a]Glyphosate was the Roundup Ultra formulation. ETK2303 is a glyphosate acid formulation. Non-ionic surfactant/acidifier (LI700) was applied at 0.5 % v/v with all ETK2303 treatments.
[b]Rates are in lb ae/A.
[c]Application timing based on quackgrass growth stage.

Volunteer wheat control with carfentrazone. Janice M. Reed and Donald C. Thill. (Department of Plant, Soil, and Entomological Sciences, University of Idaho, Moscow, ID 83844-2339) A study was conducted near Moscow, Idaho to evaluate control of volunteer wheat with carfentrazone in combination with glyphosate applied pre-plant in a no-till cropping system. The experimental design was a randomized complete block with four replications and plot size was 8 by 30 ft. Treatments were applied on April 3, 2000 with a CO_2 pressurized backpack sprayer calibrated to deliver 10 gpa at 30 psi and 3 mph (Table 1). Volunteer wheat control was evaluated visually 7 and 14 days after treatment (DAT).

Table 1. Application data.

Volunteer wheat growth stage	2 to 4 leaf
Air temperature (F)	61
Relative humidity (%)	47
Wind (mph, direction)	3 to 5, SE
Cloud cover (%)	50
Soil temperature at 2 in (F)	52
pH	5.2
OM (%)	3.8
CEC (meq/100g)	2
Texture	Silt loam

At 7 DAT, carfentrazone plus paraquat controlled volunteer wheat 100 %, while all other treatments suppressed volunteer wheat 35 to 75% (Table 2). By 14 DAT, all treatments, except glyphosate/dicamba, controlled volunteer wheat 80 to 100%. All treatments controlled volunteer wheat 100% (data not shown) at the time spring wheat was seeded in the plot area 22 DAT.

Table 2. Volunteer wheat control with carfentrazone and glyphosate combinations.

		Volunteer wheat control	
Treatment[a]	Rate	7 DAT	14 DAT
	lb/A	%	
Carfentrazone + 2,4-D + glyphosate + AMS	0.008 + 0.125 + 0.375	40	90
Carfentrazone + 2,4-D + glyphosate + AMS	0.008 + 0.125 + 0.75	75	90
Carfentrazone + 2,4-D + glyphosate + AMS	0.008 + 0.25 + 0.375	50	85
Carfentrazone + glyphosate + AMS	0.008 + 0.375	35	90
Carfentrazone + glyphosate + AMS	0.008 + 0.75	48	90
Carfentrazone + glyphosate + AMS	0.004 + 0.75	52	80
Carfentrazone + paraquat + NIS	0.008 + 0.375	100	100
Carfentrazone + sulfentrazone + glyphosate + AMS	0.008 + 0.2 + 0.375	63	100
Glyphosate/dicamba	0.5	55	78
LSD (0.05)		10	4

[a]AMS is liquid ammonium sulfate applied at 17 lbs/100 gal. NIS (R-11) is a 90% non-ionic surfactant applied at 0.25% v/v. Glyphosate/dicamba was applied as the commercial formulation.

Evaluation of glyphosate products for volunteer wheat and broadleaf weed control in fallow. Michael J. Wille and Don W. Morishita. Twin Falls Research and Extension Center, University of Idaho, Twin Falls, ID 83303-1827). A study was conducted at the University of Idaho Research and Extension Center near Kimberly, ID to compare the efficacy of two glyphosate products alone or tank-mixed with dicamba or 2,4-D for control of volunteer wheat and broadleaf weeds in fallow. Glyphosate-M is marketed as Roundup Ultra® and glyphosate-S is marketed Touchdown®. The soil at the study site was a Portneuf silt loam soil (26% sand, 64% silt, and 10% clay, pH of 8.1, 1.6% organic matter, and a CEC of 16 meq/100 g soil). Experimental design was a randomized complete block with four replications. Individual plots were 8 by 23 feet. Wheat seed was broadcast uniformly throughout the study area on April 4, 2000, to simulate volunteer wheat. Volunteer wheat (15 plants/ft^2), kochia (15 plants/ft^2), and common lambsquarters (24 plants/ft^2) were the dominant weed species. Herbicides were broadcast-applied with flat-fan nozzles at 10 gpa using a CO_2-pressurized bicycle-wheel sprayer May 27, 2000 (air temperature, 77 F; soil temperature, 70 F; relative humidity, 68%; wind velocity, 3 mph; 20% cloud cover). All weed species were 1 to 8 inches tall at herbicide application. Weed control was evaluated visually June 6 and July 3, 10 and 37 days after treatment (DAT), respectively,.

Volunteer wheat control was better than 90% for all treatments at both evaluation dates (Table). Kochia was controlled 86 to 100% 13 DAT but declined to 60 to 75% 38 DAT. Kochia control was similar among all herbicide treatments on both evaluation dates. Common lambsquarters control ranged from 69 to 96% 13 DAT. Both glyphosate products at 0.28 lb/A + 2,4-D or dicamba was as effective as both glyphosate alone at 0.469 lb/A and more effective than either glyphosate products alone at 0.28 or 0.375 lb/A at controlling common lambsquarters. Glyphosate at 0.375 lb/A + 2,4-D or dicamba was more effective than glyphosate alone at the same rate. Common lambsquarters was controlled equally well by either glyphosate alone at 0.469 lb/A or combined with 2,4-D or dicamba. Common lambsquarters control ranged from 63 to 81% 38 DAT but differences between herbicide treatments could not be distinguished. These data indicate that the two glyphosate products evaluated in this study controlled weeds equally. Also, tank-mixing 2,4-D or dicamba with lower rates of glyphosate can control weeds in fallow as effectively as higher rates of glyphosate alone and may offer an economical alternative.

Table. Volunteer wheat and broadleaf weed control in fallow with two glyphosate products near Kimberly, Idaho.

		Weed control[a]					
		TRZAX		KCHSC		CHEAL	
Treatment[b]	Rate	6/9	7/3	6/9	7/3	6/9	7/3
	lb/A	%					
Glyphosate-S + ammonium sulfate	0.28 + 1.7	98	100	92	75	73	63
Glyphosate-S + ammonium sulfate	0.375 + 1.7	100	97	100	65	75	66
Glyphosate-S + ammonium sulfate	0.469 + 1.7	100	100	100	73	88	70
Glyphosate-M + ammonium sulfate	0.28 + 1.7	99	100	93	60	69	64
Glyphosate-M + ammonium sulfate	0.375 + 1.7	98	98	98	65	76	63
Glyphosate-M + ammonium sulfate	0.469 + 1.7	99	100	92	75	89	80
Glyphosate-S + dicamba + ammonium sulfate	0.28 + 0.125 + 1.7	91	97	93	70	79	70
Glyphosate-S + dicamba + ammonium sulfate	0.375 + 0.125 + 1.7	96	99	100	75	81	73
Glyphosate-S + dicamba + ammonium sulfate	0.469 + 0.125 + 1.7	99	97	97	65	92	73
Glyphosate-M + dicamba + ammonium sulfate	0.28 + 0.125 + 1.7	96	100	95	71	86	71
Glyphosate-S + 2,4-D LVE + ammonium sulfate	0.28 + 0.5 + 1.7	94	100	94	61	93	81
Glyphosate-S + 2,4-D LVE + ammonium sulfate	0.375 + 0.5 + 1.7	99	91	94	99	63	71
Glyphosate-S + 2,4-D LVE + ammonium sulfate	0.469 + 0.5 + 1.7	100	98	98	64	96	75
Glyphosate-M + 2,4-D LVE + ammonium sulfate	0.28 + 0.5 + 1.7	100	98	91	76	92	78
LSD (0.05)		5	4	7	16	10	11

[a]Weeds evaluated for control were volunteer wheat (TRZAX), kochia (KCHSC), and common lambsquarters (CHEAL).
[b]Glyphosate-S is marketed as Touchdown® and Glyphosate-M is marketed as Roundup Ultra®.

Weed control in lentil. Brian M. Jenks, Denise M. Markle, Gary P. Willoughby, and Kent McKay. (North Central Research Extension Center, North Dakota State University, Minot, ND 58701) 'CDC Richlea' lentils were seeded April 28 at 60 lb/A into 6 inch rows in a conventional tillage system. Individual plots were 10 by 30 ft arranged in a RCBD with three replicates. Preplant incorporated (PPI) treatments were applied April 26, preemergence (PRE) treatments were applied May 3. Postemergence treatments were applied June 2 (POST) and June 5 (POST 2). All treatments were applied with a CO_2 pressurized bicycle sprayer. PPI and PRE treatments were applied with XR80015 flat fan nozzles delivering 20 gpa at 30 psi. Postemergence treatments were applied using XR8001 flat fan nozzles delivering 10 gpa at 40 psi.

Table. Lentil injury and weed control with various herbicides.

		Lentil			Control					
		Stand	Injury		POLCO		AMARE	SETLU	KCHSC	
Treatment	Rate	6-26	5-25	7-15	7-15	8-21	7-15	8-21	7-15	8-21
	lb ai/A	pl/m of row	%							
Untreated		10.7	0	0	0	0	0	0	0	0
PPI										
Ethalfluralin	0.75	10.8	8	2	86	87	96	91	91	91
Trifluralin	1		13	0	75	71	95	81	83	84
Trifluralin + metribuzin	0.75 + 0.25		14	4	70	58	90	80	77	76
PRE										
Imazethapyr	0.031		10	2	90	89	100	88	40	28
Sulfentrazone + pendimethalin	0.125 + 1	6.1	70	5	55	55	93	20	90	87
PPI/POST										
Sulfentrazone / quizalofop	0.125 / 0.048	8.7	17	3	67	68	75	57	82	87
Sulfentrazone / quizalofop	0.25 / 0.048	8.2	52	9	84	77	92	75	89	91
Sulfentrazone / quizalofop	0.5 / 0.048	5.4	66	44	93	92	97	80	98	96
Handweeded check[a]		8.9	11	3	90	92	97	94	96	98
PPI/POST 2										
Trifluralin / MCPB	0.75 / 0.125		11	0	67	62	88	78	70	63
PRE/POST										
Sulfentrazone / quizalofop	0.125 / 0.048	7.3	30	3	58	50	75	27	90	95
Sulfentrazone / quizalofop	0.25 / 0.048	5.5	58	12	86	81	97	58	96	95
Sulfentrazone / quizalofop	0.5 / 0.048	4.8	66	54	92	87	97	76	100	98
Flumioxazin / quizalofop	0.063 / 0.048	7.1	53	4	47	27	78	30	72	78
Flumioxazin / quizalofop	0.094 / 0.048	6.8	62	12	45	37	74	25	77	83
Flumioxazin / quizalofop	0.188 / 0.048	3.1	75	27	50	37	91	27	92	91
POST 2										
MCPB	0.25		0	0	22	7	60	37	38	37
LSD		2	7	12	10	15	13	22	16	20
CV		18	13	71	9	15	9	23	13	16

[a] Trifluralin was applied at 0.75 lb (PPI) followed by quizalofop at 0.048 lb (POST) to aid handweeding.

We evaluated lentil tolerance to different rates of sulfentrazone and flumioxazin applied either preplant incorporated or preemergence. All rates of sulfentrazone and flumioxazin caused moderate to severe crop injury early in the season. Crop stunting and stand reduction was observed in almost all sulfentrazone and flumioxazin treatments compared to the untreated check. The lentils recovered somewhat by mid-July, especially in lower rates of sulfentrazone and flumioxazin. A high density of yellow foxtail also impeded lentil growth. An adjuvant was not applied with quizalofop resulting in less foxtail control. Sulfentrazone at 0.125 lb generally provided less weed control compared to the higher rates. Flumioxazin controlled kochia and pigweed at the high rate only. It did not control wild buckwheat or yellow foxtail at any rate.

Kochia control during pasture establishment. Steven A. Dewey, Holli Murdock, and R. William Mace. (Department of Plants, Soils, and Biometeorology, Utah State University, Logan, Utah 84322-4820). Eleven postemergence herbicides were evaluated for their effectiveness in controlling kochia (KOCSC) in a newly seeded smooth brome/ orchardgrass/ alfalfa pasture. 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 18.5 gpa at 40 psi. The soil was a loam texture with 7.7 pH and O.M. content of less than 2%. Treatments were applied on June 15, 1999 in a randomized block design with four replications. Pasture grasses and alfalfa were approximately eight inches high and kochia was not visible at application. There was a moderate to heavy stand of seedling pigweed, lambsquarters and shepherdspurse present at the time of herbicide application. However, after the first cutting most of these weeds had died and kochia had become the predominate weed. Visual evaluations for weed control were completed August 12, 1999 and the following year on August 1, 2000.

Metsulfuron and triasulfuron gave excellent control of kochia in both the seedling and the ensuing year. Picloram and clopyralid treatments improved dramatically from 1999 to 2000, but still provided less than 75 percent control. Alfalfa injury was severe from all treatments containing picloram or clopyralid, but was only slight to moderate from most other treatments. The pasture grasses were not injured by any treatment. (Utah Agricultural Experiment Station, Logan, UT. 84322-4820)

Table. Kochia control during pasture establishment.

Treatment	Rate	Alfalfa Injury 8-1-00	Weed control KOCSC 8-12-99	Weed control KOCSC 8-1-00
	lb/A	%		
2,4-D amine	0.5	39	5	34
Dicamba/2,4-D amine	0.24	53	59	43
Picloram	0.125	100	11	63
Clopyralid	0.1875	100	10	66
Metsulfuron [a]	0.004	19	96	84
Metsulfuron [a]	0.009	29	100	94
Triasulfuron [a]	0.013	44	100	98
Triasulfuron [a]	0.019	30	100	88
Dicamba	0.24	39	92	61
Clopyralid/2,4-D amine	0.6	99	25	68
Picloram/2,4-D amine	0.32	100	6	73
Untreated		3	0	0
$LSD_{(0.05)}$		37	11.9	26.3

[a] Non-ionic surfactant added at .25% v/v.

Oxeye daisy control with metsulfuron. Steven A. Dewey, Jason Tew, and R. William Mace. (Department of Plants, Soils, and Biometeorology, Utah State University, Logan, Utah 84322-4820). Oxeye daisy (CHRLE) was treated with several herbicides including metsulfuron, clopyralid, and picloram to evaluate their effectiveness at controlling oxeye daisy in permanent pasture. Individual treatments were applied to 7 by 30 foot plots with a backpack CO_2 sprayer using flatfan 80015 nozzles providing a 7 foot spray width calibrated to deliver 18 gpa at 40 psi. The soil was a silt loam with 7.6 pH and O.M. content of less than 2%. Treatments were applied on May 18, 2000 to a randomized block design, with three replications. Oxeye daisy was 3-5" tall at the time of application. Visual evaluations for weed control were completed June 27, 2000.

Metsulfuron provided good to excellent control of oxeye daisy 5 weeks after treatment. Control from picloram and picloram plus 2,4-D was comparable to the lowest rate of metsulfuron. Clopyralid was the least effective treatment, averaging 73 percent control. Pasture grasses were not injured by any treatment. This site will be evaluated again in 2001. (Utah Agricultural Experiment Station, Logan, UT. 84322-4820)

Table. Oxeye daisy control with metsulfuron

Treatment[a]	Rate	Weed control CHRLE 6-27-00
	lb/A	%
Metsulfuron	0.0188	88
Metsulfuron	0.028	91
Metsulfuron	0.0375	95
Metsulfuron	0.0563	97
Clopyralid	0.464	73
Picloram	0.5	88
Picloram/2,4-D amine	1.25	90
Untreated		0
$LSD_{(0.05)}$		10.1

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

Peppermint tolerance to fluroxypyr. Bill D. Brewster, Carol A. Mallory-Smith, and Bradley D. Hanson. (Department of Crop and Soil Science, Oregon State University, Corvallis, OR 97331-3002) A trial was conducted near Stayton, Oregon, to evaluate the effect of fluroxypyr on established peppermint. The experimental design was a randomized complete block with four replications and 8 ft by 20 ft plots. Fluroxypyr was applied with a single-wheel, compressed-air, plot sprayer which delivered 20 gpa at 19 psi through XR 8003 flat fan nozzle tips. Herbicide application data are presented in Table 1.

Visual evaluations of crop injury were conducted periodically in April through June 2000, following fluroxypyr application. Results of three of these evaluations are presented in Table 2. All rates and timings of fluroxypyr resulted in considerable stunting of the peppermint as well as loss of chlorophyll. Stunting was still present at the higher rates over two months after application.

Table 1. Fluroxypyr application data.

Application date	4/11/00	4/18/00	5/5/00
Air temperature (F)	77	55	54
Soil temperature (F)	74	54	60
Relative humidity (%)	59	50	73

Table 2. Visual evaluations of peppermint injury.

			Peppermint injury		
Fluroxypyr rate	Mint height	Application date	May 9	May 25	June 28
lb/A	in			%	
0.062	1.5	4/11/00	25	16	3
0.125	1.5	4/11/00	30	11	8
0.25	1.5	4/11/00	58	38	10
0.062	2-4	4/18/00	30	8	0
0.125	2-4	4/18/00	43	28	5
0.25	2-4	4/18/00	60	65	21
0.062	6-10	5/5/00	18	8	0
0.125	6-10	5/5/00	28	24	5
0.25	6-10	5/5/00	33	40	18
0	---		0	0	0

Effect of row spacing and trinexapac-ethyl on perennial ryegrass seed yield. Bill D. Brewster, Carol A. Mallory-Smith, and Bradley D. Hanson. (Department of Crop and Soil Science, Oregon State University, Corvallis, OR 97331-3002) Perennial ryegrass was seeded in 3-, 6-, and 12-inch row spacings on October 2, 1998, in a trial designed to study annual bluegrass stand suppression. The trial was conducted at the Oregon State University Hyslop Research Farm near Corvallis, OR. The experimental design was a randomized complete block with four replications and 8 ft by 25 ft plots. Trinexapac-ethyl was applied at 0.36 lb/A on April 30, 1999, with a single-wheel, compressed-air, plot sprayer which applied 20 gpa at 19 psi through XR 8003 flat fan nozzle tips. The perennial ryegrass was at the 2-node stage and the annual bluegrass was flowering to hard dough. In July, the ryegrass was swathed, threshed and cleaned. The annual bluegrass stand density was determined on December 6, 1999, by counting plants in three 1-sq-ft quadrats per plot.

Trinexapac-ethyl increased perennial ryegrass seed yield by an average of 680 lb/A ($LSD_{0.05}$ = 134 lb/A) over the untreated checks. There were no differences among row spacings and there were no row spacing x growth regulator interactions. Trinexapac-ethyl also reduced the height of the ryegrass and prevented lodging. Annual bluegrass stand the following December was significantly higher in the 12-inch row spacing ($LSD_{0.05}$ = 15.5 plants/sq ft), and in the untreated checks ($LSD_{0.05}$ = 12.4 plants/sq ft).

Table. Perennial ryegrass seed yield and subsequent annual bluegrass stand, Corvallis, OR, 1999.

Row spacing	Treatment	Ryegrass seed	Annual bluegrass
inches		lb/A	plants/sq ft
3	Trinexapac-ethyl	2143	6.2
3	Check	1375	21.2
6	Trinexapac-ethyl	1969	9.3
6	Check	1366	35.2
12	Trinexpac-ethyl	1948	25.7
12	Check	1281	54.0

Tolerance of carbon-seeded perennial ryegrass to herbicides. Bill D. Brewster, Carol A. Mallory-Smith, and Bradley D. Hanson. (Department of Crop and Soil Science, Oregon State University, Corvallis, OR 97331-3002) A trial was conducted at the Oregon State University Hyslop Research Farm near Corvallis, OR to evaluate herbicides for controlling annual bluegrass in new seedings of perennial ryegrass. The experimental design was a randomized complete block with four replications and 8 ft by 35 ft plots. Perennial ryegrass ('Delaware Dwarf') was seeded on September 28, 1999, with 12-inch row spacing. A 1-inch-wide band of activated charcoal at a rate of 300 lb/A was sprayed over the seeded row as it was being planted. Herbicides were applied on September 29, 1999, with a single-wheel, compressed-air, plot sprayer which delivered 20 gpa at 19 psi through XR8003 flat fan nozzle tips. Additional application information is presented in Table 1. Visual evaluations were conducted periodically after crop and weed emergence. The ryegrass was swathed, threshed, and cleaned in July 2000.

Some injury occurred with all of the treatments, but by mid-winter the symptoms were largely gone. Visible injury persisted longer with the higher rate of clomazone and azafenidin than with the other treatments (Table 2). All treatments, except the lower rate of clomazone and sulfentrazone, provided at least 95% control of annual bluegrass through early February. The higher rate of sulfentrazone and both rates of azafenidin produced perennial ryegrass seed yields greater than the standard diuron.

Table 1. Herbicide application data.

Air temperature (F)	43
Soil temperature (F)	46
Relative humidity (%)	51
Wind (mph)	0
Soil moisture	dry on surface

Table 2. Visual evaluations of annual bluegrass control and crop injury and perennial ryegrass seed yield.

		Annual bluegrass control		Perennial ryegrass injury		
Treatment	Rate	October 20, 1999	February 8, 2000	October 20, 1999	February 8, 2000	Seed yield
	lb/A	%				lb/A
Diuron	2.4	100	99	11	6	1345
Norflurazon	0.49	99	95	5	0	1450
Norflurazon	0.98	100	99	11	4	1355
Clomazone	0.25	99	93	11	0	1360
Clomazone	0.5	100	98	18	15	1432
Sulfentrazone	0.25	99	91	3	0	1335
Sulfentrazone	0.5	100	96	14	9	1506
Azafenidin	0.188	100	97	16	5	1499
Azafenidin	0.375	100	100	24	20	1571
Check	0	0	0	0	0	1467
						$LSD_{0.05}$ 149

Control of wild oat in barley. Alvin J. Bussan, Chris Murphy, Susan B. Kelly. (Department of Land Resources and Environmental Sciences, Montana State University, Bozeman MT 59717) This field trial was conducted to evaluate suspected wild oat resistance to imazamethabenz and ACCase inhibitors in irrigated barley. This site, located on the Fairfield Bench in north central Montana, has been in continuous malt barley production for 30 + years. Imazamethabenz is an Acetolactate synthase (ALS) inhibitor and wild oat resistance has been suspected on the Bench because of continuous use over the last 6 to 8 years. Management prior to the early 1990's was accomplished with triallate. However, continuous triallate use led to resistance in wild oat nearly a decade ago. Site description information is summarized in Table 1. Herbicide treatments were applied with a hand-held CO_2 backpack sprayer with 10 GPA water at 40 psi at 3 mph. Application timings and climatic conditions at time of application are summarized in Table 2. Herbicide effects on barley and wild oat are shown in Table 3.

Table 1. Site description

Crop	Malt Barley
Planting Date	April 20, 2000
Planting Rate	95 lb\acre
Row spacing	12 inches
Previous Crop	Malt Barley
Soil Type	loam
Plot Size	7' by 25'

Table 2. Application data and climatic conditions

Application Date	May 16, 2000 (A)	May 23, 2000 (B)
Application Timing	Spring Post-emergence	Spring Post-emergence
Time of Day	7 AM	7 AM
Air Temperature	60 F	52 F
Wind Velocity	3 mph	5 mph
Soil Temperature	58	54
Cloud Cover (%)	25	0
Crop Stage at Application	2 leaves	4 leaves

Table 3. Effects of herbicide application on malt barley and wild oat

				Barley		Wild Oat
Treatment	Rate	Appl. Code	Timing	Stunt 06/15/00	Injury 06/15/00	Control 06/15/00
	(LB A/A)				%	
imazamethabenz*	0.375	A	1-3 lf	2.5	7.5	47.5
imazamethabenz*	0.47	A	1-3 lf	0	0	60
imazamethabenz*	0.94	A	1-3 lf	12.5	10	77.5
tralkoxydim+	0.176	B	3-5 lf	0	0	32.5
tralkoxydim+	0.24	B	3-5 lf	2.5	0	52.5
tralkoxydim+	0.48	B	3-5 lf	10	10	67.5
fenoxaprop	0.083	B	3-5 lf	17.5	7.5	82.5
fenoxaprop	0.125	B	3-5 lf	30	10	94
fenoxaprop	0.25	B	3-5 lf	50	20	96
non-treated				0	0	0
			LSD (P=.05)	7.47	9.68	12.01

* = NIS 0.25 V/V, + = NIS 0.5 V/V, and AMS 1.7 LB/A

Control of wild oat with imazamethabenz increased with rate, but only resulted in 78% control at twice the label rate. Irrigation was initiated several days after imazamethabenz application, which resulted in decreased efficacy. Primary wild oat tillers were killed, but irrigation helped secondary tillers grow through imazamethabenz injury Tralkoxydim and fenoxaprop are relatively new wild oat herbicide for barley, but are both Acetyl-CoA carboxylase (ACCase) inhibitors. Poor control resulted from tralkoxydim. Tralkoxydim failed to manage emerged seedlings resulting in only 52% control at the labeled rate. Variable control of wild oat with tralkoxydim was seen in other studies conducted across Montana in 2000. Fenoxaprop effectively managed established wild oat, but resulted in a high level of injury. Regardless, numerous wild oats emerged with subsequent irrigation that resulted in a large amount of seed production even though they were not visible above the crop canopy.

Herbicide resistance did not appear to be contributing to the lack of wild oat control. Rather, an extremely high population of wild oat at the site, drought stress prior to herbicide application, timing of flood irrigation with respect to herbicide application, and lack of cultural management practices lead to poor results. Producers on the Bench will have to adjust their management systems to allow for future management of wild oat. For example, barley seeding rates average from 45 to 55 lb. seed per acre, yet crop competition is critical for managing late emerging weeds. Crop rotation is also needed to allow for use of herbicides with alternative modes of action. Triallate resistant wild oats are widespread across the Bench. ACCase resistant wild oats that are cross-resistant to triallate have also been identified in several areas. It is only a matter of time before triple resistant wild oats are present and no herbicide management options are available for barley.

Barley variety tolerance to fenoxaprop/safener. Lori J. Crumley and Donald C. Thill. (Plant Science Division, University of Idaho, Moscow, ID 83844-2239) Two studies were established to evaluate injury of 20 barley varieties to fenoxaprop/safener near Moscow and Winchester, Idaho. The experimental design was a randomized split-plot factorial with main plots as barley variety and subplots as herbicide rate with four replications. Main plots were 5 by 60 ft and subplots were 5 by 20 ft. Fenoxaprop was applied with a CO_2 pressurized backpack sprayer calibrated to deliver 10 gal/A at 40 psi (Table 1). Injury was visually evaluated on June 12 and 19, 2000 at Moscow and June 23 and 29, 2000 at Winchester. Barley was harvested with a small plot combine on August 23, 2000 at Moscow and September 26, 2000 at Winchester.

Table 1. Soil and application data.

Location	Moscow	Winchester
Application date	June 5, 2000	June 19, 2000
Application timing	4 to 5 leaf	4 to 5 leaf
Air temp (F)	83	49
Relative humidity (%)	52	66
Wind (mph)	3 to 7	3 to 7
Soil temperature at 2 in (F)	68	45
pH	5	4.9
OM (%)	3.6	5.0
CEC (meq/100g)	19	26
Texture	Loam	Silt loam

There was no variety by herbicide rate interaction (data not shown). The two most sensitive varieties at both locations were Klages and Galena with an average injury over all evaluations of 15 and 16%, respectively (Table 2). The most tolerant variety at Moscow was Stander with an average injury over the two evaluation dates of 2%. At Winchester, the most tolerant variety was Camas with an average injury over the two evaluation dates of 7%. Barley injury at Moscow averaged over both evaluations was 48% higher for two-row varieties than six-row varieties and 12% greater for feed varieties compared to malt varieties. However, barley yield was not effected. Head type and market class did not effect barley variety injury at Winchester. Chinook and Camas were the highest yielding barley varieties at Moscow (2528 lb/A) and Winchester (2345 lb/A), respectively. The lowest yielding variety at Moscow was Galena producing 1493 lb/A. At Winchester, seed yield of Morex and B2601 were low due to animal predation.

Table 2. Barley injury and grain yield of 20 barley varieties pooled over herbicide treatments.

			Moscow			Winchester		
			Injury			Injury		
Variety	Market Class	Head Type	June 12	June 19	Yield	June 23	June 29	Yield
		row	%		lb/A	%		lb/A
B-1202	Malt	2	8	5	1566	9	12	1639
Chinook	Malt	2	5	6	2528	9	9	1814
Crystal	Malt	2	3	5	1790	8	12	1386
Harington	Malt	2	2	5	1914	14	14	1820
Klages	Malt	2	12	22	1845	9	21	1360
Bancroft	Feed	2	8	6	2176	9	16	1882
Baronesse	Feed	2	6	6	2217	9	18	2203
Camas	Feed	2	12	6	2212	9	5	2345
Galena	Feed	2	16	13	1493	12	18	1474
Gallatin	Feed	2	10	6	1840	8	18	1737
Orca	Feed	2	6	6	1498	11	14	1841
Xena	Feed	2	4	6	2057	8	20	2218
Bear	Hulless Feed	2	8	19	1797	12	16	1590
B-2601	Malt	6	8	6	1614	10	16	764
Morex	Malt	6	4	6	2372	13	10	497
Stander	Malt	6	3	0	2205	9	11	1277
Colter	Feed	6	2	6	1699	8	9	1405
Maranna	Feed	6	3	5	1595	8	11	1137
Steptoe	Feed	6	6	0	2032	12	12	1178
Tango	Feed	6	4	6	2001	9	16	1268
LSD (0.05)			5	5	270	4	9	390

At Moscow, fenoxaprop injured barley 5 to 6% and 8 to 9% when applied at 0.083 lb/A and 0.166 lb/A, respectively (Table 3). At Winchester, barley was injured 10% on June 23 and 14% on June 29; however, treatments did not differ from each other. Grain yield of barley treated with fenoxaprop was reduced 11% at Moscow and 10% at Winchester compared to the untreated control. Results were similar for a greenhouse study performed in February, 2000 (data not shown). In the greenhouse study, biomass of barley was reduced 7% by fenoxaprop when compared to the untreated check.

Table 3. Effect of fenoxaprop/safener on barley injury and yield pooled over barley varieties.

		Moscow			Winchester		
		Injury			Injury		
Treatment	Rate	June 12	June 19	Yield	June 23	June 29	Yield
	lb/A	——%——		lb/A	——%——		lb/A
Fenoxaprop/safener	0.083	5	6	1861	10	14	1490
Fenoxaprop/safener	0.166	8	9	1805	10	14	1487
Untreated control	--	—	—	2057	—		1648
LSD (0.05)		1	1	104	NS	NS	93

Effect of fenoxaprop application timing on barley injury near Moscow, ID in 2000. Lori J. Crumley and Donald C. Thill (Plant Science Division. University of Idaho, Moscow, ID 83844-2339) A study was established east of Moscow, Idaho to evaluate 'Baronesse' spring barley response to fenoxaprop plus fenchlorazole (safener) applied at six different timings. The experimental design was a two by six complete block factorial design plus a control with four replications. Plots were 8 by 24 ft. Fenoxaprop was applied with a CO_2 pressurized backpack sprayer calibrated to deliver 10 gal/A at 30 psi (Table 1). Injury was evaluated visually 7, 10, and 14 days after treatment (DAT). Height measurements were taken at heading on July 7, 2000. Barley was harvested with a small plot combine from a 4 by 21 ft area in each plot on August 18, 2000.

Table 1. Soil and application data.

Application date		5/18	5/30	6/6	6/13	6/20	6/27
Application timing		1 leaf	3 leaf	1 to 2 tiller	3 to 4 tiller	4 to 5 tiller	6 tiller
Air temp (F)		44	58	59	69	49	54
Relative humidity (%)		72	75	77	61	90	89
Wind (mph)		1-3	2-5	0	3	0	0
Cloud cover (%)		35	85	5	35	0	0
Soil temperature at 2 in (F)		45	50	56	62	54	46
Dew presence (Y/N)		N	N	N	N	Y	N
pH	4.5						
OM (%)	5.03						
CEC (meq/100 g)	13						
Texture	loam						

Fenoxaprop applied at 0.083 and 0.166 lb ai/A at the 1 to 2 tiller stage visibly injured barley (chlorosis and stunting of plants) 10 to 35% 7, 10, and 14 DAT (Table 2). Fenoxaprop applied at 0.083 and 0.166 lb ai/A at the 4 to 5 tiller stage injured barley plants 20 to 22%, respectively 10 DAT. All other treatments injured barley 0 to 13%. Barley plants treated at the 1 to 2 and 4 to 5 tiller stage were 15 to 37% shorter in height compared to the untreated control. Overall grain yield in herbicide treated plots averaged 7% less than the control, however differences were not significant.

Table 2. Effect of fenoxaprop rate and timing on barley injury, height, and yield.

Treatment	Rate	Application timing	Injury 7 DAT	Injury 10 DAT	Injury 14 DAT	Height	Yield
	lb ai/A			%		cm	lb/A
Fenoxaprop + safener	0.083	1 leaf	0	5	5	27	3998
Fenoxaprop + safener	0.166	1 leaf	0	5	5	27	3828
Fenoxaprop + safener	0.083	3 leaf	3	5	7	25	3861
Fenoxaprop + safener	0.166	3 leaf	2	6	13	26	3773
Fenoxaprop + safener	0.083	1 to 2 tiller	10	26	27	23	3515
Fenoxaprop + safener	0.166	1 to 2 tiller	13	35	35	19	3312
Fenoxaprop + safener	0.083	3 to 4 tiller	8	1	5	24	3521
Fenoxaprop + safener	0.166	3 to 4 tiller	5	3	1	22	3802
Fenoxaprop + safener	0.083	4 to 5 tiller	0	20	6	22	3633
Fenoxaprop + safener	0.166	4 to 5 tiller	0	22	2	17	3340
Fenoxaprop + safener	0.083	6 tiller	0	2	0	24	3484
Fenoxaprop + safener	0.166	6 tiller	1	2	0	22	3513
Untreated check			--	--	--	27	3904
LSD (0.05)			5	5	8	4	NS

Cold temperatures after application may increase barley injury. A 4 F decrease in the average maximum temperature occurred after application on June 6 (1 to 2 tiller stage) compared to the previous 7 days (Table 3). The minimum temperature recorded during the experiment (May 18 and July 3, 2000) was 34 F on June 16, 2000.

Table 3. Temperature data.

Application date	Avg Min Temp for 1-7 DAT	Avg Max Temp for 1-7 DAT	Avg Temp for 1-7 DAT
		F	
5/18	46	71	58
5/30	42	69	56
6/6	45	65	55
6/13	43	71	57
6/20	43	77	60
6/27	46	78	62

The effect of fenoxaprop/safener combined with broadleaf herbicides on four barley varieties. Lori J. Crumley and Donald C. Thill. (Plant Science Division, University of Idaho, Moscow, ID 83844-2239) A study was established east of Moscow, Idaho to determine the effect of fenoxaprop/safener (fenchlorazole) combined with broadleaf herbicides on injury to four barley varieties. The experimental design was a randomized complete block split-plot with barley variety as the main plots and herbicide treatments as subplots. Plot size was 8 by 24 ft. Herbicide treatments were applied using a CO_2 pressurized back pack sprayer calibrated to deliver 10 gal/A at 30 psi (Table 1). Injury was evaluated visually on June 12, 16, and 21, 2000. Barley was harvested with a small plot combine from a 4 by 21 ft area of each plot on September 7, 2000.

Table 1. Application data.

Application date	June 6, 2000
Barley growth stage	4 leaf
Air temp (F)	60
Relative humidity (%)	79
Wind (mph)	0-3
Soil temperature at 2 in (F)	47
pH	4.5
OM (%)	4.8
CEC (meq/100 g)	16
Texture	Loam

There was no variety by treatment interaction (data not shown). All herbicide treatments injured barley 5% on June 12 (data not shown). Fenoxaprop applied alone and in combination with bromoxynil injured barley 3 and 4%, respectively, on June 16, and 2% on June 21 (Table 2). All other treatments injured barley 1% or less on June 16. No injury was visible by June 21. Barley yield did not differ among herbicide treatments or from the untreated control.

Table 2. The effect of herbicide treatments on barley injury and grain yield pooled over barley varieties.

Treatment	Rate	Injury June 16	Injury June 21	Yield
	lb/A	%	%	lb/A
Fenoxaprop[1]	0.083	3	2	2538
Bromoxynil	0.25	0	0	2518
MCPA	0.25	0	0	2617
Fenoxaprop + bromoxynil	0.083 + 0.25	4	2	2530
Fenoxaprop + MCPA	0.083 + 0.25	1	0	2636
Bromoxynil + MCPA	0.25 + 0.25	1	0	2939
Fenoxaprop + bromoxynil + MCPA	0.083 + 0.25 + 0.25	1	0	2353
Untreated control	—	—	—	2492
LSD (0.05)		2	1	NS

[1]Fenoxaprop/safener (Puma)

Barley injury did not differ between the four barley varieties for either evaluation date (Table 3). The highest yielding variety was Morex. Harrington was the lowest yielding variety due to poor stand establishment.

Table 3. Herbicide injury and grain yield of four barley varieties pooled over herbicide treatment.

Variety	Injury June 16	Injury June 21	Yield[a]
	%	%	lb/A
Baronesse	2	1	2745[a]
Camas	2	1	2736[a]
Harrington	1	0	1352[b]
Morex	1	0	3176[c]
LSD (0.05)	NS	NS	—

[a]Means with same letter are not significantly different at 0.05 probability level.

Redstem filaree control in spring barley. Tim D'Amato and Philip Westra. (Weed Research Laboratory, Colorado State University, Ft. Collins, CO 80523) Redstem filaree (EROCI) is a common weed problem for barley producers in the San Luis Valley of south central Colorado. Applications of broadleaf herbicides registered for use in spring barley such as 2,4-D, dicamba, and bromoxynil are ineffective in controlling redstem filaree. Fluroxypyr was recently labeled for use in barley, and carfentrazone ethyl will be labeled for use in barley in 2001. A field trial was established to assess the efficacy of these herbicides on redstem filaree in spring barley. Fluroxypyr treatments provided poor to fair redstem filaree control. Carfentrazone ethyl applied with a nonionic surfactant alone was rated poor to fair for redstem filaree control but provided excellent control in tank mixes with 2,4-D ester or fluroxypyr. Leaf burn was observed soon after application on barley treated with carfentrazone ethyl, but the symptom did not persist more than ten days.

Treatments were applied May 18, 2000 with a CO_2 pressured backpack sprayer with 11002LP flat fan nozzles on a ten foot wide boom calibrated to deliver 22 gallons per acre. Plot size was 10 feet by 30 feet with three replications per treatment. Treatments were applied on redstem filaree 2 to 3 inches tall, and four inch tall barley at the two tiller stage. Control ratings are based on visual evaluations made 19 and 55 days after treatment applications.

Table

Treatment[1]	Rate	EROCI	EROCI
	Lb/A	% Control – June	% Control - July
Fluroxypyr	0.094	25.0 de	65.0 c
Fluroxypyr	0.14	43.3 c	71.7 bc
Fluroxypyr	0.094		
+ 2,4-D	+ 0.25	71.7 b	78.3 b
Carfentrazone ethyl	0.008	66.7 b	75.0 b
Carfentrazone ethyl[2]	0.008		
+ Fluroxypyr	+ 0.094	97.0 a	90.7 a
Carfentrazone ethyl[2]	0.008		
+ 2,4-D ester	+ 0.25	95.0 a	90.0 a
Carfentrazone ethyl[2]	0.008		
+ Fluroxypyr	+ 0.094		
+ 2,4-D	+ 0.25	99.0 a	97.7 a

[1] 0.25% v/v nonionic surfactant added to all treatments
[2] 4% v/v 28% urea ammonium nitrate added

Integrated effects of barley variety and tralkoxydim rate on wild oat control. 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 and tralkoxydim rate on wild oat control. The study was conducted at the University of Idaho Research and Extension Center near Kimberly, Idaho. Soil type was a Portneuf silt loam soil (29% sand, 65% silt, and 6% clay), with a pH of 8.1, 1.6% organic matter and a CEC of 14 meq/100 g soil. Experimental design was a 3 by 4 factorial randomized complete block with four replications. Individual plots were 8 by 30 feet. Barley varieties were 'Galena', a tall-statured 2-row malting variety; 'Harrington', a short-statured 2-row malting barley; 'Colter', a tall-statured 6-row feed barley; and 'Nebula', a short statured 6-row variety. All varieties were seeded April 17, 2000, at a rate of 100 lb seed/A. Tralkoxydim was applied at three rates: 0X, 0.5X and 1X (1X=0.18 lb/A) on May 18, at the 2 to 5 leaf wild oat stage using a CO_2-pressurized bicycle-wheel sprayer calibrated to deliver 10 gpa. Environmental conditions at application were: air temperature 65 F, soil temperature 66 F, relative humidity 82%, wind 5 mph, and 5% cloud cover. Wild oat and barley stand counts were taken from May 20 to June 1. Wild oat plant densities averaged 29 plants/ft^2. Crop injury and wild oat control was evaluated visually after heading on July 6. Barley and wild oat above-ground biomass was collected from a 0.25 m^2 area of each plot July 19. Individual plants of each species were counted and the number and height of each reproductive culm recorded for each plant. Wild oat plants from each plot were air-dried and dry weight biomass recorded. Seed collected from the wild oat was cleaned and counted. Barley was harvested with a small-plot combine August 22.

Tralkoxydim did not injury barley at either rate. Wild oat control averaged across herbicide rates was similar among barley varieties (63%) except Nebula, which averaged 53% control. Interaction between varieties and herbicide rates was significant for wild oat control. Wild oat control in Nebula treated with the 0.09 lb/A tralkoxydim was 65% compared to the other varieties at the same rate, which averaged 92%. At the higher tralkoxydim rate wild oat control averaged 95% across all varieties. Similar results were observed in wild oat densities. Numbers of reproductive culms per wild oat plant averaged about 1 per plant. Wild oat seed rain differed only among herbicide treatments and averaged 43, 7, and 5 seed/ft^2 in the control, 0.09, and 0.18 lb/A tralkoxydim rates. Barley yield was not different among varieties, but did respond to herbicide rate. Grain yield averaged 50, 86, and 79 bu/A in the control, 0.09, and 0.18 lb/A tralkoxydim rates. This study demonstrates the differences barley varieties and tralkoxydim rates can have on wild oat interference.

Table. Spring barley variety and wild oat response to three rates of tralkoxydim[a] herbicide, near Kimberly, Idaho.

		Barley		Wild oat					Barley	
		culms per plant	culm height	control	population density	culms	culm height	seed rain	yield	test wt.
			inches	%	plants/ft²	no./plant	inches	seed/ft²	bu/A	lb/bu
Variety										
Galena		3	22	62	6	1.3	30	10	71	44
Harrington		2	24	63	7	1.0	32	16	78	46
Colter		2	25	62	14	1.0	30	24	78	41
Nebula		2	18	53	12	1.0	28	22	61	35
LSD (0.05)		0.8	1	2	ns	0.1	2	ns	ns	3
Tralkoxydim rate										
lb/A										
0.0		1.9	23	0	43	1.0	33	43	50	40
0.09		2.8	22	85	3	1.13	29	7	86	42
0.18		2.9	21	94	0	1.0	28	5	79	41
LSD (0.05)		0.4	1	3	6	0.1	2	13	14	ns
Variety	**Tralkoxydim rate**									
	lb/A									
Galena	0.0	2	22	0	35	1.0	31	27	50	40
Harrington	0.0	3	25	0	46	1.0	34	30	59	46
Colter	0.0	2	26	0	46	1.0	33	56	56	38
Nebula	0.0	2	30	0	45	1.0	32	60	35	37
Galena	0.09	3	23	89	1	1.5	29	4	83	45
Harrington	0.09	4	24	95	0	1.0	32	1	95	46
Colter	0.09	2	25	92	12	1.0	27	17	90	42
Nebula	0.09	2	18	65	6	1.0	27	6	77	37
Galena	0.18	3	21	96	0	1.0	—	0	80	45
Harrington	0.18	4	24	95	0	1.0	30	17	79	45
Colter	0.18	3	25	94	0	1.0	30	1	88	43
Nebula	0.18	3	16	93	0	1.0	25	1	70	32
LSD (0.05)		ns	ns	5	ns	0.2	2	ns	ns	ns

[a]Tralkoxydim was applied with Supercharge and ammonium sulfate.

Wild oat control in spring barley. Traci A. Rauch and Donald C. Thill. (Plant Science Division, University of Idaho, Moscow, ID 83844-2339) A study was established near Tammany, Idaho in 'Baronesse' spring barley to evaluate crop response, wild oat control, and spring barley yield with various grass herbicides. Plots were 8 by 30 ft arranged in a randomized complete block design 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 barley injury was evaluated visually on June 6, June 20, and July 18, 2000. Wild oat control was evaluated visually on June 27 and July 18, 2000. Barley seed was harvested with a small plot combine from a 4.1 by 27 ft area in each plot on August 15, 2000.

Table 1. Application data.

Application date	May 29, 2000
Spring barley growth stage	4 to 5 leaf
Wild oat growth stage	3 to 4 leaf
Air temperature (F)	58
Relative humidity (%)	61
Wind (mph, direction)	3, N
Cloud cover (%)	20
Soil temperature at 2 in (F)	55
pH	5.4
OM (%)	3.3
CEC (meq/100g)	23
Texture	silt loam

Tralkoxydim, imazamethabenz alone or in combinations did not injure barley on June 6 (Table 2). All other treatments injured barley 8 to 22%. By July 18, clodinafop and flucarbazone-sodium still injured barley 16 and 35%, respectively. Diclofop and imazamethabenz alone or in combinations suppressed wild oat 76% or less; while clodinafop, fenoxaprop/safener, and tralkoxydim controlled wild oat 89 to 95%. Seed yield of barley treated with tralkoxydim was greater than seed treated with clodinafop, flucarbazone-sodium, imazamethabenz alone, and imazamethabenz + difenzoquat + AMS. Barley seed yield for all treatments except flucarbazone-sodium was greater than the untreated check.

Table 2. Crop response, wild oat control, and spring barley yield.

		Barley injury		Wild oat	Barley
Treatment[a]	Rate	June 6	July 18	control[b]	yield
	lb/A	%			lb/A
Imazamethabenz	0.47	0	0	71	2603
Imazamethabenz + difenzoquat	0.235 + 0.5	0	0	76	2910
Imazamethabenz + AMS	0.47	0	0	75	2996
Imazamethabenz + difenzoquat + AMS	0.235 + 0.5	0	0	66	2736
Diclofop	1.0	8	0	74	2793
Fenoxaprop/safener	0.082	12	0	89	3219
Clodinafop	0.05	19	16	95	2667
Tralkoxydim + AMS	0.24	0	0	94	3478
Flucarbazone-sodium	0.027	22	35	84	2219
Untreated check	–	–	–	–	1826
LSD (0.05)		3	3	11	690
Density (plants/ft^2)				25	

[a]AMS (liquid ammonium sulfate) was applied at 17 lb/100 gal. Nonionic surfactant (R-11) was applied at 0.25 % v/v with all imazamethabenz and flucarbazone-sodium treatments. Crop oil concentrate (Score) was applied at 0.32 qt/A with clodinafop.
[b]July 18, 2000 evaluation date.

Formulation efficacy of tralkoxydim in combination with broadleaf herbicides in spring wheat and spring barley.
Branden L. Schiess and Donald C. Thill. (Plant Science Division, University of Idaho, Moscow, ID 83844-2339)
A study was conducted near Southwick, ID in 'Westbred 926' hard red spring wheat and near Victor, ID in 'Morex' spring barley to determine the effect of three tralkoxydim formulations in combination with 2,4-D or bromoxynil/MCPA on wild oat control and crop injury. Plots were 8 by 30 feet, arranged in randomized complete block design with four replications. All herbicide treatments were applied with a CO_2 pressurized backpack sprayer calibrated to deliver 10 gpa at 33 psi and 3 mph (Table 1). Injury and wild oat control were evaluated visually on May 31 and July 21, 2000 for wheat and June 17 and July 15, 2000 for barley. Wheat was harvested August 3, 2000 with a small plot combine. Barley was not harvested.

Table 1. Application data.

Location	Southwick	Victor
Crop	wheat	barley
Application date	May 23, 2000	June 3, 2000
Wheat growth stage	3 to 5 leaf	4 to 6 leaf
Wild oat growth stage	2 to 5 leaf	4 to 8 leaf
Wild oat plants/ft^2	24	18
Air temperature (F)	60	65
Soil temperature at 2 in (F)	63	54
Relative humidity (%)	70	48
Wind (mph)	0	2
Cloud cover (%)	0	0

On May 31, wheat injury was 5 to 26% for all plots treated with tralkoxydim formulations (Table 2). Wheat injury for fenoxaprop and clodinafop was 5 and 15%, respectively. No treatment controlled wild oat on May 31, 2000. However, on July 15, all treatments controlled wild oat 85 to 95%. Wheat yields were between 65 and 80 bu/A in treated plots compared to the control, which yielded 42 bu/A. On June 17, barley injury was 3 to 8% for all plots treated with tralkoxydim formulations. Barley was injured 11 and 20% by fenoxaprop and clodinafop, respectively. No treatment adequately controlled wild oat on June 17, and by July 15 wild oat was controlled between 71 and 95%.

Table 2. Formulation efficacy of tralkoxydim in combination with broadleaf herbicides in spring wheat and spring barley.

Treatment[a]	Rate	Crop injury May 31 wheat	Crop injury July 21 wheat	Crop injury June 17 barley	Wild oat control May 31 wheat	Wild oat control July 21 wheat	Wild oat control June 17 barley	Wild oat control July 15 barley	Wheat yield
	lb/A	%							bu/A
Tralkoxydim	0.18	10	0	3	10	91	66	93	78
Tralkoxydim + bromoxynil / MCPA	0.125 + 0.5	24	2	6	17	90	79	95	68
Tralkoxydim + bromoxynil / MCPA	0.15 + 0.5	20	1	8	16	94	65	95	76
Tralkoxydim + bromoxynil / MCPA	0.18 + 0.5	25	1	6	17	91	75	95	79
YF11315	0.18	5	0	4	9	91	73	95	76
YF11315 + bromoxynil / MCPA	0.125 + 0.5	26	2	8	15	91	65	95	74
YF11315 + bromoxynil / MCPA	0.15 + 0.5	21	1	6	14	91	70	95	80
YF11315 + bromoxynil / MCPA	0.18 + 0.5	13	0	6	10	96	70	95	74
YF11425	0.18	10	1	5	6	90	73	95	70
YF11425 + bromoxynil / MCPA	0.125 + 0.5	17	1	5	15	89	61	91	72
YF11425 + bromoxynil / MCPA	0.15 + 0.5	17	0	8	9	94	79	95	72
YF11425 + bromoxynil / MCPA	0.18 + 0.5	21	1	6	10	95	79	95	70
Tralkoxydim + 2,4-D	0.125 + 0.5	19	1	6	7	91	64	89	67
Tralkoxydim + 2,4-D	0.15 + 0.5	14	0	6	7	89	39	84	80
Tralkoxydim + 2,4-D	0.18 + 0.5	12	1	6	10	91	51	94	70
YF11315 + 2,4-D	0.125 + 0.5	14	0	6	7	85	25	90	66
YF11315 + 2,4-D	0.15 + 0.5	12	0	6	7	90	44	89	72
YF11315 + 2,4-D	0.18 + 0.5	12	0	6	6	92	34	81	76
YF11425 + 2,4-D	0.125 + 0.5	10	0	6	12	90	31	89	80
YF11425 + 2,4-D	0.15 + 0.5	17	0	8	12	89	35	83	69
YF11425 + 2,4-D	0.18 + 0.5	17	0	6	10	92	31	90	71
Fenoxyprop-P-ethyl + 2,4-D	0.083 + 0.5	5	0	20	11	91	29	71	79
Clodinafop + 2,4-D + COC	0.05 + 0.5	15	0	11	5	96	45	90	71
Control		--	--	--	--	--	--	--	42
LSD (0.05)		11	NS	4	NS	NS	15	NS	17

[a]YF11315 and YF11425 are tralkoxydim formulations, TF8035 (Supercharge) at 0.5% v/v and AMS (Ammonium Sulfate) at 5% v/v were added to all treatments containing tralkoxydim formulations, bromoxynil/MCPA was applied as the commercial formulation, 2,4-D was applied as the ester formulation, COC = crop oil concentrate (Score) applied at 0.8% v/v.

Carfentrazone and fluroxypyr for control of kochia in spring wheat. Alvin J. Bussan, Susan B. Kelly, and Chris Murphy. (Department of Land Resources and Environmental Sciences, Montana State University, Bozeman MT, 59717) A field trial was conducted near Fort Benton, MT, to evaluate efficacy of carfentrazone and fluroxypyr for control of kochia when applied at different times in wheat. Previous research at MSU suggested potential synergy of carfentrazone and fluroxypyr for control of kochia. Carfentrazone and fluroxypyr are seen as management alternatives to dicamba and ALS inhibiting herbicides for kochia control.

McNeal spring wheat was seeded May 1st, 2000 at 60 lbs. per acre on a previously fallowed field. The field was chosen because it had been managed with dicamba in each of the previous five years, and had a recent history of lack of control of kochia after the dicamba applications. Herbicides were applied when kochia was in the puffball and 4 to 6 inch stage. Puffball treatments were applied on May 28 at 7 am, with an air temperature of 57 F, a soil temperature of 55 F, winds at 5 mph, 50% cloud cover and surface soil moisture. Treatments applied at the 4 to 6 inch stage occurred on June 14th at 7 am, with an air temperature of 65 F, a soil temperature of 60 F, winds at 7 mph, 75% cloud cover and no soil moisture. Drought conditions prevailed at the site throughout the growing season. Herbicide treatments were applied with a hand-held CO_2 backpack sprayer with 10 GPA water at 40 psi at 3 mph. Herbicide effects are shown in Table 1.

Table 1. Effects of herbicide application on spring wheat and kochia

			Spring Wheat		Kochia	
			Injury	Stunting	Control	
Treatment	Rate	Timing	Jun-14-00	Jun-14-00	Jun-14-00	Jul-07-00
	(lb/a)			%		
Weedy Check			0	0	0	0
Carfen-*+	0.0082	Puffball	0	0	72.5	35
Fluroxypyr*	0.062	Puffball	0	0	80	77.5
Fluroxypyr*	0.094	Puffball	0	0	76.3	76.3
Fluroxypyr*	0.125	Puffball	0	0	80	78.8
Carfen- + fluroxypyr*+	0.0082+0.062	Puffball	0	0	87.5	72.5
Carfen- + fluroxypyr*+	0.082 + 0.094	Puffball	0	0	76.3	75
Fluroxypyr + 2,4-D*	0.0374 +.1585	Puffball	0	0	72.5	63.8
Fluroxypyr + 2,4-D*	0.0564 +0.235	Puffball	0	0	80	76.3
Fluroxypyr + 2,4-D*	0.075 +0.319	Puffball	0	0	76.3	76.3
Carfen- + fluroxypyr and 2,4-D*+	0.0082 + 0.062 +.1585	Puffball	0	0	87.5	68.8
Carfen-*+	0.0082	4" +	0	0	80	68.8
fluroxypyr*	0.062	4" +	0	0	46.3	40
fluroxypyr*	0.094	4" +	0	0	72.5	66.3
fluroxypyr*	0.125	4" +	0	0	72.5	67.5
Carfen- + fluroxypyr*+	0.0082 +0.062	4" +	0	0	47.5	42.5
Carfen- +fluroxypyr*+	0.0082 +0.094	4" +	0	0	76.3	67.5
fluroxypyr + 2,4-D*	0.0374 +.1585	4" +	0	0	53.8	45
fluroxypyr + 2,4-D*	0.0564 +0.235	4" +	0	0	61.3	56.3
fluroxypyr + 2,4-D*	0.075 +0.319	4" +	0	0	76.3	66.7
Carfen- + fluroxypyr and 2,4-D*+	0.0082 + 0.062 +.1585	4" +	0	0	83.8	75
LSD (P=.05)			0	0	19.27	21.22

— Carfentrazone,* = NIS added at 0.25% v/v, + = AMS added at 2 lb/acre

Kochia control was slightly better, but not significantly different, when herbicides were applied at the puffball stage for most treatments. Carfentrazone alone was not effective for controlling kochia at either stage of application. Carfentrazone did not improve activity of fluroxypyr indicating that there was no additivity or synergy. Kochia control with fluroxypyr was not improved by the addition of 2,4-D either. Fluroxypyr was equally effective at 0.062 to 0.125 lb/A a.i. when applied to kochia in the puffball stage. However, kochia efficacy increased with fluroxypyr rate when applied to 4'' kochia. Herbicide efficacy at the site was impacted by drought conditions, as little moisture was available. In addition, the kochia at the site were resistant to ALS-inhibiting herbicides and may have been resistant to dicamba. Greenhouse studies are being conducted to quantify susceptibility/resistance of kochia progeny from the site to dicamba and fluroxypyr.

Foxtail control in spring wheat. Brian M. Jenks, Denise M. Markle, and Gary P. Willoughby. (North Central Research Extension Center, North Dakota State University, Minot, ND 58701) Spring wheat (Alsen) was seeded May 3 into 6-inch rows at 90 lb/A in a conventional tillage system. Individual plots were 10 by 30 ft arranged in a RCBD with three replicates. Treatments were applied using XR8001 flat fan nozzles delivering 10 gpa at 40 psi. Postemergence treatments were applied on June 5 with a CO_2 pressurized bicycle sprayer. The primary weeds were yellow foxtail and wild buckwheat. The crop was harvested on August 31.

Table. Foxtail control, crop injury, and spring wheat yield.

Treatment	Rate	Wheat		SETLU		POLCO		Yield
		Jun 26	Jul 20	Jun 26	Jul 20	Jun 26	Jul 20	
	lb ai/A	% Injury		% Control				bu/A
Untreated		0	0	0	0	0	0	0
Clodinafop + DSV	0.063 + 12.8 fl oz	0	0	95	96	0	0	0
Clodinafop + DSV + bromoxynil & MCPAe	0.063 + 12.8 fl oz + 0.5	0	0	92	93	90	87	34
Clodinafop + DSV + thifensulfuron + MCPA ester	0.063 + 12.8 fl oz + 0.023 + 0.38	0	0	88	87	96	95	33
Fenoxaprop	0.05	5	0	96	95	0	0	0
Fenoxaprop + bromoxynil & MCPAe	0.05 + 0.5	2	0	91	78	88	87	37
Fenoxaprop + thifensulfuron + MCPA ester	0.05 + 0.023 + 0.38	1	0	90	88	97	96	37
Tralkoxydim + Supercharge + AMS	0.18 + 0.5 % + 15 lb/100 gal	0	0	92	93	0	0	0
Tralkoxydim + bromoxynil & MCPAe + Supercharge + AMS	0.18 + 0.5 + 0.5 % + 15 lb/100 gal	0	0	92	88	86	74	29
Tralkoxydim + thifensulfuron + MCPA ester + Supercharge + AMS	0.18 + 0.023 + 0.38 + 0.5 % + 15 lb/100 gal	0	0	87	79	95	95	34
Flucarbazone + NIS	0.025 + 0.25 %	14	5	88	85	83	92	29
Flucarbazone + NIS + bromoxynil & MCPAe	0.025 + 0.25 % + 0.5	13	5	83	77	86	86	36
Flucarbazone + NIS + thifensulfuron + MCPA ester	0.025+ 0.25 % + 0.023 + 0.38	15	5	90	91	95	95	35
LSD		2	NS	4	12	4	6	NS
CV		24	0	3	9	4	6	13

Flucarbazone caused significant early crop stunting, but the wheat generally recovered by late July. All grass products provided good to excellent early-season foxtail control. However, some tankmixes had slightly lower control as the season progressed. In treatments without a broadleaf herbicide, the wild buckwheat literally pulled the wheat to the ground resulting in no yield. Thifensulfuron was slightly more effective on wild buckwheat than bromoxynil and MCPAe. Flucarbazone alone had good activity on wild buckwheat.

Broadleaf weed control in spring wheat with carfentrazone tank mixed with other broadleaf herbicides. Don W. Morishita and Michael J. Wille. (Division of Plant Sciences, University of Idaho, Moscow ID 83303) A study was conducted at the University of Idaho Research and Extension Center near Kimberly, Idaho to evaluate broadleaf weed control in irrigated spring wheat ('Whitebird') with carfentrazone-ethyl applied in tank mixture with other broadleaf herbicides. Wheat was planted April 11, 2000, at a rate of 100 lb/A. Experimental design was a randomized complete block with four replications. Individual plots were 8 by 25 ft. Soil type was a Portneuf silt loam (26% sand, 64% silt, 10% clay) with 1.6% organic matter, 8.1 soil pH, and CEC of 16 meq/100 g soil. All herbicides were applied May 27 using a CO_2-pressurized bicycle-wheel sprayer equipped with 11001 flat fan nozzles calibrated to deliver 10 gpa. Environmental conditions at the time of application were as follows: air and soil temperature 58 F, relative humidity 94%, wind speed 0 mph, and dew was present. Kochia and common lambsquarters were the two dominant weed species with average densities of 35 and 28 plants/ft^2, respectively. Crop injury alone was evaluated visually 1 day after treatment (DAT). Crop injury and weed control was evaluated 14 and 37 DAT. Plots were harvested September 30 with a small-plot combine.

Crop injury evaluations 1 DAT ranged from 3 to 13%. Injury was greatest with carfentrazone treatments that included either 28% UAN or ammonium sulfate (Table). By 14 DAT, carfentrazone tank mixed with 2,4-D LV ester or dicamba and 28% UAN were the only treatments with injury greater than 10%. At 37 DAT, no crop injury was observed. Kochia control at 14 and 37 DAT ranged from 48 to 86%. Fluroxypyr & 2,4-D + tribenuron controlled kochia 86% 37 DAT while the best carfentrazone tank mix treatment with 2,4-D amine and dicamba controlled kochia 71%. Kochia control with all other treatments was unacceptable (<70%) 37 DAT. Common lambsquarters control ranged from 96 to 100% and was not different among herbicide treatments at either evaluation date. Grain yield of the untreated check averaged 18 bu/A while grain yield among herbicide treatments ranged from 29 to 39 bu/A. Carfentrazone + MCPA amine, carfentrazone + 2,4-D amine with and without 28% UAN, and fluroxypyr & 2,4-D + tribenuron were among the highest yielding treatments. These data show that carfentrazone + 2,4-D or MCPA control common lambsquarters effectively and suppress kochia enough to produce maximum yields.

Table. Weed control, spring wheat injury, and grain yield with carfentrazone tank mixtures near Kimberly, Idaho.

					Weed control[a]				
		Crop injury[c]			KCHSC		CHEAL		
Treatment[b]	Rate	5/28	6/9	7/3	6/9	7/3	6/9	7/3	Yield
	lb/A	%							bu/A
Check		0	0	0	0	0	0	0	18
Carfentrazone +	0.008 +	6	3	0	55	48	99	100	37
2,4-D amine +	0.25 +								
nonionic surfactant	0.25% v/v								
Carfentrazone +	0.008 +	10	5	0	61	53	99	99	37
2,4-D amine +	0.25 +								
nonionic surfactant +	0.25% v/v +								
28% UAN	4% v/v								
Carfentrazone +	0.008 +	10	4	0	69	56	96	100	29
2,4-D amine +	0.25 +								
nonionic surfactant +	0.25% v/v +								
ammonium sulfate	2								
Carfentrazone +	0.008 +	13	14	0	75	65	96	100	36
2,4-D LV ester +	0.25 +								
nonionic surfactant +	0.25% v/v +								
28% UAN	4% v/v								
Carfentrazone +	0.008 +	11	6	0	59	51	99	100	39
MCPA amine +	0.375 +								
nonionic surfactant +	0.25% v/v +								
28% UAN	4% v/v								
Carfentrazone +	0.008 +	8	13	0	81	71	100	99	29
2,4-D amine +	0.25 +								
dicamba +	0.0625 +								
nonionic surfactant +	0.25% v/v +								
28% UAN	4% v/v								
Fluroxypyr & 2,4-D +	0.468 +	3	0	0	84	86	99	100	37
tribenuron +	0.0059 +								
nonionic surfactant	0.25% v/v								
LSD (0.05)		3	5	ns	12	22	ns	ns	14

[a]Weeds evaluated for control were kochia (KCHSC) and common lambsquarters (CHEAL).
[b]Fluroxypyr & 2,4-D is a commercial formulation.
[c]Crop injury evaluations were taken 1 (5/28), 14 (6/9), and 37 (7/3) days after treatment.

Comparison of postemergence wild oat herbicides in irrigated 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 initiated near Paul, Idaho to compare postemergence herbicides applied at three growth stages for wild oat control in spring wheat ('WB 936R'). Wheat was planted April 9, 2000, at 128 lb/A. Soil type at this location was a Portneuf silt loam (19% sand, 71% silt, and 10% clay) with a 7.8 pH, 1.5% organic matter, and CEC of 15 meq/100 g soil. Experimental design of this study was a randomized complete block with four replications. Individual plots were 8 by 25 ft. Herbicides were applied with a CO_2-pressurized bicycle-wheel sprayer calibrated to deliver 10 gpa using 11001 flat fan nozzles. Information on environmental conditions at each application is shown in Table 1. Crop injury was evaluated 12 days after the last treatment (DALT) was applied (June 7) and again when wild oat control was evaluated June 29. The crop was harvested August 16 with a small-plot combine.

Table 1. Environmental conditions at each application and weed species density.

Application date	5/13	5/20	5/26
Application timing	2 to 3 leaf	4 to 5 leaf	6 to 7 leaf
Air temperature (F)	68	57	45
Soil temperature (F)	60	52	46
Relative humidity (%)	68	82	92
Wind speed (mph)	4	5	4
Cloud cover (%)	70	15	0
Wild oat/ft^2	26	33	33

Crop injury ranging from 3 to 13% was observed across herbicide treatments 12 DALT. Highest injury was observed with fenoxaprop applied at the 4 to 5 leaf stage. By 33 DALT, the highest injury level was only 6%. Wild oat control was most consistent with clodinafop applied at the 4 to 5 leaf or 6 to 7 leaf growth stage and averaged 94 and 90%, respectively. Next highest wild oat control treatment was fenoxaprop (81%) applied at the 4 to 5 leaf stage. Wild oat control with tralkoxydim declined as wild oat growth stage increased. Tank mixing carfentrazone with clodinafop or fenoxaprop did not reduce wild oat control compared to either clodinafop or fenoxaprop alone applied at the same time (2 to 3 leaf). However, tank mixing carfentrazone with tralkoxydim and imazamethabenz reduced wild oat control compared to tralkoxydim or imazamethabenz applied alone. All herbicide treatments had higher yields than the untreated check, which yielded 20 bu/A. Highest and most consistent yields among groups of herbicides were with the clodinafop treatments. Yields from all other herbicide treatments decreased with applications made at later growth stages.

Table 2. Crop injury, wild oat control, and spring wheat yield with postemergence wild oat herbicides near Paul, Idaho.

Treatment[a]	Rate	Growth stage	Crop injury 6/7	Crop injury 6/29	Wild oat control	Yield
	lb/A		%	%	%	bu/A
Check			0	0	0	20
Clodinafop + Score	0.05 + 10.2 fl oz/A	2-3 leaf	4	1	76	79
Clodinafop + Score	0.05 + 10.2 fl oz/A	4-5 leaf	9	6	94	74
Clodinafop + Score	0.05 + 10.2 fl oz/A	6-7 leaf	5	4	90	63
Clodinafop + carfentrazone + Score	0.05 + 0.008 + 10.2 fl oz/A	2-3 leaf	8	1	70	78
Fenoxaprop	0.1	2-3 leaf	6	3	79	76
Fenoxaprop	0.1	4-5 leaf	13	3	81	56
Fenoxaprop	0.1	6-7 leaf	8	4	69	53
Fenoxaprop + carfentrazone	0.1 + 0.0008	2-3 leaf	6	0	79	76
Tralkoxydim + Supercharge + ammonium sulfate	0.24 + 0.5% v/v + 2	2-3 leaf	8	0	75	70
Tralkoxydim + Supercharge + ammonium sulfate	0.24 + 0.5% v/v + 2	4-5 leaf	5	3	65	55
Tralkoxydim + Supercharge + ammonium sulfate	0.24 + 0.5% v/v + 2	6-7 leaf	4	0	30	38
Tralkoxydim + carfentrazone + Supercharge + ammonium sulfate	0.24 + 0.008 + 0.5% v/v + 2	2-3 leaf	6	0	61	78
Imazamethabenz + NIS	0.41 0.25% v/v	2-3 leaf	3	0	56	51
Imazamethabenz + carfentrazone + NIS	0.41 + 0.008 + 0.25% v/v	2-3 leaf	3	0	44	50
BAY MKH6562 + NIS	0.027 + 0.25% v/v	2-3 leaf	5	6	69	67
LSD (0.05)			5	5	10	15

[a]Score and Supercharge are proprietary adjuvants. NIS = nonionic surfactant.

Wild oat control in spring wheat with fenoxaprop tank mixed with broadleaf herbicides. Don W. Morishita, Gale Harding, and Michael J. Wille. (Twin Falls Research and Extension Center, University of Idaho, Twin Falls, ID 83303-1827) A study was conducted in irrigated spring wheat ('Penewawa') near Rexburg, Idaho to evaluate fenoxaprop tank mixtures with broadleaf herbicides for wild oat control. Wheat was planted April 3, 2000, at 114 lb/A seeding rate. Experimental design was a randomized complete block with four replications and individual plots were 8 by 25 ft. All herbicides were applied May 19, 2000, with a CO_2-pressurized bicycle-wheel sprayer calibrated to deliver 10 gpa using 11001 flat fan nozzles. Wild oat growth stage at application was 2 to 4 leaf and density averaged 24 plants/ft^2. Environmental conditions at application were as follows: air temperature 60 F, soil temperature 58 F, relative humidity 72%, wind speed 6 mph, and 100% cloud cover. Crop injury was evaluated visually 7 days after treatment (DAT) and again 63 DAT along with wild oat control. Grain was harvested August 22 with a small-plot combine.

No crop injury was observed 7 DAT (data not shown) and only slight injury (4%) was observed 63 DAT (Table). Wild oat control using fenoxaprop alone or fenoxaprop tank mixtures was not different. Overall wild oat control averaged 79% among these treatments. Wild oat control with tralkoxydim at 0.18 and 0.24 lb/A tank mixed with bromoxynil & MCPA at 0.5 lb/A averaged 61%; and imazamethabenz + difenzoquat at 0.23 + 0.5 lb/A controlled wild oat 45%. All herbicide treatments had yields higher than the check (29 bu/A). Fenoxaprop alone and fenoxaprop tank mix treatments had yields ranging from 114 to 139 bu/A and were not different from one another. Both rates of tralkoxydim tank mixtures and the imazamethabenz + difenzoquat combination had grain yields lower than five of the fenoxaprop treatments.

Table. Crop injury, wild oat control, and barley yield with fenoxaprop tank mixed with broadleaf herbicides, near Rexburg, Idaho.

Treatment[a]	Rate	Crop injury	Wild oat control	Yield
	lb/A	%		bu/A
Check		-	-	29
Fenoxaprop	0.10 +	0	79	134
Fenoxaprop +	0.10 +	0	74	122
thifensulfuron & tribenuron +	0.0188 +			
NIS	0.25% v/v			
Fenoxaprop +	0.10 +	0	83	123
thifensulfuron +	0.0188 +			
NIS	0.25% v/v			
Fenoxaprop +	0.10 +	4	76	127
thifensulfuron +	0.0188 +			
MCPA LVE +	0.375 +			
NIS	0.25% v/v			
Fenoxaprop +	0.10 +	4	89	134
thifensulfuron +	0.0089 +			
fluroxypyr +	0.089 +			
NIS	0.25% v/v			
Fenoxaprop +	0.10 +	4	83	138
thifensulfuron +	0.014 +			
fluroxypyr +	0.0625 +			
NIS	0.25% v/v			
Fenoxaprop +	0.10 +	3	74	122
bromoxynil & MCPA	0.5			
Fenoxaprop +	0.10 +	0	73	136
bromoxynil	0.25			
Fenoxaprop +	0.10 +	3	84	125
MCPA LVE	0.375			
Fenoxaprop +	0.10 +	0	85	128
fluroxypyr	0.125			
Fenoxaprop +	0.10 +	0	80	114
MCPA LVE +	0.375 +			
fluroxypyr	0.125			
Fenoxaprop +	0.10 +	0	71	114
bromoxynil +	0.25 +			
fluroxypyr	0.125			
Fenoxaprop +	0.10 +	0	74	139
thifensulfuron +	0.014 +			
bromoxynil +	0.25 +			
NIS	0.25% v/v			
Tralkoxydim +	0.18 +	0	58	99
bromoxynil & MCPA +	0.5 +			
Turbocharge® +	0.5% v/v +			
ammonium sulfate	2.0			
Tralkoxydim +	0.24 +	0	63	107
bromoxynil&MCPA +	0.5 +			
Turbocharge® +	0.5% v/v +			
ammonium sulfate	2.0			
Imazamethabenz +	0.23 +	0	45	77
difenzoquat +	0.5 +			
NIS	0.25% v/v			
LSD (0.05)		ns	11	26

[a]Bromoxynil & MCPA is a commercial premixed formulation and thifensulfuron & tribenuron is a commercial premixed formulation. NIS = nonionic surfactant. Turbocharge® is a proprietary adjuvant.

The effect of application timing on wild oat control with different grass herbicides in spring wheat. Traci A. Rauch, Donald C. Thill and Mike Hubbard. (Plant Science Division, University of Idaho, Moscow, ID 83844-2339 and Kootenai Valley Farm and Research, Bonners Ferry, ID 83805) Two studies were established in 'Westbred 926' hard red spring wheat near Bonners Ferry, ID to examine wild oat control and wheat yield with different application timings of grass herbicides. Experiment one was a split-plot design with four replications. Main plots were herbicide treatments (16 by 30 ft) and the subplots were application timing (8 by 30 ft). In experiment two, plots were 8 by 30 ft arranged in a randomized complete block design with four replications. In both experiments, all herbicide treatments were applied with a CO_2 pressurized backpack sprayer calibrated to deliver 10 gpa at 40 psi and 3 mph (Tables 1 and 2). The entire plot areas were oversprayed with thifensulfuron/tribenuron at 0.019 lb/A on June 6, 2000. Wheat injury was evaluated visually on June 7 and 26, 2000 for experiment one and June 5, 12 and 21, 2000 for experiment two. Weed control was evaluated visually on June 26 and July 12 and 25, 2000 for experiment one and July 7 and 24, 2000 for experiment two. In both experiments, wheat seed was harvested with a small plot combine from a 5 by 27 ft area in each plot on August 31, 2000.

Table 1. Application and soil data for experiment one.

Application date	May 27, 2000		June 13, 2000
Growth stage			
Spring wheat	2 to 3 leaf		2 tiller
Wild oat	1 to 3 leaf		5 to 7 leaf
Air temperature (F)	72		63
Relative humidity (%)	40		49
Wind (mph, direction)	4, S		0
Cloud cover (%)	0		75
Soil temperature at 2 in (F)	62		62
pH		5.2	
OM (%)		15.4	
CEC (meq/100g)		31	
Texture		loam	

Table 2. Application and soil data for experiment two.

Application date		May 27, 2000	June 5, 2000	June 13, 2000
Growth stage				
Wheat		2 to 3 leaf	5 to 6 leaf	2 tiller
Wild oat		1 to 3 leaf	4 to 5 leaf	6 to 7 leaf
Air temperature (F)		73	74	62
Relative humidity (%)		48	51	49
Wind (mph, direction)		0	0	0
Cloud cover (%)		40	70	60
Soil temperature at 2 in (F)		62	65	62
pH	5.2			
OM (%)	15.4			
CEC (meq/100g)	31			
Texture	loam			

In experiment one, no treatment visibly injured wheat on June 7 and June 26, 2000 (data not shown). Wild oat control was best with the 5 to 7 leaf timing of clodinafop and flucarbazone-sodium (86 and 92%) but did not differ from the 5 to 7 timing of fenoxaprop and the 1 to 3 leaf timing of clodinafop (75 and 76%) (Table 3). All other treatments only suppressed wild oat (29 to 65%). Wheat yield was highest with the 1 to 3 leaf timing of fenoxaprop and the 5 to 7 leaf timings of clodinafop and flucarbazone-sodium (1108 to 1157 lb/A). All treatments yielded more than the untreated checks except both timings of imazamethabenz and tralkoxydim and the 1 to 3 leaf timing of imazamethabenz + difenzoquat.

No treatment injured wheat on June 5 in experiment two (data not shown). On the June 12 and 21 evaluation dates, the 4 to 5 and the 6 to 7 leaf timings, repectively, of imazamethabenz and flucarbazone-sodium injured wheat 6 to 16% (Table 4). Flucarbazone-sodium at the 6 to 7 leaf timing controlled wild oat 97% and was not different from the 6 to 7 leaf timing of clodinafop and the 4 to 5 leaf timing of clodinafop and flucarbazone-sodium (78 to 93%). All other treatments suppressed wild oat (20 to 73%). Wheat seed yield was the highest with the 4 to 5 leaf timing of flucarbazone-sodium and the 6 to 7 leaf timing of clodinafop and flucarbazone-sodium (2736 to 2833 lb/A) and did not differ from the 1 to 3 leaf and 4 to 5 leaf timings of clodinafop (2365 to 2559 lb/A). All treatments yielded more than the untreated check expect the 1 to 3 leaf and the 4 to 5 leaf timings of imazamethabenz.

Table 3. Wild oat control and wheat yield with two application timings of grass herbicides (experiment one).

Treatment[a]	Rate	Application timing[b]	Wild oat control[c]	Wheat yield[d]
	lb/A		%	lb/A
Imazamethabenz	0.47	1 to 3 leaf	29	552
Imazamethabenz	0.47	5 to 7 leaf	32	490
Imazamethabenz + difenzoquat	0.235 + 0.5	1 to 3 leaf	30	595
Imazamethabenz + difenzoquat	0.235 + 0.5	5 to 7 leaf	44	890
Fenoxaprop	0.083	1 to 3 leaf	57	1157
Fenoxaprop	0.083	5 to 7 leaf	75	885
Clodinafop	0.05	1 to 3 leaf	76	897
Clodinafop	0.05	5 to 7 leaf	86	1108
Tralkoxydim	0.24	1 to 3 leaf	59	701
Tralkoxydim	0.24	5 to 7 leaf	65	851
Flucarbazone-sodium	0.027	1 to 3 leaf	60	958
Flucarbazone-sodium	0.027	5 to 7 leaf	92	1121
Untreated check	--	1 to 3 leaf	--	488
Untreated check	--	5 to 7 leaf	--	456
LSD (0.05)			21	405
Density (plants/ft^2)			24	

[a]90% non-ionic surfactant (R-11) at 0.25% v/v was applied with imazamethabenz, difenzoquat, and flucarbazone-sodium. Crop oil concentrate (Score) was applied at 0.32 qt/A with clodinafop. Ammonium sulfate at 17 lb/100 gal and a crop oil concentrate/non-ionic surfactant blend (Supercharge) at 0.5% v/v was applied with tralkoxydim.
[b]Application timing based on wild oat growth stage.
[c]July 12, 2000 evaluation date.
[d]Only three replications were harvested due to a poor wheat stand.

Table 4. Wild oat control and wheat yield with three application timings of grass herbicides (experiment two).

			Wheat injury			
Treatment[a]	Rate	Application timing[b]	June 12	June 21	Wild oat control[c]	Wheat yield
	lb/A		%			lb/A
Imazamethabenz	0.31	1 to 3 leaf	0	0	24	1300
Imazamethabenz	0.31	4 to 5 leaf	6	0	20	1581
Imazamethabenz	0.31	6 to 7 leaf	0	11	44	1920
Fenoxaprop	0.062	1 to 3 leaf	0	0	32	2033
Fenoxaprop	0.062	4 to 5 leaf	0	0	46	2259
Clodinafop	0.05	1 to 3 leaf	0	0	73	2365
Clodinafop	0.05	4 to 5 leaf	0	0	79	2559
Clodinafop	0.05	6 to 7 leaf	0	1	93	2775
Tralkoxydim	0.18	4 to 5 leaf	0	0	49	2168
Tralkoxydim	0.18	6 to 7 leaf	0	0	56	1926
Flucarbazone-sodium	0.027	1 to 3 leaf	0	0	50	1958
Flucarbazone-sodium	0.027	4 to 5 leaf	10	2	78	2736
Flucarbazone-sodium	0.027	6 to 7 leaf	0	16	97	2833
Untreated check	--	--			--	1065
LSD (0.05)			2	4	16	474
Density (plants/ft^2)					24	

[a]90% non-ionic surfactant (R-11) at 0.25% v/v was applied with imazamethabenz and flucarbazone-sodium. Crop oil concentrate (Score) was applied at 0.32 qt/A with clodinafop. Ammonium sulfate at 15 lb/100 gal and a crop oil concentrate/non-ionic surfactant blend (Supercharge) at 0.5% v/v was applied with tralkoxydim.
[b]Application timing based on wild oat growth stage.
[c]July 24, 2000 evaluation date.

The effect of grass herbicides combined with carfentrazone, fluroxypyr, and 2,4-D on weed control in spring wheat. Traci A. Rauch and Donald C. Thill. (Plant Science Division, University of Idaho, Moscow, ID 83844-2339) Two studies were established in 'Westbred 926' hard red spring wheat to examine crop response and weed control with grass herbicides combined with carfentrazone, fluroxypyr, and 2,4-D. Plots were 8 by 30 ft arranged in a randomized complete block design 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 7, 2000 for experiment one and June 14 and 28, 2000 for experiment two. Weed control was evaluated visually on July 12 and 25, 2000 for experiment one and June 28 and July 20, 2000 for experiment two. In experiment two, wheat seed was harvested with a small plot combine from a 4.1 by 27 ft area in each plot on August 18, 2000. Experiment one was not harvested due to poor wild oat control throughout the entire study.

Table 1. Application and soil data for experiment one and experiment two.

	Experiment one	Experiment two
Application date	May 25, 2000	June 5, 2000
Growth stage		
Spring wheat	1 to 2 leaf	3 to 4 tiller
Wild oat	1 to 2 leaf	1 to 2 tiller
Catchweed bedstraw	1 to 3 in	--
Common lambsquarters	--	3 to 4 in
White campion	1 to 4 in	--
Air temperature (F)	62	74
Relative humidity (%)	53	56
Wind (mph, direction)	1, S	0
Cloud cover (%)	5	99
Soil temperature at 2 in (F)	53	57
pH	5.2	4.7
OM (%)	15.4	3.6
CEC (meq/100g)	31	19
Texture	loam	silt loam

In experiment one, no treatment visibly injured wheat on June 7 (data not shown). White campion control was greater with tralkoxydim + carfentrazone + MCPA ester (80%) than all other treatments (34 to 54%) expect fenoxaprop + carfentrazone + MCPA ester (75%) (Table 2). No treatment adequately controlled catchweed bedstraw (25 to 48%) or wild oat (10 to 64%).

In experiment two on June 14, fenoxaprop and clodinafop treatments injured wheat 10 to 11% and 3 to 7%, respectively (Table 3). By June 28, no injury was visible from any treatment (data not shown). All 2,4-D (amine or ester) treatments controlled common lambsquarters 98 to 99%, while fluroxypyr treatments controlled common lambsquarters 61 to 78%. Any combination with fluroxypyr did not affect wild oat control (84 to 99%) compared the grass herbicide alone (81 to 99%). 2,4-D ester and amine (0.75 lb/A) in combination with clodinafop (without fluroxypyr) reduced wild oat control 21 and 25%, respectively, compared to clodinafop alone. Wheat yield for all treatments was greater than the untreated check except fluroxypyr and 2,4-D (amine and ester) alone. Seed yield of wheat treated with clodinafop + fluroxypyr + 2,4-D amine was greater than all grass herbicides alone, fenoxaprop and tralkoxydim with fluroxypyr, and clodinafop in combination with the high rates of 2,4-D amine and ester.

Table 2. Weed control with carfentrazone alone or combined with other grass herbicides in spring wheat (experiment one).

Treatment[a]	Rate	Weed control		
		White campion[b]	Catchweed bedstraw[b]	Wild oat[c]
	lb/A	%		
Carfentrazone	0.008	48	35	--
Clodinafop	0.05	--	--	64
Clodinafop + carfentrazone	0.05 + 0.008	54	48	46
Diclofop	1.0	--	--	10
Diclofop + carfentrazone + UAN	1.0 + 0.008 + 4% v/v	39	35	19
Imazamethabenz	0.375	--	--	12
Imazamethabenz + carfentrazone	0.375 + 0.008	50	31	14
Imazamethabenz + carfentrazone + UAN	0.375 + 0.008 + 4% v/v	46	35	15
Imazamethabenz + difenzoquat	0.375 + 0.5	--	--	30
Imazamethabenz + difenzoquat + carfentrazone	0.375 + 0.5 + 0.008	44	38	25
Fenoxaprop	0.078	--	--	42
Fenoxaprop + carfentrazone	0.078 + 0.008	54	34	39
Fenoxaprop + carfentrazone + MCPA ester	0.078 + 0.008 + 0.375	75	40	60
Tralkoxydim + TF8035	0.188 + 0.5% v/v	--	--	10
Tralkoxydim + carfentrazone	0.188 + 0.008	34	25	15
Tralkoxydim + carfentrazone + TF8035	0.188 + 0.008 + 0.5% v/v	50	31	18
Tralkoxydim + carfentrazone + MCPA ester + TF8035	0.188 + 0.008 + 0.375 + 0.5% v/v	80	49	31
Untreated check	--	--	--	--
LSD (0.05)		23	NS	19
Density (plants/ft^2)		8	1	24

[a]90% non-ionic surfactant (R-11) at 0.25% v/v was applied with carfentrazone alone and in combinations with diclofop and imazamethabenz. Crop oil concentrate (Score) was applied at 0.32 qt/A with clodinafop. UAN is urea ammonium nitrate. Ammonium sulfate was applied at 15 lb/100 gal with tralkoxydim. TF8035 is a crop oil concentrate/non-ionic surfactant blend (Supercharge). Rates for MCPA treatments are in lb ae/A.
[b]July 12, 2000 evaluation date.
[c]July 25, 2000 evaluation date.

Table 3. Crop response, weed control and wheat yield with fluroxypyr and 2,4-D alone or combined with other grass herbicides in spring wheat (experiment two).

Treatment[a]	Rate	Wheat injury[b]	Weed control		Wheat[e] yield
			Common lambsquarters[c]	Wild oat[d]	
	lb/A	%			lb/A
Fluroxypyr	0.125	0	64	--	599
2,4-D amine	0.375	0	98	--	1018
2,4-D ester	0.375	0	99	--	1003
Fenoxaprop	0.83	10	--	99	2118
Fenoxaprop + fluroxypyr	0.83 + 0.125	11	69	97	2134
Tralkoxydim	0.24	1	--	81	2119
Tralkoxydim +fluroxypyr	0.24 + 0.125	4	61	84	2211
Clodinafop	0.05	4	--	99	1767
Clodinafop + fluroxypyr	0.05 + 0.125	7	60	99	2318
Clodinafop + fluroxypyr	0.05 + 0.25	5	78	99	2346
Clodinafop + 2,4-D amine	0.05 + 0.375	4	99	94	2716
Clodinafop + 2,4-D amine	0.05 + 0.75	6	98	74	2140
Clodinafop + 2-4 D ester	0.05 + 0.375	5	99	96	2814
Clodinafop + 2,4-D ester	0.05 + 0.75	4	99	78	2142
Clodinafop + fluroxypyr + 2,4-D amine	0.05 + 0.125 + 0.25	3	99	97	2918
Clodinafop + fluroxypyr + 2,4-D ester	0.05 + 0.125 + 0.25	5	99	99	2613
Untreated check	--	--	--	--	746
LSD (0.05)		3	10	8	643
Density (plants/ft^2)			31	10	

[a]2,4-D amine and 2,4-D ester were the Saber and Salvo formulations, respectively. Crop oil concentrate (Score) was applied at 0.32 qt/A with clodinafop. Ammonium sulfate at 17 lb/100 gal and a crop oil concentrate/non-ionic surfactant blend (Supercharge) were applied with tralkoxydim. Rates for MCPA treatments are in lb ae/A.
[b]June 14, 2000 evaluation date.
[c]June 28, 2000 evaluation date.
[d]July 20, 2000 evaluation date.
[e]Wheat yield was low due to hail.

Weed control in glyphosate-resistant spring wheat. Traci A. Rauch and Donald C. Thill. (Plant Science Division, University of Idaho, Moscow, ID 83844-2339) A study was established near Genesee, ID in 'Bobwhite' glyphosate-resistant spring wheat to examine crop response and weed control with different timings of glyphosate applied alone or combined with other herbicides. Plots were 8 by 30 ft arranged in a randomized complete block design 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 6 and 19, 2000. Weed control was evaluated visually on June 19, July 11 and 28, 2000. Wheat seed was harvested with a small plot combine from a 4.1 by 27 ft area in each plot on August 29, 2000.

Table 1. Application and soil data.

Application date	June 1, 2000		June 9, 2000
Spring wheat growth stage	4 to 5 leaf		5 to 8 leaf
Wild oat growth stage	3 leaf		5 to 8 leaf
Common lambsquarters growth stage	1 to 3 in		6 in
Air temperature (F)	63		63
Relative humidity (%)	55		62
Wind (mph, direction)	1, E		0
Cloud cover (%)	0		99
Soil temperature at 2 in (F)	65		55
pH		5.1	
OM (%)		2.4	
CEC (meq/100g)		21	
Texture		silt loam	

Glyphosate (r) with thifensulfuron/tribenuron injured wheat 16% on June 6, 2000 (Table 2). No injury was visible by June 19 (data not shown). Wild oat control ranged from 92 to 99% for all treatments. All treatments controlled common lambsquarters 99% except all rates of glyphosate (r) applied alone at either timing (85 to 89%). Wheat seed yield was lowest for the untreated check at 4235 lb/A but did not differ from any treatment.

Table 2. Weed control, wheat injury and yield with glyphosate alone or combined with other herbicides in glyphosate-resistant spring wheat.

				Weed control[e]		
Treatment[a]	Rate[b]	Application timing[c]	Wheat injury[d]	Wild oat	Common lambsquarters	Wheat yield
	lb/A		%	%	%	lb/A
Glyphosate (r)	0.375	3 leaf	0	92	89	5630
Glyphosate (r)	0.56	3 leaf	0	92	89	6066
Glyphosate (r)	0.75	3 leaf	0	92	88	5158
Glyphosate (r)+ dicamba	0.357 + 0.06	3 leaf	0	99	99	4547
Glyphosate (r)+ thifen/triben	0.375 + 0.014	3 leaf	16	99	99	4678
Glyphosate (r)+ bromoxynil	0.375 + 0.25	3 leaf	0	99	99	5359
Fenoxaprop/safener	0.083	3 leaf	0	99	--	3929
Glyphosate (r)	0.375	5 to 8 leaf	0	96	85	4731
Glyphosate (r)	0.56	5 to 8 leaf	0	96	85	5617
Glyphosate (r)	0.75	5 to 8 leaf	0	96	86	5447
Glyphosate (r)+ 2,4-D ester	0.375 + 0.25	5 to 8 leaf	0	99	99	5301
Glyphosate (r)+ glyphosate (r)	0.375 + 0.375	3 leaf + 5 to 8 leaf	0	99	99	5590
Glyphosate (r)+ glyphosate (r)	0.75 + 0.75	3 leaf + 5 to 8 leaf	0	99	99	5705
Glyphosate (t)	0.75	5 to 8 leaf	0	99	99	5128
Tralkoxydim	0.24	5 to 8 leaf	0	99	--	4870
Untreated check		--	--	--	--	4235
LSD (0.05)			1	NS	4	NS
Density (plants/ft^2)				4	49	

[a]Glyphosate (r) is the Roundup Ultra formulation. Glyphosate (t) is the Touchdown formulation. Thifen/triben is the commercial formulation of thifensulfuron/tribenuron and was applied with a 90% non-ionic surfactant (R-11) at 0.25% v/v. Tralkoxydim was applied with ammonium sulfate at 17 lb/100 gal and crop oil concentrate/non-ionic surfactant blend (Supercharge) at 0.5 % v/v.

[b]Rates for all glyphosate treatments are in lb ae/A.

[c]Application timing based on the wild oat growth stage.

[d]June 6, 2000 evaluation date.

[e]July 11, 2000 evaluation date.

Carfentrazone in combination with other broadleaf herbicides for weed control in spring wheat. Janice M. Reed and Donald C. Thill. (Department of Plant, Soil, and Entomological Sciences, University of Idaho, Moscow, ID 83844-2339) A study was conducted near Genesee, Idaho to evaluate control of broadleaf weeds in spring wheat with carfentrazone in combination with other broadleaf herbicides. Plot size was 8 by 30 ft, arranged in a randomized complete block design with four replications. Herbicide treatments were applied with a CO_2 backpack sprayer calibrated to deliver 10 gpa at 30 psi and 3 mph (Table 1). Weed control was evaluated visually on June 6, 13, and 27, 2000. Wheat was harvested on August 22, 2000 from a 4.2 by 27 ft area of each plot.

Table 1. Application and soil data.

Application date	May 30, 2000
Growth stages	
Wheat	4 to 5 leaf
Henbit (LAMAM)	2 leaf to 6 in. tall
Field pennycress (THLAR)	2 leaf to 4 in. tall
Catchweed bedstraw (GALAP)	1 to 6 in. tall
Common lambsquarter (CHEAL)	1 to 4 in. tall
Air temperature (F)	59
Relative humidity (%)	70
Wind (mph, direction)	3, NW
Cloud cover (%)	10
Soil temperature at 2 in (F)	58
pH	5.2
OM (%)	2.5
CEC (meq/100g)	17
Texture	Silt loam

Wheat injury with treatments containing UAN ranged from 10 to 24%, however, injury was highest (32%) with fluroxypyr/2,4-D + thifensulfuron/tribenuron (Table 2). Henbit control ranged from 0 to 76%, and was quite variable among treatments due to high density and variation in henbit growth stages at the time of herbicide application. Field pennycress control was 92 to 100% with all treatments except carfentrazone in combination with MCPA, fluroxypyr/MCPA ester, bromoxynil/MCPA ester, and MCPA ester alone. Catchweed bedstraw control was best with carfentrazone in combination with 2,4-D ester (89%), MCPA amine (84%), and fluroxypyr/MCPA ester (85%). Carfentrazone + bromoxynil/MCPA and MCPA ester suppressed common lambsquarter 76 and 79%, respectively, while all other treatments controlled common lambsquarter 90 to 100%. Wheat yield ranged from 5477 to 6608 lb/A and no treatment differed from the untreated check.

Table 2. Weed control and wheat yield with carfentrazone in combination with boadleaf herbicides.

Treatment[a]	Rate	Wheat injury[b]	Control[c] LAMAM	THLAR	GALAP	CHEAL	Wheat yield
	lb/A	%	--------------------------------------%--------------------------------------				lb/A
Carfentrazone + 2,4-D amine + NIS	0.008 + 0.25	0	0	100	21	99	6608
Carfentrazone + 2,4-D amine + NIS + UAN	0.008 + 0.25	10	3	100	0	99	6391
Carfentrazone + 2,4-D amine + NIS + AMS	0.008 + 0.25	8	0	94	0	95	5891
Carfentrazone + 2,4-D ester + NIS + UAN	0.008 + 0.25	24	68	99	89	98	6021
Carfentrazone + MCPA amine + NIS + UAN	0.008 + 0.375	10	31	79	84	92	6134
Carfentrazone + fluroxypyr + NIS + UAN	0.008 + 0.062	10	0	99	0	100	6349
Carfentrazone + fluroxypyr/2,4-D + NIS + UAN	0.008 + 0.312	10	0	100	0	100	6269
Carfentrazone + fluroxypyr/MCPA ester + NIS + UAN	0.008 + 0.333	20	74	84	85	90	5723
Carfentrazone + thifensulfuron/tribenuron + NIS + UAN	0.008 + 0.014	10	0	98	0	100	6262
Fluroxypyr/2,4-D + thifensulfuron/tribenuron + NIS	0.467 + 0.014	32	76	92	70	100	6274
Bromoxynil/MCPA ester	0.5	0	0	92	0	94	6138
MCPA ester	0.5	5	0	79	0	79	5477
Carfentrazone + bromoxynil	0.008 + 0.187	4	77	92	74	95	6259
Carfentrazone + bromoxynil/MCPA ester	0.008 + 0.187	0	28	88	35	76	6149
Untreated check	---	---	---	---	---	---	5833
	LSD (0.05)	17	7	4	8	5	920
	Plants/ft^2		21	2	2	3	

[a]NIS is 90% nonionic surfactant (R-11) applied at 0.25% v/v. UAN is urea ammonium nitrate applied at 4% v/v. AMS is liquid ammonium sulfate applied at 17 lb/100 gal. Fluroxypyr/2,4-D, fluroxypyr/MCPA, thifensulfuron/tribenuron, and bromoxynil/MCPA were applied as the commercial formulations.

[b]June 13 evaluation.

[c]June 27 evaluation.

Fenoxaprop/safener with broadleaf combinations for wild oat control in spring wheat. Janice M. Reed and Donald C. Thill (Department of Plant, Soil, and Entomological Sciences, University of Idaho, Moscow, ID 83844-2339) A study was conducted near Moscow, Idaho to evaluate control of wild oat in spring wheat with fenoxaprop plus fenchlorazole (safener) alone and in combination with broadleaf herbicides. The experimental design was a randomized complete block with three replications and plot size was 8 by 30 ft. Herbicide treatments were applied on May 26, 2000 with a CO_2 backpack sprayer calibrated to deliver 10 gpa at 30 psi and 3 mph (Table 1). Wild oat control was rated visually at heading on July 12, 2000. Wheat was harvested at maturity from a 4.2 by 27 ft area of each plot.

Table 1. Application information.

Wheat growth stage	4 to 6 leaf
Wild oat growth stage	3 to 4 leaf
Air temperature (F)	62
Relative humidity (%)	70
Wind (mph, direction)	3, SW
Cloud cover (%)	100
Soil temperature at 2 in (F)	60
pH	5.2
OM (%)	2.5
CEC (meq/100g)	17
Texture	Silt loam

Fenoxaprop/safener applied alone or with broadleaf herbicides controlled wild oat 100% by heading (Table 2). Tralkoxydim and clodinafop controlled wild oat 50 and 75%, respectively. All treatments had significantly higher wheat yield than the control. Wheat yield for all fenoxaprop/safener treatments combined with broadleaf herbicides and for clodinafop + bromoxynil/MCPA did not differ from each other and ranged from 2209 to 2505 lb/A. Wheat yield for bromoxynil/MCPA + thifensulfuron was 1.5 times greater than the control but less than all other treatments.

Table 2. Wild oat control and wheat yield with fenoxaprop/safener plus broadleaf herbicides.

Treatment[a]	Rate	Wild oat control	Wheat yield
	lb/A	%	lb/A
Untreated	—	—	697
Fenoxaprop/safener	0.083	100	2576
Fenoxaprop/safener + thifensulfuron/tribenuron + NIS	0.083 + 0.019	100	2447
Fenoxaprop/safener + thifensulfuron + NIS	0.083 + 0.019	100	2505
Fenoxaprop/safener + thifensulfuron + MCPA ester + NIS	0.083 + 0.019 + 0.375	100	2252
Fenoxaprop/safener + thifensulfuron + fluroxypyr + NIS	0.083 + 0.009 + 0.089	100	2349
Fenoxaprop/safener + thifensulfuron + fluroxypyr + NIS	0.083 +0.014 + 0.063	100	2374
Fenoxaprop/safener + bromoxynil/MCPA	0.083+ 0.5	100	2495
Fenoxaprop/safener + bromoxynil	0.083 + 0.25	100	2465
Fenoxaprop/safener + MCPA ester	0.083 + 0.375	100	2408
Fenoxaprop/safener + fluroxypyr	0.083 + 0.157	100	2223
Fenoxaprop/safener + fluroxypyr + MCPA ester	0.083 + 0.157 + 0.375	100	2405
Fenoxaprop/safener + bromoxynil + fluroxypyr	0.083 + 0.25 + 0.089	100	2340
Fenoxaprop/safener + bromoxynil + thifensulfuron + NIS	0.083 + 0.25 + 0.014	100	2209
Tralkoxydim + bromoxynil/MCPA + COC/NIS	0.0179 + 0.5	50	2134
Clodinafop + bromoxynil/MCPA + COC	0.05 + 0.5	75	2465
Bromoxynil/MCPA + thifensulfuron	0.5 + 0.014	0	1017
Average wild oat density (plants/ft^2)		58	
LSD (0.05)		3	315

[a] Thifensulfuron/tribenuron and bromoxynil/MCPA were applied as the commercial formulations. NIS (R-11) is 90% non-ionic surfactant applied at 0.25% v/v. COC/NIS is a crop oil, nonionic surfactant blend (Supercharge) applied at 0.5% v/v. COC is a crop oil concentrate (Score) applied at 0.8% v/v.

Comparison of imazamethabenz and difenzoquat to other postemergence wild oat herbicides in spring wheat. Matthew J. West, 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 ('WB 936R') to compare several herbicide combinations for wild oat control. The experiment was located near Paul, ID in wheat planted April 10, 2000, 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. The experimental design was a randomized complete block with four replications and individual plots were 8 by 25 ft. All herbicides were applied May 13 with the following environmental conditions: air temperature 60 F, soil temperature 50 F, relative humidity 63%, and 4 mph wind speed. Wild oat density averaged 20 plants/ft^2. Crop injury was evaluated visually May 20 and crop injury and wild oat control was evaluated June 29. Wheat was harvested August 17 with a small-plot combine.

Slight spring wheat injury was observed with several treatments, however injury was 5% or less by June 29 (Table). Wild oat control ranged from 63 to 93% and was best with fenoxaprop, 0.24 lb/A tralkoxydim, clodinafop, 0.47 lb/A imazamethabenz + AMS, and BAY MKH6562. Grain yield in treated plots was higher than the check except for 0.235 lb/A imazamethabenz + diclofop, and 0.156 lb/A imazamethabenz + AMS.

Table. Crop injury and wild oat control with postemergence herbicides in spring wheat near Paul, Idaho.

Treatment[a]	Rate	Crop injury 5/20	Crop injury 6/29	Wild oat control	Yield
	lb/A	%	%	%	bu/A
Check		0	0	0	42
Imazamethabenz + NIS	0.47 + 0.25% v/v	0	3	71	67
Imazemethabenz + NIS + ammonium sulfate	0.47 + 0.25% v/v + 2	0	0	86	76
Imazemethabenz + Difenzoquat + NIS	0.235 + 0.5 + 0.25% v/v	3	0	68	70
Imazemethabenz + Difenzoquat + NIS + ammonium sulfate	0.235 + 0.5 + 0.25% v/v + 2	0	0	68	89
Imazemethabenz + NIS + ammonium sulfate	0.156 + 0.25% v/v + 2	0	0	63	67
Clodinafop + Score	0.05 + 0.8	0	0	86	90
Tralkoxydim + Supercharge + ammonium sulfate	0.18 + 0.5 + 2	3	0	70	71
Tralkoxydim + Supercharge + ammonium sulfate	0.24 + 0.5 + 2	0	0	83	77
Fenoxaprop	0.1	3	0	86	72
BAY MKH6562 + NIS	0.027 + 0.25% v/v	0	5	84	72
LSD (0.05)		3	ns	10	24

[a]NIS = nonionic surfactant; Score and Supercharge are proprietary adjuvants.

Comparison of postemergence wild oat herbicides in irrigated 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 initiated near Paul, Idaho to compare postemergence herbicides applied at three growth stages for wild oat control in spring wheat ('WB 936R'). Wheat was planted April 9, 2000, at 128 lb/A. Soil type at this location was a Portneuf silt loam (19% sand, 71% silt, and 10% clay) with a 7.8 pH, 1.5% organic matter, and CEC of 15 meq/100 g soil. Experimental design was a randomized complete block with four replications. Individual plots were 8 by 25 ft. Herbicides were applied with a CO_2-pressurized bicycle-wheel sprayer calibrated to deliver 10 gpa using 11001 flat fan nozzles. Information on environmental conditions at each application is shown in Table 1. Crop injury was evaluated 12 days after the last treatment (DALT) was applied (June 7) and again when wild oat control was evaluated June 29. The crop was harvested August 16 with a small-plot combine.

Table 1. Environmental conditions at each application and weed species density.

Application date	5/13	5/20	5/26
Application timing	2 to 3 leaf	4 to 5 leaf	6 to 7 leaf
Air temperature (F)	68	57	45
Soil temperature (F)	60	52	46
Relative humidity (%)	68	82	92
Wind speed (mph)	4	5	4
Cloud cover (%)	70	15	0
Wild oat/ft^2	26	33	33

Crop injury ranging from 3 to 13% was observed across herbicide treatments 12 DALT. Highest injury was observed with fenoxaprop applied at the 4 to 5 leaf stage. By 33 DALT, the highest injury level was only 6%. Wild oat control was most consistent with clodinafop applied at the 4 to 5 leaf or 6 to 7 leaf growth stage and averaged 94 and 90%, respectively. Next highest wild oat control treatment was fenoxaprop (81%) applied at the 4 to 5 leaf stage. Wild oat control with tralkoxydim declined as wild oat growth stage increased. Tank mixing carfentrazone with clodinafop or fenoxaprop did not reduce wild oat control compared to either clodinafop or fenoxaprop alone applied at the same time (2 to 3 leaf). However, tank mixing carfentrazone with tralkoxydim and imazamethabenz reduced wild oat control compared to tralkoxydim or imazamethabenz applied alone. All herbicide treatments had higher yields than the untreated check, which yielded 20 bu/A. Highest and most consistent yields among groups of herbicides were with the clodinafop treatments. Yields from all other herbicide treatments decreased with applications made at later growth stages.

Table 2. Crop injury, wild oat control, and spring wheat yield with postemergence wild oat herbicides near Paul, Idaho.

Treatment[a]	Rate	Growth stage	Crop injury 6/7	Crop injury 6/29	Wild oat control	Yield
	lb/A		%			bu/A
Check			0	0	0	20
Clodinafop + Score	0.05 + 10.2 fl oz/A	2-3 leaf	4	1	76	79
Clodinafop + Score	0.05 + 10.2 fl oz/A	4-5 leaf	9	6	94	74
Clodinafop + Score	0.05 + 10.2 fl oz/A	6-7 leaf	5	4	90	63
Clodinafop + carfentrazone + Score	0.05 + 0.008 + 10.2 fl oz/A	2-3 leaf	8	1	70	78
Fenoxaprop	0.1	2-3 leaf	6	3	79	76
Fenoxaprop	0.1	4-5 leaf	13	3	81	56
Fenoxaprop	0.1	6-7 leaf	8	4	69	53
Fenoxaprop + carfentrazone	0.1 + 0.0008	2-3 leaf	6	0	79	76
Tralkoxydim + Supercharge + ammonium sulfate	0.24 + 0.5% v/v + 2	2-3 leaf	8	0	75	70
Tralkoxydim + Supercharge + ammonium sulfate	0.24 + 0.5% v/v + 2	4-5 leaf	5	3	65	55
Tralkoxydim + Supercharge + ammonium sulfate	0.24 + 0.5% v/v + 2	6-7 leaf	4	0	30	38
Tralkoxydim + carfentrazone + Supercharge + ammonium sulfate	0.24 + 0.008 + 0.5% v/v + 2	2-3 leaf	6	0	61	78
Imazamethabenz + NIS	0.41 0.25% v/v	2-3 leaf	3	0	56	51
Imazamethabenz + carfentrazone + NIS	0.41 + 0.008 + 0.25% v/v	2-3 leaf	3	0	44	50
BAY MKH6562 + NIS	0.027 + 0.25% v/v	2-3 leaf	5	6	69	67
LSD (0.05)			5	5	10	15

[a]Score and Supercharge are proprietary adjuvants. NIS = nonionic surfactant.

Fluroxypyr combined with other broadleaf herbicides for kochia control. Michael J. Wille and Don W. Morishita. (Twin Falls Research and Extension Center, University of Idaho, Twin Falls, ID 83303-1827). A study was conducted at the University of Idaho Research and Extension Center near Kimberly, ID to compare the efficacy of fluroxypyr combined with broadleaf herbicides for the control of kochia and other broadleaf weeds in spring wheat ('Treasure'). The soil at the study site was a Portneuf silt loam soil (26% sand, 64% silt, and 10% clay, with a pH of 8.1, 1.6% organic matter, and a CEC of 16 meq/100 g soil). Experimental design was a randomized complete block with four replications. Individual plots were 8 by 25 feet. Wheat was planted April 14, 2000, and grown under irrigation. Kochia (15 plants/ft^2), and common lambsquarters (1 plant/ft^2) were the dominant weed species. Herbicides were applied with a CO_2-pressurized bicycle-wheel sprayer at wheat tillering. Herbicide treatments were broadcast-applied with flat fan nozzles at 10 gpa June 1, 2000 (air temperature, 56F; soil temperature, 55F; relative humidity, 66%; wind velocity, 5 mph; 0% cloud cover). Kochia and common lambsquarters were 2 to 4 inches and 1 to 2 inches tall, respectively at herbicide application. Weed control was evaluated visually June 9 and July 6, 8 and 34 days after treatment (DAT), respectively. Plots were harvested with a small-plot combine on August 23, 2000.

Barley was injured 14 to 16% by combinations of dicamba + carfentrazone, and fluroxypyr + carfentrazone 8 DAT while other treatments caused only 1 to 3% injury (Table). Crop injury 34 DAT ranged from 0 to 9% and did not differ among herbicide treatments. Kochia control 8 DAT ranged from 71 to 92% and was similar among herbicide treatments. By 34 DAT, all herbicide treatments controlled kochia 80 to 90% except bromoxynil + 2,4-D which controlled kochia only 64%. Common lambsquarters control, which was evaluated only on July 6, was 90% or better for all herbicide treatments. Grain yields ranged from 30 to 39 bu/A and did not differ among treatments. Grain test weight averaged from 40 to 42 lb/bu for all herbicide treatments (data not shown) compared to 26 lb/bu for the untreated check.

Table. Crop injury, weed control and grain yield response to herbicide combinations in spring wheat, near Kimberly, Idaho.

				Weed control[a]			
		Crop injury		KCHSC		CHEAL	
Treatment[b]	Rate	6/9	7/6	6/9	7/6	7/6	Grain yield
	lb/A	%					bu/A
Check		0	0	0	0	0	30
Fluroxypyr + NIS	0.047 + 0.25% v/v	1	6	71	80	90	33
Fluroxypyr + thifensulfuron + NIS	0.047 + 0.023 + 0.25% v/v	3	3	81	83	100	39
Fluroxypyr + tribenuron + NIS	0.047 + 0.00778 + 0.25% v/v	3	4	85	89	100	36
Fluroxypyr + NIS	0.062 + 0.25% v/v	0	4	76	84	95	35
Fluroxypyr + thifensulfuron + NIS	0.062 + 0.023 + 0.25% v/v	3	0	73	84	100	35
Fluroxypyr + tribenuron + NIS	0.062 + 0.00778 + 0.25% v/v	0	5	84	91	99	39
Fluroxypyr + tribenuron + NIS	0.062 + 0.0125 + 0.25% v/v	1	0	79	85	99	37
Fluroxypyr + MCPA LV4 + NIS	0.125 + 0.463 + 0.25% v/v	1	4	73	90	100	31
Fluroxypyr + MCPA LV4 + NIS	0.062 + 0.231 + 0.25% v/v	1	3	71	84	100	38
Bromoxynil + 2,4-D	0.25 + 0.50	3	9	73	64	100	37
Dicamba + carfentrazone + NIS	0.0625 + 0.008 + 0.25% v/v	16	8	96	90	99	34
Fluroxypyr + carfentrazone + NIS	0.062 + 0.008 + 0.25% v/v	14	4	92	91	96	38
LSD (0.05)		5	7	9	7	5	9

[a]Weeds evaluated for control were kochia (KCHSC) and common lambsquarters (CHEAL).
[b]NIS = nonionic surfactant

Wild Oat Control in Roundup-Ready Spring Wheat. Joseph P. Yenish, John D. Toker, and Edward J. Scheenstra. (Washington State University, Pullman, WA 99164-6420) The study was conducted in Whitman County, WA to determine wild oat control and spring wheat yield response. The study was designed as a randomized complete block with 3 replications. All herbicides were applied using a CO_2 backpack sprayer calibrated to deliver 10 gallons per acre at 35 psi. Timing of herbicide applications included EPOST = early postemergence applied to 3-4 leaf spring wheat on 5/7/00 and LPOST = late postemergence applied to 4-6 leaf spring wheat on 5/18/00. A glyphosate-resistant spring wheat variety was used across the study to ensure crop safety in glyphosate treatments.

Wild oat was effectively controlled by all treatments of glyphosate and glyphosate combinations. Greatest wheat yield was with glyphosate in combination with broadleaf herbicides or with split early plus late applications of glyphosate. Test weights were generally unaffected by herbicide treatment with differences largely due to wild oat or other weed seed contaminating harvested grain samples rather than reduced kernel quality. Harvested grain was not cleaned as samples were weighed and were not saved which precluded further postharvest sample cleaning.

Table. Wild oat control and spring wheat yield and test weight.

			Wild Oat Control	Spring Wheat	
Treatment	Rate	Timing	8/7/00	Yield	Test wt.
			— % —	bu/a	lbs/bu
Weedy check			0	84	59
Glyphosate	0.375	EPOST	85	109	61
Glyphosate	0.56	EPOST	92	92	62
Glyphosate	0.75	EPOST	95	106	61
Glyphosate + dicamba	0.375 + 0.06	EPOST	87	114	61
Glyphosate + thifensulfuron + tribenuron[a]	0.375 + 0.01 + 0.005	EPOST	92	115	60
Glyphosate + bromoxynil	0.375 + 0.25	EPOST	94	108	57
Glyphosate	0.75	LPOST	95	102	62
Glyphosate	0.56	LPOST	95	109	59
Glyphosate	0.75	LPOST	97	108	62
Glyphosate + 2,4-D Ester	0.75 + 0.25	LPOST	97	90	59
Glyphosate + glyphosate	0.375 + 0.375	EPOST + LPOST	97	113	58
Glyphosate + glyphosate	0.75 + 0.75	EPOST + LPOST	97	111	58
Bromoxynil + MCPA + thifensulfuron + tribenuron + fenoxyprop[a]	0.375 + 0.375 + 0.013 + 0.006 + 0.084	EPOST	88	99	60
Bromoxynil + MCPA + thifensulfuron + tribenuron + fenoxyprop[a]	0.375 + 0.375 + 0.013 + 0.006 0.084	LPOST	75	93	55
LSD (p=0.05)			6	17	5

[a]applied with 0.25% v/v nonionic surfactant.

Flumioxazin in spring wheat. Richard K. Zollinger and Scott A. Fitterer. (Department of Plant Sciences, North Dakota State University, Fargo, ND 58105). Experiments were conducted near Valley City and Fargo, ND to evaluate weed control and crop safety from flumioxazin applied early preplant (EPP) and preemergence (PRE). In Valley City, EPP treatments were applied April 24, 2000 at 12:00 pm with 76 F air, 47 F soil at a depth of 2 to 4 inch, 37% relative humidity, 40% clouds, 1 to 5 mph S wind, dry soil surface, and moist subsoil. '2375' wheat was planted on May 10, 2000. PRE treatments were applied May 11, 2000 at 12:30 pm with 64 F air, 57 F soil at a depth of 2 to 4 inch, 50% relative humidity, 100% clouds, 3 to 5 mph NE wind, moist soil surface, and wet subsoil. In Fargo, EPP treatments were applied May 11, 2000 at 9:00 am with 53 F air, 53 F soil at a depth of 2 to 4 inch, 90% relative humidity, 95% clouds, 5 to 10 mph SW wind, dry soil surface, and moist subsoil. 'Oxen' wheat was planted on May 25, 2000. PRE treatments were applied May 26, 2000 at 10:00 am with 65 F air, 58 F soil at a depth of 2 to 4 inch, 48% relative humidity, 80% clouds, 8 to 11 mph NW wind, dry soil surface, and moist subsoil. Treatments were applied to the center 6.67 feet of the 10 by 40 ft plots with a bicycle-wheel-type plot 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.

Wheat injury was only observed at Fargo. Injury symptoms at June 8 were necrotic speckling and blotches and at July 6 were stunting and stand thinning. Flumioxazin applied with glyphosate improved weed control from glyphosate applied alone and generally gave greater than 80% foxtail and broadleaf weed control. At Fargo on July 6, common lambsquarters was completely controlled and the flumioxazin and herbimax treatment did not kill volunteer wheat which eventually out competed the seeded wheat.

Table 1. Flumioxazin in spring wheat – Valley City, ND.

Treatment[a]	Rate	Fxtl[b]	Ebns[c]	Rrpw[d]	Coma[e]
	lb/A	% control			
EPP					
Glyphosate	0.75	57	43	60	27
Flumioxazin + glyphosate	0.063 + 0.75	82	99	99	88
Flumioxazin + glyphosate	0.125 + 0.75	94	96	95	90
PRE					
Glyphosate	0.75	53	55	73	45
Flumioxazin + glyphosate	0.063 + 0.75	80	95	96	87
Flumioxazin + glyphosate	0.125 + 0.75	85	96	93	78
Flumioxazin + Herbimax	0.063 + 1 qt	72	96	96	93
Untreated		0	0	0	0
LSD (0.05)		13	12	10	14

[a]All treatments were applied with 2.5 lb/A AMS. Herbimax is a petroleum oil.
[b]Fxtl = green and yellow foxtail; [c]Ebns = Eastern black nightshade; [d]Rrpw = redroot pigweed; [e]Coma = common mallow.

Table 2. Flumioxazin in spring wheat - Fargo, ND.

		Wheat		June 8			July 6		
Treatment[a]	Rate	June 8	July 6	Fxtl[b]	Colq[c]	Dali[d]	Fxtl[b]	Rrpw[e]	Dali[d]
	lb/A	% injury		% control					
EPP									
Glyphosate	0.75	0	0	60	86	99	30	60	93
Flumioxazin + glyphosate	0.063 + 0.75	4	0	82	99	93	75	94	99
Flumioxazin + glyphosate	0.125 + 0.75	2	0	88	99	99	80	89	99
PRE									
Glyphosate	0.75	2	3	75	99	73	35	50	99
Flumioxazin + glyphosate	0.063 + 0.75	5	20	90	99	99	90	93	99
Flumioxazin + glyphosate	0.125 + 0.75	5	25	88	99	99	91	99	99
Flumioxazin + Herbimax	0.063 + 1 qt	3	0	85	96	86	80	93	99
Untreated		0	0	0	0	0	0	0	0
LSD (0.05)		4	8	7	9	9	14	10	7

[a]All treatments were applied with 2.5 lb/A AMS. Herbimax is a petroleum oil.
[b]Fxtl = green and yellow foxtail; [c]Colq = common lambsquarters; [d]Dali = dandelion; [e]Rrpw = redroot pigweed.

Comparison of glyphosate application timing and frequency for weed control in glyphosate-tolerant sugar beet. 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 evaluate glyphosate application timing for weed control in irrigated glyphosate-tolerant sugar beet. These treatments also were compared to two micro herbicide rate treatments, one of which included fluroxypyr. The study was established at the University of Idaho Research and Extension Center near Kimberly, Idaho. Sugar beet ('HM 108RR') was planted April 18, 2000, on 22-inch rows at a seeding rate of 57024 seed/A. Experimental design was a randomized complete block with four replications and individual plots were 4 rows by 30 ft. Soil type was a Portneuf silt loam (26% sand, 64% silt, and 10% clay) with an 8.1 pH, 1.6% organic matter, and CEC of 16 meq/100 g soil. Herbicides were broadcast-applied with a CO_2-pressurized bicycle-wheel sprayer calibrated to deliver 10 gpa using 11001 flat fan nozzles. Additional application information is shown in Table 1. Crop injury and weed control was evaluated visually June 28 and July 28. The two center rows of each plot were harvested mechanically September 20.

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

Application date	5/13	5/22	5/24	5/27	6/2	6/7
Application timing	cotyledon	9 days after cotyledon	2-leaf	14 d after cotyledon	4-leaf	25 d after cotyledon 14 d after 2 leaf
Air temperature (F)	60	74	80	72	67	66
Soil temperature (F)	60	64	72	70	70	70
Relative humidity (%)	62	25	46	28	60	56
Wind speed (mph)	4	9	5	3	6	1
Cloud cover (%)	0	40	0	0	0	0
Weed species/ft^2						
kochia	1	1	1	1	1	1
common lambsquarters	33	37	33	33	9	32
redroot pigweed	0	0	0	11	2	10

Application date	6/16	6/23	6/30	7/5	7/18
Application timing	14 d after 4 leaf	30 d after 2 leaf	28 d after 4 leaf	42 d after 2 leaf	46 d after 4 leaf
Air temperature (F)	75	78	90	72	70
Soil temperature (F)	90	66	79	69	64
Relative humidity (%)	32	41	2	52	44
Wind speed (mph)	3	4	42	5	5
Cloud cover (%)	0	0	0	0	0
Weed species/ft^2					
kochia	1	2	-	-	-
common lambsquarters	20	20	-	-	-
redroot pigweed	3	3	-	-	-

None of the glyphosate treatments injured the crop (Table 2). Addition of fluroxypyr to ethofumesate & desmedipham & phenmedipham severely injured the crop. Two glyphosate applications, with the first initiated at the 2-leaf stage, controlled kochia, common lambsquarters, redroot pigweed, and green foxtail 86 to 100% regardless of the evaluation date. Two glyphosate applications, with the first initiated at the 4-leaf stage, controlled all weed species 95 to 100%. These two treatments performed as well as three or four sequential glyphosate applications and controlled the weeds more consistently than the micro rate treatments. All glyphosate treatments had sugar beet yields ranging from 29 to 31 ton/A and were all greater than the untreated check, which yielded 22 ton/A.

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

					Weed control[a]									
		Application	Crop injury		KCHSC			CHEAL			AMARE		SETVI	
Treatment[b]	Rate	date	6/23	7/28	6/23	7/28	9/21	6/23	7/28	9/21	7/28	9/21	7/28	Yield
	lb/A				%									ton/A
Check			-	-	-	-	-	-	-	-	-	-	-	22
Glyphosate /	0.75 /	5/24	0	0	100	100	93	100	93	94	98	86	88	29
glyphosate	0.75	6/7												
Glyphosate /	0.75 /	5/24	0	0	100	100	95	100	100	95	100	95	100	29
glyphosate /	0.75 /	6/7												
glyphosate	0.75	6/23												
Glyphosate /	0.75 /	5/24	0	0	100	100	95	100	100	95	100	95	99	29
glyphosate /	0.75 /	6/7												
glyphosate /	0.75 /	6/23												
glyphosate	0.75	7/5												
Glyphosate /	0.75 /	6/2	0	0	95	100	95	95	98	95	99	95	100	31
glyphosate	0.75	6/16												
Glyphosate /	0.75 /	6/2	0	0	96	100	95	94	100	95	100	95	100	29
glyphosate /	0.75 /	6/16												
glyphosate	0.75	6/30												
Glyphosate /	0.75 /	6/2	0	0	99	100	95	99	100	95	100	95	100	30
glyphosate /	0.75 /	6/16												
glyphosate /	0.75 /	6/30												
glyphosate	0.75	7/18												
Efs&dmp&pmp +	0.083 +	5/13	0	0	91	85	94	98	94	88	91	80	78	25
triflusulfuron +	0.0052 +	5/22												
clopyralid +	0.031 +	5/27												
methylated seed oil	1.5% v/v													
Efs&dmp&pmp +	0.083 +	5/13	95	90	99	75	53	99	48	63	83	0	95	4
fluroxypyr +	0.0156 +	2/22												
methylated seed oil	1.5% v/v	5/27												
LSD (0.05)			2	1	ns	17	10	4	14	10	7	15	ns	4

[a]Weed species evaluated for control were kochia (KCHSC), common lambsquarters (CHEAL), redroot pigweed (AMARE), and green foxtail (SETVI).
[b]Efs&dmp&pmp is a 1:1:1 commercial formulation of ethofumesate, desmedipham, and phenmedipham.

Comparison of micro herbicide rates for weed control in sugar beet. Don W. Morishita and Michael J. Wille. (Twin Falls Research and Extension Center, University of Idaho, Twin Falls, ID 83303-1827) Several micro herbicide rate combinations were compared for weed control in sprinkler irrigated sugar beet ('HM PM-21'). Objectives of this experiment were to: 1) compare the standard early postemergence combination of ethofumesate & desmedipham & phenmedipham (efs&dmp&pmp) + triflusulfuron + clopyralid to micro rate broadcast and band applications of the same or similar herbicide combinations; 2) evaluate increasing micro rates with sequential applications, and 3) compare methylated seed oil to Hasten®, an esterified vegetable oil and nonionic surfactant blend and Placement®, a petroleum-based drift control agent. This study was conducted at the University of Idaho Research and Extension Center near Kimberly, Idaho. The crop was planted April 18, 2000, on 22-inch rows at a seeding rate of 57024 seed/A. Soil type was a Portneuf silt loam (26% sand, 64% silt, and 10% clay) with 8.1 pH, 1.6% organic matter, and CEC of 16 meq/100 g soil. Experimental design was a randomized complete block with four replications and individual plots were 4 rows by 30 ft. Herbicides were applied with a CO_2-pressurized bicycle-wheel sprayer calibrated to deliver 20 gpa in an 11-inch band using 8001 even fan nozzles or 10 gpa broadcast using 11001 flat fan nozzles. Additional application information is shown in Table 1. Crop injury and weed control was evaluated visually June 15 and July 14, which was 8 and 44 days after the last treatment (DALT) was applied. The two center rows of each plot were harvested mechanically September 21.

Table 1. Herbicide application information and weed species densities.

Application date	5/15	5/22	5/27	6/7
Application timing	cotyledon	7 days after cotyledon	12 days after cotyledon	23 days after cotyledon
Air temperature (F)	46	74	63	66
Soil temperature (F)	44	64	60	70
Relative humidity (%)	62	25	62	56
Wind speed (mph)	2	8	1	1
Cloud cover (%)	25	40	0	0
Weed species/ft^2				
kochia	1	3	2	3
common lambsquarters	5	30	25	29
redroot pigweed	0	0	22	18
hairy nightshade	<1	6	3	1

Crop injury was observed 8 DALT among several of the treatments. The injury was associated with air temperatures exceeding 80 F in the afternoon of May 27, which was the third application date. At 44 DALT, no injury was observed in any of the herbicide treatments. Overall, weed control with the standard rate of efs&dmp&pmp + triflusulfuron + clopyralid at 0.25 + 0.0156 + 0.094 lb/A controlled common lambsquarters, kochia, redroot pigweed, hairy nightshade, and green foxtail 91 to 100% across both evaluation dates. Between the two micro rate band applications, increasing the efs&dmp&pmp rate from 0.083 lb/A on the first and second applications to 0.122 lb/A on the third and fourth applications controlled the six weed species better than using the same efs&dmp&pmp rate on all four applications. Comparing band and broadcast applications at equivalent rates showed that weed control with an 11-inch band application was about equal to the broadcast applications. Adding ethofumesate to the efs&dmp&pmp + triflusulfuron + clopyralid tank mix improved kochia control from 56 to 80% 44 DALT. Using a combination of Hasten® and Placement® with the micro rates controlled kochia 90% at 44 DALT compared to using Hasten® or Placement® alone, which controlled kochia 81 and 78%, respectively. Redroot pigweed control 44 DALT and hairy nightshade control 8 DALT ranged from 91 to 100% for all herbicide treatments. All herbicide treatments had higher sugar beet yields than the untreated check. The standard rate treatment consisting of efs&dmp&pmp + triflusulfuron + clopyralid at 0.25 + 0.0156 + 0.094 lb/A applied four times had the highest numerical yield at 27 ton/A, but was statistically similar to all but two of the micro rate treatments. This study shows that kochia is difficult to control with micro rates applied at the same rate at each application However, kochia can be satisfactorily controlled with the micro rates if the efs&dmp&pmp rate increases with the last two applications, or if ethofumesate is added to the tank mixture.

Table 2. Crop injury, weed control, and sugar beet yield with micro rates near Kimberly, Idaho.

					Weed control[a]							
		Application	Crop injury		CHEAL		KCHSC		AMARE		SOLSA	
Treatment[b]	Rate	timing[c]	6/15	7/14	6/15	7/14	6/15	7/14	6/15	7/14	6/15	Yield
	lb/A		%									ton/A
Check												3
Efs&dmp&pmp (11" band) +	0.25	Cotyledon /	15	0	99	100	91	94	94	98	100	27
triflusulfuron +	0.0156	7 d later /										
clopyralid	0.094	12 d later /										
		23 d later										
Efs&dmp&pmp (11" band) +	0.083	Cotyledon /	3	0	78	94	78	56	77	91	99	24
triflusulfuron +	0.0052	7 d later /										
clopyralid +	0.031	12 d later /										
MSO	1.5 % V/V	23 d later										
Efs&dmp&pmp (broadcast) +	0.083	Cotyledon /	9	0	84	95	73	40	80	96	95	20
triflusulfuron +	0.0052	7 d later /										
MSO	1.5 % V/V	12 d later /										
		23 d later										
Efs&dmp&pmp (11" band) +	0.083	Cotyledon &	5	0	90	95	86	90	85	94	95	25
triflusulfuron +	0.0052	7 d later /										
clopyralid +	0.031											
MSO /	1.5 % V/V											
Efs&dmp&pmp (11" band) +	0.122	12 d later &										
triflusulfuron +	0.0052	23 d later										
clopyralid +	0.031											
MSO	1.5 % V/V											
Efs&dmp&pmp (broadcast) +	0.083	Cotyledon &	4	0	97	95	77	42	86	95	96	20
triflusulfuron +	0.0052	7 d later /										
clopyralid +	0.031											
MSO /	1.5 % V/V											
Efs&dmp&pmp (broadcast) +	0.122	12 d later &										
triflusulfuron +	0.0052	23 d later										
clopyralid +	0.031											
MSO	1.5 % V/V											
Efs&dmp&pmp (broadcast) +	0.083	Cotyledon /	11	0	97	98	94	80	92	95	97	25
triflusulfuron +	0.0052											
ethofumesate +	0.125											
MSO /	1.5 % V/V											
Efs&dmp&pmp (broadcast) +	0.083	7 d later /										
triflusulfuron +	0.0052											
ethofumesate +	0.166											
MSO /	1.5 % V/V											
Efs&dmp&pmp (broadcast) +	0.122	12 d later &										
triflusulfuron +	0.0052	23 d later										
ethofumesate +	0.25											
MSO	1.5 % V/V											
Dmp&pmp (broadcast) +	0.081	Cotyledon &	1	0	93	98	91	56	89	92	98	25
triflusulfuron +	0.0052	7 d later /										
MSO	1.5 % V/V											
dmp&pmp (broadcast) +	0.122	12 d later /										
triflusulfuron +	0.0052	23 d later										
MSO	1.5 % V/V											
Efs&dmp&pmp (broadcast) +	0.083	Cotyledon /	6	0	95	97	80	81	84	95	98	24
triflusulfuron +	0.0052	7 d later /										
clopyralid +	0.031	12 d later /										
Hasten	1.5 % V/V	23 d later										
Efs&dmp&pmp (broadcast) +	0.083	Cotyledon /	9	0	96	96	75	78	81	95	96	23
triflusulfuron +	0.0052	7 d later /										
clopyralid +	0.031	12 d later /										
Placement	6 fl oz/A	23 d later										
Efs&dmp&pmp (broadcast) +	0.083	Cotyledon /	9	0	96	96	89	90	81	95	99	25
triflusulfuron +	0.0052	7 d later /										
clopyralid +	0.031	12 d later /										
Hasten +	1.5 % V/V	23 d later										
Placement	6 fl oz/A											
LSD (0.05)			10	ns	6	4	15	35	10	7	6	6

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

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

[c]Cotyledon, 7 d later, 12 d later, and 23 d later correspond to applications made May 15, 22, 27, and June 7, 2000.

Broadleaf and grass weed control in sugar beet with soil-applied and sequential postemergence herbicides compared to micro herbicide rates. 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 at the University of Idaho Research and Extension Center near Kimberly, ID to compare the effectiveness of micro herbicide rates of ethofumesate & desmedipham & phenmedipham (efs&dmp&pmp) with other herbicide treatments for weed control in sugar beet. Sugar beet ('HM PM-21') was planted April 18, 2000, on 22-inch rows at a seeding rate of 57,024 seed/A and grown under sprinkler irrigation. Soil type was a Portneuf silt loam (26% sand, 64% silt, and 10% clay, pH 8.1, 1.6% organic matter, and CEC of 16 meq/100 g soil). The experiment was designed as 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.
Treatments using micro herbicide rates were broadcast-applied at 10 gpa using 11001 flat-fan nozzles spaced 15 inches apart. All other treatments were applied in 10-inch bands at 20 gpa using 8001 even-fan nozzles spaced 22 inches apart. Additional application information and weed species densities are shown in Table 1. Weed control was evaluated visually June 15 and June 27, 8 and 20 days after last applications (DALT). Sugar beet was harvested from the center two rows of each plot with a mechanical harvester on September 21.

Table 1. Application data and weed species densities.

Application date	4/24	5/13	5/22	5/27	6/7
Application timing	PRE	cotyledon	7 d after cotyledon 2-leaf	14 after dcotyledon 7 d after 2-leaf	11d after2-leaf
Air temperature (F)	54	47	80	70	70
Soil temperature (F)	29	50	64	64	64
Relative humidity (%)	48	52	25	25	57
Wind speed (mph)	5	1	8	8	4
Cloud cover (%)	100	10	40	40	0
Weed species/ft^2					
common lambsquarters	0	0	25	24	1
kochia	0	6	3	2	25
redroot pigweed	0	0		10	16

None of the herbicide treatments injured sugar beet (Table 2). Kochia control 8 DAT ranged from 67 to 100%, and 78 to 100% 20 DAT but differences among treatments could not be distinguished. Common lambsquarters control 8 DAT was ≥95% for all treatments except those consisting of two applications of efs&dmp&pmp + triflusulfuron at 0.25+0.015 lb/A with the addition of dimethenamid at either 0.60 or 1.28 lb/A in the second application which controlled kochia 87 to 88%. All herbicide treatments controlled common lambsquarters ≥93% 20 DAT except two applications of efs&dmp&pmp + triflusulfuron at 0.25+0.015 lb/A plus dimethenamid at 0.64 lb/A in the second application which controlled common lambsquarters 78%. Redroot pigweed control, which was evaluated on June 26 only, was ≥97% for all herbicide treatments and did not differ among treatments. Sugarbeet yield was similar for all herbicide-treated plots, ranging from 17 to 29 tons/A, compared to 6 tons/A for the untreated checks.

Table 2. Broadleaf and grass weed control in sugar beets with soil-applied and sequential postemergence herbicides compared to micro herbicide rates.

	Application		Crop injury		Weed control[a]					
					KCHSC		CHEAL		AMARE	
Treatment[b]	Rate	Timing	6/15	6/27	6/15	6/27	6/15	6/27	6/27	Yield
	lb/A		%							tons/A
Check										6
Cycloate + glyphosate + NIS	3 + 1 + 0.25% v/v	PRE	0	0	95	93	100	95	100	23
efs&dmp&pmp + triflusulfuron + clopyralid	0.25 + 0.015 + 0.094	2-leaf								
Efs&dmp&pmp + triflusulfuron + clopyralid	0.25 + 0.015 + 0.094	+7 d								
Ethofumesate + glyphosate	1.12 + 0.375 +	PRE	0	0	100	100	97	98	100	29
Efs&dmp&pmp + triflusulfuron + clopyralid	0.25 + 0.015 + 0.094	2-leaf								
Efs&dmp&pmp + triflusulfuron + clopyralid	0.25 + 0.015 + 0.094	+ 7 d								
Efs&dmp&pmp + triflusulfuron	0.25 + 0.015	cotyledon	0	0	67	78	87	78	93	17
Efs&dmp&pmp + triflusulfuron + dimethenamid	0.25 + 0.015 + 0.64	+9 d								
Efs&dmp&pmp + triflusulfuron	0.25 + 0.015	cotyledon	0	0	80	97	88	97	97	25
Efs&dmp&pmp + triflusulfuron + dimethenamid	0.25 + 0.015 + 1.28	+9 d								
Dmp&pmp + triflusulfuron	0.25 + 0.015	cotyledon	0	0	92	78	97	93	98	24
Desmedipham + triflusulfuron + dimethenamid	0.25 + 0.015 + 0.64	+9 d								

Table 2 (con't.).

	Application		Crop injury		Weed control[a]					
					KCHSC		CHEAL		AMARE	
Treatment[b]	Rate	Timing	6/15	6/27	6/15	6/27	6/15	6/27	6/27	Yield
	lb/A				%					tons/A
Efs&dmp&pmp + triflusulfuron + clopyralid + MSO	0.083 + 0.005 + 0.031	cotyledon +9 d +5 d +11 d	0	0	76	73	100	98	98	27
Efs&dmp&pmp + triflusulfuron + clopyralid + Destiny	0.083 + 0.005 + 0.031 + 1.0	cotyledon +9 d +5 d +11 d	15	0	76	93	96	98	100	21
Efs&dmp&pmp + triflusulfuron + clopyralid + Newtone	0.083 + 0.005 + 0.031 + 1.0	cotyledon +9 d +5 d +11 d	10	0	77	85	100	97	98	18
Efs&dmp&pmp + triflusulfuron + clopyralid + Newtone + Destiny	0.083 + 0.005 + 0.031 + 1.0 + 0.5	cotyledon +9 d +5 d +11 d	0	0	75	95	100	98	98	16
Efs&dmp&pmp + triflusulfuron + clopyralid + Firstmate	0.083 + 0.005 + 0.031 + 1.5	cotyledon +9 d +5 d +11 d	0	0	80	87	95	97	97	20
LSD (0.05)			10	0	25	21	6	11	5	13

[a]Weed species evaluated were kochia (KCHSC), common lambsquarters (CHEAL) and redroot pigweed (AMARE).

[b]Efs&dmp&pmp is a 1:1:1 commercial formulation of ethofumesate, desmedipham and phenmedipham, NIS = nonionic surfactant, MSO = methylated seed oil, and Destiny Newtone and Firstmate are proprietary adjuvants.

Comparison of desmedipham and phenmedipham formulations for 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 conducted at the University of Idaho Research and Extension Center near Kimberly, ID to compare the effectiveness of novel formulations of desmedipham & phenmedipham (dmp&pmp), and ethofumesate & desmedipham & phenmedipham (efs&dmp&pmp)to existing formulations for weed control in sugar beet. A3 BO38584 01 EC A1 (EC31) was the code for the dmp&pmp formulation and AE BO49913 01 EC35 (EC25) was the code for the efs&dmp&pmp formulation. Sugar beet ('Beta 8757 LL') was planted April 17, 2000, on 22-inch rows at a seeding rate of 57,024 seed/A, and grown under sprinkler irrigation. Soil type was a Portneuf silt loam (pH of 8.1, 1.6% organic matter, and CEC of 16 meq/100 g soil). The experiment was arranged as 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. Formulations of dmp&pmp, and efs&dmp&pmp were applied in 10-inch bands at 20 gpa using 8001 even-fan nozzles. Glufosinate and glufosinate + ethofumesate applications were broadcast-applied at 10 gpa using 11001 flat-fan nozzles spaced 15 inches apart. All herbicide treatments were applied three times with the exception of glufosinate + ethofumesate, which was applied only once. Additional application information and weed species densities are shown in Table 1. Weed control was evaluated visually June 2 and 26, 9 and 33 days after last applications of dmp&pmp and efs&dmp&pmp were applied, and July 5, nine days after the last application of glufosinate and glufosinate + ethofumesate. Sugar beet was harvested from the center two rows of each plot with a mechanical harvester on September 28.

Table 1. Application data and weed species densities.

Application date	5/9	5/17	5/24	6/7	6/23
Application timing	cotyledon	7 d after cotyledon	14 d after cotyledon +2-leaf	7 d after 2-leaf	14 d after 2-leaf
Air temperature (F)	60	47	80	70	70
Soil temperature (F)	58	55	72	78	66
Relative humidity (%)	45	75	46	58	38
Wind speed (mph)	7	3	5	0	5
Cloud cover (%)	100	0	0	0	0
Weed species/ft^2					
common lambsquarters	0	0	25	24	23
kochia	0	6	26	29	16
redroot pigweed	0	0	0	39	11

Crop injury ranged from 1 to 20% on June 2, and treatments did not differ from each other except for EC31 at 0.5 lb/A which averaged 20% (Table 2). No crop injury from any treatment was evident on any subsequent evaluation date. Common lambsquarters control on June 2 ranged from 60 to 100%. Dmp&pmp, and efs&dmp&pmp at 0.125 lb/A controlled common lambsquarters 60 to 63% EC31 and EC 25 at the same rate controlled common lambsquarters 77 and 85%, respectively. At 0.25 lb/A, all formulations of dmp&pmp and efs&dmp&pmp controlled common lambsquarters 86 to 94%. All formulations of dmp&pmp, and efs&dmp&pmp at 0.5 lb/A controlled common lambsquarters 94 to 100%. All herbicide treatments controlled common lambsquarters ≥92% on June 26, and ≥84% on July 5 and did not differ among each other on either evaluation date. Redroot pigweed control ranged from 68 to 99% on June 2. All herbicide formulations and rates controlled redroot pigweed 84 to 99% except dmp&pmp, and efs&dmp&pmp at 0.125 lb/A which controlled redroot pigweed 68 and 69%, respectively. All herbicide treatments controlled redroot pigweed ≥94% and ≥83% on June 26 and July 5, respectively. Treatments did not differ among each other and no trends were evident with regard to herbicide formulation or rates on either evaluation date. Kochia control ranged from 60 to 90% on June 2 and herbicide treatments did not differ among each other. On June 26, all herbicide treatments controlled kochia >90% except efs&dmp&pmp at 0.5 lb/A which controlled kochia only 74%. Kochia control on July 5 was >80% for all herbicide treatments and did not differ among each other. No trend was evident with respect to herbicide formulations or rates on either of the latter evaluation dates. The addition of Scoil did not improve control in any weed species in any formulation or at any herbicide rate. Because of severe weed pressure, herbicide-treated plots were hoed. Hoeing time for each plot was recorded. Hoeing times for herbicide-treated plots with formulations of dmp&pmp or efs&dmp&pmp ranged from 7 to 17 minutes per plot and did not differ from each other. All however, required significantly more labor than plots treated with glufosinate at either rate, or glufosinate + ethofumesate which required no hoeing. Sugar beet yields of herbicide treated plots ranged from 24 to 33 tons/A and did not differ among each other, but all were greater than the untreated check which yielded only 16 ton/A.

Table 2. Crop injury, weed control and yield response to novel premix formulations of desmedipham & phenmedipham and ethofumesate & desmedipham & phenmedipham.

		Crop injury			Weed control[a]									Hand-weeding times	
					CHEAL			AMARE			KCHSC				
Treatment[b]	Rate	6/2	6/26	7/5	6/2	6/26	7/5	6/2	6/26	7/5	6/2	6/26	7/5	6/16	Yield
	lb/A	%												minutes	ton/A
Check														0	16
A3 B038584 01 EC31 A1	0.125	1	0	0	74	97	97	78	97	83	65	98	98	9	30
A3 B038584 01 EC31 A1	0.25	5	0	0	91	99	100	96	99	99	81	99	98	9	33
A3 B038584 01 EC31 A1	0.5	20	0	0	100	100	99	99	100	100	86	100	99	8.76	29
Dmp&pmp	0.125	1	0	0	63	99	99	68	94	98	63	100	100	14.81	32
Dmp&pmp	0.25	3	0	0	87	100	100	90	98	96	76	99	93	10.11	28
Dmp&pmp	0.5	15	0	0	97	100	100	99	100	100	90	100	99	7.91	31
A3 B038584 01 EC31 A1 + Scoil	0.25 + 1.5 % v/v	16	0	0	92	99	98	98	100	100	86	98	97	10.46	28
Dmp&pmp + Scoil	0.25 + 1.5 % v/v	9	0	0	94	99	97	97	99	98	74	94	96	13.43	31
AE B049913 01 EC25 AI	0.125	9	0	0	85	97	97	93	100	99	81	92	89	9.41	28
AE B049913 01 EC25 AI	0.25	13	0	0	87	100	100	97	100	99	84	99	96	7.20	27
AE B049913 01 EC25 AI	0.5	6	0	0	94	99	100	84	99	99	74	74	81	9.33	27
Efs&dmp&pmp	0.125	3	0	0	60	97	97	69	98	94	60	91	85	16.62	30
Efs&dmp&pmp	0.25	6	0	0	93	97	99	88	97	96	71	94	95	7.17	28
Efs&dmp&pmp	0.5	11	0	0	94	100	100	98	100	99	75	100	99	7.01	24
AE B049913 01 EC25 AI + Scoil	0.25 + 1.5 % v/v	16	0	0	86	99	100	87	98	99	76	98	99	7.87	28
Efs&dmp&pmp + Scoil	0.25 + 1.5 % v/v	6	0	0	96	100	100	97	100	100	89	99	98	8.43	28
Glufosinate + ammonium sulfate	0.312 + 3		0	0		92	95		100	100		96	99	0	27
Glufosinate + ammonium sulfate	0.357 + 3		0	0		98	100		100	100		99	99	0	32
Glufosinate + Ethofumesate + ammonium sulfate	0.357 + 1.0 + 3		0	0		94	84		98	97		94	86	0	29
LSD (0.05)		9	ns	ns	15	ns	ns	16	ns	ns	ns	15	ns	1.17	7

[a]Weed species evaluated were kochia (KCHSC), common lambsquarters (CHEAL) and redroot pigweed (AMARE).

[b]All herbicide treatments were applied three times except glufosinate + ethofumesate. AE B038584 01 EC31 A1 is a formulation of desmedipham and phenmedipham. AE B049913 01 EC25 AI is a formulation desmedipham, phenmedipham, and ethofumesate. Efs&dmp&pmp is a 1:1:1 commercial formulation of ethofumesate, desmedipham, and phenmedipham. ~~Efs&dmp&pmp is a 1:1:1 commercial formulation of ethofumesate, desmedipham and phenmedipham.~~ Scoil is a proprietary surfactant.

Tolerance of two glyphosate-tolerant sugar beet varieties to glyphosate. 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 at the University of Idaho Research and Extension Center near Kimberly, ID to compare the tolerance of two glyphosate-tolerant sugar beet varieties to four glyphosate rates. Sugar beet varieties 'Beta 8757RR' and 'HM 108RR' were planted April 17, 2000, on 22-inch rows at a seeding rate of 57,024 seed/A and grown under sprinkler irrigation. Soil type was a Portneuf silt loam (26% sand, 64% silt, and 10% clay, pH 8.1, 1.6% organic matter, and CEC of 16 meq/100 g soil). The experiment was arranged in a 2 by 5 factorial design with four replications. Individual plots were 4 rows by 30 ft. All herbicides were broadcast-applied with a CO_2-pressurized bicycle-wheel sprayer at 10 gpa using 11001 flat-fan nozzles spaced 15 inches apart. Hand-weeded check plots were weeded June 2 and June 26. Additional application information and weed species densities are shown in Table 1. Crop injury was visually evaluated 10, 18, 31, and 40 days after the last application (DALT) on June 26, July 5, 14, and 26, respectively. Sugar beet was harvested September 20 with a mechanical harvester.

Table 1. Application data and weed species densities.

Application date	5/24	6/2	6/16
Application timing	2-leaf	4-leaf	8-leaf
Air temperature (F)	80	65	75
Soil temperature (F)	72	63	90
Relative humidity (%)	46	60	32
Wind speed (mph)	5	6	3
Cloud cover (%)	0	0	0

Neither sugarbeet variety was injured by any glyphosate rate applied at any of the sugar beet growth stages. Sugar beet yield ranged from 28 to 33 tons/A and did not differ either by variety or herbicide treatment. Sucrose yield ranged from 7640 to 9020 lb/A and also did not differ between variety or herbicide treatment.

Table 2. Crop injury[a], root yield, and sucrose yield response of two glyphosate-tolerant sugar beet varieties.

Variety	Glyphosate rate	Application timing	Injury	Root yield	Sucrose yield
	lb/A		%	ton/A	lb/A
Beta 8757 RR	0.75	2-leaf	0	32	8630
		4-leaf			
		8-leaf			
	1.5	2-leaf	0	31	8750
		4-leaf			
		8-leaf			
	1.125	2-leaf	0	31	8410
		4-leaf			
		8-leaf			
	2.25	2-leaf	0	29	7760
		4-leaf			
		8-leaf			
	Handweeded		0	31	8390
HM 108 RR	0.75	2-leaf	0	33	8730
		4-leaf			
		8-leaf			
	1.5	2-leaf	0	33	9020
		4-leaf			
		8-leaf			
	1.125	2-leaf	0	31	8300
		4-leaf			
		8-leaf			
	2.25	2-leaf	0	28	7640
		4-leaf			
		8-leaf			
	Hand-weeded		0	31	8390
LSD			ns	ns	ns

[a]No visible crop injury was observed on any of four evaluation dates.

Weed control and sunflower tolerance of azafenidin and sulfentrazone. Paul E. Hendrickson, Brian M. Jenks, Michael T. Edwards, Christopher M. Mayo, and James D. Harbour, (Carrington Research Extension Center, Carrington, ND 58421; North Central Research Extension Center, Minot, ND 58701; DuPont Crop Protection, Broomfield, CO 80020; DuPont Crop Protection, Grand Island, NE 68003; and DuPont Crop Protection, Fargo, ND 58104;) Trials were established at Carrington and Minot, ND; Blunt, SD; Goodland, KS; and Wellington, CO to evaluate weed control and sunflower response to azafenidin and sulfentrazone applied alone or in combination with pendimethalin and quizalofop-P-ethyl. Azafenidin and sulfentrazone were applied as preplant incorporated (PPI) and preemergence (PRE) treatments at Carrington, Minot and Blunt (Table 1). At Goodland, all treatments were applied PPI, while at Wellington, all treatments were applied PRE. Plots were arranged in a randomized complete block design with three replicates. Weeds evaluated were redroot pigweed (AMARE), common lambsquarters (CHEAL), wild buckwheat (POLCO), toothed spurge (EPHDE), kochia (KCHSC), yellow foxtail (SETLU), green foxtail (SETVI), and barnyardgrass (ECHCG).

Azafenidin and sulfentrazone generally provided good to excellent (80 to 100%) control of redroot pigweed, common lambsquarters, wild buckwheat, kochia, and barnyardgrass (Tables 2 to 4). Control of yellow foxtail (Table 2) and toothed spurge (Table 3) was less than adequate. Green foxtail control was less than adequate at Goodland (Table 3), but was good to excellent at Wellington (Table 4). The addition of pendimethalin generally did not increase weed control. Sunflower was tolerant to azafenidin and sulfentrazone (data not shown).

Table 1. Planting date, and application and soil data.

	Carrington	Minot	Blunt	Goodland	Wellington
Planting date	May 26	May 31	May 16	June 1	June 21
Application data					
PPI	May 25	May 30	May 16	May 25	--
PRE	May 30	June 2	May 16	--	June 21
POST	July 7	June 22	June 4	--	--
Soil texture	silt loam	loam	silt loam	silt loam	clay loam
pH	6.7	6.4	6.0	7.9	8.0
OM%	2.9	3.5	2.5	2.0	2.4

Table 2. Weed control from azafenidin and sulfentrazone applied alone or in combination with pendimethalin and quizalofop-P-ethyl.

			Carrington, ND[a]			Minot, ND[b]	Blunt, SD[c]
Treatment	Rate	Timing	AMARE	CHEAL	SETLU	AMARE	POLCO
	lb ia/A		%				
Sulfentrazone	0.1875	PPI	100	100	40	76	94
Sulfentrazone	0.375	PPI	100	100	53	92	99
Sulfentrazone / quizalofop-P-ethyl	0.1875 + 0.055	PPI / POST	100	100	99	71	99
Azafenidin	0.125	PPI	100	100	50	80	--
Sulfentrazone	0.1875	PRE	93	95	27	80	92
Sulfentrazone	0.375	PRE	100	100	67	94	94
Azafenidin	0.0625	PRE	90	90	33	71	95
Azafenidin	0.0938	PRE	99	98	60	87	85
Azafenidin	0.125	PRE	99	100	75	90	82
Azafenidin / quizalofop-P-ethyl	0.125 + 0.055	PRE / POST	98	99	99	63	85
Azafenidin + pendimethalin	0.0625 + 1	PRE	97	99	40	80	89
Sulfentrazone + pendimethalin	0.1875 + 1	PRE	99	100	33	88	86
Pendimethalin	1	PRE	80	83	20	80	50
Check	0	check	0	0	0	0	0
LSD (0.05)			4	8	17	13	4

[a]Weed control evaluated July 20, 2000.
[b]Weed control evaluated July 11, 2000.
[c]Weed control evaluated July 26, 2000.

Table 3. Weed control from PPI herbicide applications[a] (Goodland, KS).

Treatment	Rate	AMARE	EPHDE	SETVI
	lb ia/A		%	
Sulfentrazone	0.1875	99	65	53
Sulfentrazone	0.375	98	72	57
Azafenidin	0.0625	93	57	47
Azafenidin	0.0938	87	38	33
Azafenidin	0.125	91	65	45
Azafenidin + pendimethalin	0.0625 + 1	93	51	62
Azafenidin + pendimethalin	0.0938 + 1	86	70	80
Azafenidin + pendimethalin	0.125 + 1	86	62	62
Sulfentrazone + pendimethalin	0.1875 + 1	98	68	70
Pendimethalin	1.2	91	57	73
Check	0	0	0	0
LSD (0.05)		13	35	39

[a]Weed control evaluated August 22, 2000.

Table 4. Weed control from PRE herbicide applications[a] (Wellington, CO).

Treatment	Rate	AMARE	KCHSC	ECHCG	SETVI
	lb ia/A		%		
Sulfentrazone	0.1875	78	96	92	78
Sulfentrazone	0.375	94	99	87	87
Azafenidin	0.0625	89	86	88	89
Azafenidin	0.0938	90	86	92	87
Azafenidin	0.125	88	95	86	92
Azafenidin + pendimethalin	0.0625 + 1	86	96	86	88
Azafenidin + pendimethalin	0.0938 + 1	95	93	98	94
Azafenidin + pendimethalin	0.125 + 1	90	94	98	98
Sulfentrazone + pendimethalin	0.1875 + 1	82	99	91	81
Pendimethalin	1.2	78	95	93	77
Check	0	0	0	0	0
LSD (0.05)		14	14	7	8

[a]Weed control evaluated August 14, 2000.

Tolerance of wheat and triticale to herbicides. Bill D. Brewster, Carol A. Mallory-Smith, and Bradley D. Hanson. (Department of Crop and Soil Science, Oregon State University, Corvallis, OR 97331-3002) 'Madsen' winter wheat and 'Bogo' triticale were planted on October 14, 1999, in a split-plot design to evaluate tolerance to herbicide treatments. Individual plots were 8 ft by 70 ft and were replicated four times. The trial was conducted at the Oregon State University Hyslop Research Farm near Corvallis, OR. Herbicide treatments were applied with a single-wheel, compressed air plot sprayer which applied 20 gpa at 19 psi through XR8003 flat fan nozzle tips. Additional application data are presented in Table 1. The grain was harvested with a small-plot combine on July 24, 2000.

Visual evaluations of crop injury (Table 2) on February 17, 2000, indicated that flufenacet-metribuzin at the higher rate of application caused considerable stunting of both cultivars. This treatment also reduced grain yields ($LSD_{0.05}$ = 5.6 bu/A). No cultivar x herbicide interaction was found in the analysis of the grain yields.

Table 1. Herbicide application data information.

Application date	October 15, 1999	November 15, 1999
Stage of growth	Preemergence	2 leaf
Air temperature (F)	35	66
Soil temperature (F)	40	60
Relative humidity (%)	55	75

Table 2. Wheat and triticale injury and grain yield following herbicide applications, Corvallis, OR.

			Wheat		Triticale	
Treatment[a]	Timing	Rate	Injury	Yield	Injury	Yield
		lb/A	%	bu/A	%	bu/A
Flufenacet-metribuzin	PES	0.42	16	125	20	152
Flufenacet-metribuzin	PES	0.84	38	116	40	140
Tralkoxydim	POE	0.24	5	122	0	160
Tralkoxydim	POE	0.48	20	120	0	156
Sulfosulfuron	POE	0.031	0	125	0	158
Sulfosulfuron	POE	0.0625	1	126	0	158
Flucarbazone-sodium	POE	0.027	0	127	0	162
Flucarbazone-sodium	POE	0.054	1	123	0	159
Check		0	0	123	0	155

[a]Non-ionic surfactant added to postemergence treatments at 0.5% v/v.

Rye control with imazamox in herbicide-resistant wheat. Daniel A. Ball. (Oregon State University, Columbia Basin Ag. Research Center, Pendleton, OR 97801). A study was conducted in near Pendleton, Oregon to evaluate postemergence imazamox application timings for rye (*Secale cereale* L.) control, crop injury in an imidazolinone herbicide resistant wheat, and seed production of rye treated with imazamox. Clearfield™ winter wheat var. 'CV 9804' was seeded on 21 October, 1999 at 90 lb/A on 10-inch rows at 1 inch depth into moist soil with a Great Plains double-disk drill. Rye seeds were planted prior to winter wheat seeding with a drop spreader to insure uniformity of weed infestation. The resulting rye infestation was heavy and uniform throughout the plot area. Postemergence imazamox treatments at 0.048 lb ai/A were applied at various times (Table 1) with a hand-held CO_2 backpack sprayer in 15 gpa water at 30 psi. All imazamox treatments received 32% nitrogen solution at 1.25% (v/v) and methylated seed oil at 1.25% (v/v). Plots were 10 ft by 30 ft in size with 4 replications. The soil is a Walla Walla silt loam (28.8% sand, 61.6% silt, 9.6% clay, 5.4 pH, 2.0% organic matter, 12.4 Meq/100 g CEC). Ratings of visual crop injury were made on April 10 and 2 June, 2000. Wheat plant heights and spike counts were taken on June 26 and grain was harvested on July 26, 2000 with a HEGE 140 plot combine. Grain yields were converted to bu/A based on a 60 lb/bu test weight. Prior to grain harvest, 20 rye spikes were collected per plot, and weighed. Rye spikes were collected from each plot, hand threshed, and apparently viable seeds were counted.

Table 1. Application details.

Application	1	2	3	4	5	6	7
Date	23 Nov. 1999	17 Feb. 2000	13 Mar. 2000	20 Mar. 2000	17 Apr. 2000	24 Apr. 2000	1 May, 2000
Air temp. (°F)	47	57	59	52	70	58	62
Relative humidity (%)	60	40	58	61	64	40	70
Wind speed (mph)	SW @ 2	SW @ 2	SW @ 3	NW @ 4	E @ 3	NW @ 4	calm
Cloud cover (%)	100	10	65	90	0	5	0
Soil temp. at 2 in. (°F)	46	51	61	53	52	44	54
Wheat stage	2 lf	4.5 lf	6.1 lf	6.7 lf	7.5 lf	8.3 lf	8.5 lf
Feral rye stage	1.8 lf	4.4 lf	6.5 lf	6.5 lf	9.5 lf	9.8 lf	heading

Wheat injury was visible on 10 April for imazamox treatments that had been applied by that date. Wheat spike counts and grain yield were negatively affected by imazamox treatments applied after 17 April, even though no appreciable crop injury was visible when evaluated on 2 June (Table 2). Reduced spike count and wheat grain yields from late imazamox treatment were due to season-long interference from rye as well as possible negative effects on developing wheat florets. The last two imazamox application timings resulted in wheat yield lower than the untreated check. Similarly, late imazamox applications decreased rye spike weight and the number of apparently viable seed per spike. Control of rye from early postemergence treatments ranged from 89 to 97 percent. Rye control was diminished from imazamox treatments applied after 17 April. Rye control from earlier treatments improved wheat grain yield compared to the untreated check, and reduced rye seed production. Application of imazamox for suppression of rye should be timed early enough to prevent season-long weed interference, and crop injury, but late enough to reduce weed seed production.

Table 2. Rye control, crop injury, and wheat grain yield in imidazolinone resistant wheat.

Treatment [a]	Timing	Wheat injury 10 Apr	Wheat injury 2 June	Feral rye control 2 June	Wheat head count 26 June	Wheat plant height 26 June	Wheat grain yield 26 July	Rye seed production	Rye seed production
		%	%	%	#/m	cm	bu/A	gm/20 spikes	Seeds/20 spikes
Imazamox	23 Nov	4	1	91	95	107	89	10.0	474
Imazamox	17 Feb	10	1	89	97	109	90	8.7	435
Imazamox	13 Mar	15	3	88	86	110	80	5.8	340
Imazamox	20 Mar	13	5	93	89	107	74	7.3	410
Imazamox	17 Apr	-	1	90	59	112	35	2.5	200
Imazamox	24 Apr	-	1	60	46	113	28	0.0	0
Imazamox	1 May	-	0	36	50	115	13	0.03	1
Untreated	—	0	0	0	63	113	32	16.1	666
LSD (0.05)		7	ns	15	20	7	15	2.9	97

[a] 32% nitrogen solution at 1.25 % v/v and methylated seed oil at 1.25 % v/v added to all imazamox applications.

Evaluation of jointed goatgrass control in Clearfield™ winter wheat. Brent R. Beutler and John O. Evans. (Department of Plants, Soils, and Biometeorology, Utah State University, Logan, Utah 84322-4820). 'CV-9804' a Clearfield™ winter wheat cultivar was planted September 20, 1999 on the Wallace Beutler farm in North Logan, UT. Herbicide treatments including imazamox, 2,4-D, and imazamox tank mixed with different adjuvants were applied to evaluate jointed goatgrass control in Clearfield™ winter wheat. Treatments were applied to 10 by 30 foot plots with a CO_2 sprayer using flatfan 8002 nozzles providing a 10 foot spray width calibrated to deliver 19 gpa at 40 psi. The soil was a Millville silt loam with 7.9 pH and O.M. content of less than 2%. All treatments were applied postemergence on April 25, 2000 in a randomized block design, with four replications. One treatment consisted of a split application with 0.40 lb/A imazamox applied 25 April followed by 0.40 lb/A imazamox applied May 9. Wheat was in the 3-5 leaf stage at the first application and the 5-7 leaf stage at the second. Jointed goatgrass stages were 1-3 leaf and 3-5 leaf, respectively. Visual evaluations for wheat injury and jointed goatgrass injury were performed May 17, and June 29, 2000. Reproductive jointed goatgrass tillers were counted July 18, and plots were harvested August 2, 2000. Due to an erratic stand, extreme competition from jointed goatgrass seedlings, and lack of moisture, winter wheat yields were extremely low and uneven, and are therefore not reported here.

None of the treatments appeared to have any negative effect on winter wheat. All treatments that included imazamox severely reduced the jointed goatgrass population. The split application of imazamox and imazamox+methylated seed oil gave the highest jointed goatgrass injury ratings. However the number of reproductive tillers remaining in these treatments was not significantly lower than imazamox+crop oil concentrate or imazamox+organo-silicone surfactant.
(Utah Agricultural Experiment Station, Logan, UT. 84322-4820)

Table. Evaluation of jointed goatgrass control in Clearfield™ winter wheat.

			Wheat		AEGCY		
			Injury[c]		Injury[c]		Tillers
Treatment[a]	Rate	Timing	5/17	6/29	5/17	6/29	7/18
	lb /A						no/m^2
Untreated[b]			0	0	0	0	500+
2,4-D ester[b]	0.40	April 25	0	0	0	0	500+
2,4-D amine[b]	0.50	April 25	0	0	0	0.5	500+
Imazamox+	0.040+	April 25	0	0	7.3	7.5	13.0
2,4-D ester[b]	0.20						
Imazamox+	0.040+	April 25	0	0	6.5	6.9	9.8
2,4-D ester[b]	0.40						
Imazamox+	0.040+	April 25	0	0	7.0	6.6	40.0
2,4-D amine[b]	0.25						
Imazamox+	0.040+	April 25	0	0	6.5	6.4	39.3
2,4-D amine[b]	0.50						
Imazamox[b]	0.032	April 25	0	0	6.3	5.8	19.3
Imazamox[b]	0.040	April 25	0	0	7.3	6.3	19.0
Imazamox[b]	0.048	April 25	0	0	7.5	7.6	11.8
Imazamox+	0.040+	April 25+	0	0	7.3	9.1	0.0
imazamox[b]	0.040	May 9					
Imazamox+	0.040+	April 25	0	0	7.3	7.4	2.8
crop oil concentrate	1.25(%v/v)						
Imazamox+	0.040+	April 25	0	0	8.3	9.0	1.3
methylated seed oil	1.25(%v/v)						
Imazamox+	0.040+	April 25	0	0	7.3	7.5	8.3
organo-silicone	0.10(%v/v)						
$LSD_{(0.05)}$			0	0	0.7	0.7	8.5

[a] 28-0-0 at 1.25% v/v was added to all treatments.
[b] NIS at 0.25% v/v added.
[c] Injury scale is 0-10 with 0 being no injury and 10 indicating complete kill.

Enhancement of imazamox on Italian ryegrass with adjuvants. Bill D. Brewster, Carol A. Mallory-Smith, and Bradley D. Hanson. (Department of Crop and Soil Science, Oregon State University, Corvallis, OR 97331-3002) A trial was conducted at the Oregon State University Hyslop Research Farm to evaluate the effectiveness of certain adjuvants in increasing the control of Italian ryegrass with imazamox. The trial design was a randomized complete block with four replications and 8 ft by 25 ft plots. Herbicide treatments were applied with a single-wheel, compressed-air, plot sprayer which delivered 20 gpa at 19 psi through XR8003 flat fan nozzle tips. The soil was a Woodburn silt loam with a pH of 5.4 and an organic matter content of 2.0%

'Clearfield' soft red winter wheat was seeded at 125 lb/A on October 22, 1999; and the trial area was over-seeded with Italian ryegrass. Additional herbicide application data are presented in Table 1.

Flufenacet-metribuzin, diclofop-methyl, and AE F130060 plus AE F115008 plus AE F107892 provided slightly better ryegrass control than the best imazamox treatments (Table 2). The higher application rate and the addition of adjuvants improved the performance of imazamox. The addition of non-ionic surfactant, methylated seed oil, or organo-silicate surfactant with urea ammonium nitrate (UAN) was better than a crop oil concentrate with UAN. Ammonium sulfate increased the activity of imazamox slightly more than UAN, expecially when applied with a methylated seed oil.

Table 1. Herbicide application data.

	Preemergence	Postemergence
Application date	October 25, 1999	December 3, 1999
Air temperature (F)	48	43
Soil temperature (F)	50	45
Relative humidity (%)	61	85
Wind (mph)	2	2-3
Wheat stage of growth	preemergence	3-4 leaf, 0-1 tiller
Italian ryegrass stage of growth	preemergence	3-4 leaf, 0-1 tiller

Table 2. Italian ryegrass control and wheat injury and yield.

Herbicide	Rate	Adjuvant[a]	Timing[b]	Italian ryegrass control	Wheat Injury[d]	Wheat Yield[e]
	lb/A			%	%	bu/A
Flufenacet-metribuzin	0.42		PES	98	6	83
Diclofop-methyl	1.0		POE	98	0	82
AE F130060 +	0.0112 +		POE	98	3	78
AE F115008 +	0.0022 +					
AE F107892	0.0134					
Imazamox	0.032		POE	76	0	63
	0.032	UAN + MSO	POE	84	20	74
	0.04	UAN + MSO	POE	90	26	73
	0.032	UAN + NIS	POE	86	13	76
	0.04	UAN + NIS	POE	91	21	71
	0.032	UAN + COC	POE	75	15	68
	0.04	UAN + COC	POE	81	18	72
	0.032	UAN + OSS	POE	86	11	75
	0.04	UAN + OSS	POE	91	15	69
	0.032	AMS + NIS	POE	89	18	71
	0.04	AMS + NIS	POE	91	24	78
	0.032	AMS + MSO	POE	93	30	72
	0.04	AMS + MSO	POE	94	34	82
Check	0			0	0	48
					$LSD_{0.05}$	20

[a]UAN = urea ammonium nitrate 32% applied at 1.25% v/v.
MS0 = methylated seed oil applied at 1.25% v/v.
NIS = non-ionic surfactant applied at 0.5% v/v.
COC = crop oil concentrate applied at 1.25% v/v.
OSS = organo-silicate surfactant applied at 0.25% v/v.
AMS = ammonium sulfate (9.6 lb/gal) applied at 1 qt/A.
[b]PES = preemergence surface, POE - postemergence.
[c]Evaluated May 24, 2000.
[d]Evaluated February 24, 2000.
[e]Harvested July 24, 2000.

Italian ryegrass and wild oat control in winter wheat in western Oregon. Bill D. Brewster, Carol A. Mallory-Smith, and Bradley D. Hanson. (Department of Crop and Soil Science, Oregon State University, Corvallis, OR 97331-3002) Field trials were conducted on seven farms in the Willamette Valley of Oregon to evaluate herbicide treatments for the control of Italian ryegrass and wild oats. The Haugerud site was infested with volunteer oats rather than wild oats. The experimental design was a randomized complete block with four replications and 8 ft by 25 ft plots. Herbicide treatments were applied with a single-wheel, compressed-air, plot sprayer which delivered 20 gpa at 19 psi through XR8003 flat fan nozzle tips. A non-ionic surfactant was added to the early postemergence treatments at 0.25% v/v, and a proprietary adjuvant was added to the tralkoxydim treatment at 0.5% v/v. Application data are presented in Table 1. Grain yield was obtained by harvesting with a small-plot combine. Results of visual evaluations conducted in June 2000 are presented in Tables 2 and 3.

Flufenacet-metribuzin followed by chlorsulfuron-metsulfuron plus metribuzin provided good to excellent control of Italian ryegrass, but failed to control volunteer oats or wild oats. Chlorsulfuron-metsulfuron plus metribuzin followed by tralkoxydim was less effective on ryegrass and more effective on wild oats than the flufenacet treatment. The postemergence application of AE F130060 plus AE F115008 plus AE F107892 was less consistent but sometimes better than the flufenacet treatment and provided excellent wild oat control. With the exception of the Loop site, all treatments increased wheat grain yield compared to the check (Table 4).

Table 1. Herbicide application data.

	Location						
	Haugerud	Loop	Morris	Millhauser	Moritz	DeJong	McKee
PES application date	10/25/99	11/8/99	11/22/99	11/10/99	11/3/99	10/25/99	11/3/99
EPOE application date	11/17/99	12/20/99	1/5/00	11/29/99	12/3/99	12/3/99	11/29/99
EPOE wheat growth stage	2 leaf	2-3 leaf	2-3 leaf	3 leaf	2-3 leaf	3 leaf	2 leaf
EPOE ryegrass growth stage	2 leaf	2-3 leaf	1-2 leaf	1-3 leaf	1-2 leaf	1-2 leaf	2 leaf
EPOE wild oat growth stage	2 leaf	2-3 leaf	—	1-3 leaf	1-2 leaf	—	—
POE Application date	12/21/99	1/5/00	1/25/00	12/20/99	12/10/99	12/20/99	12/20/99
POE wheat growth stage	4 leaf	3 leaf	3 leaf	4 leaf	3-4 leaf	4 leaf	3 leaf
POE ryegrass growth stage	4 leaf	3-4 leaf	2-4 leaf	3-5 leaf	2-3 leaf	4 leaf	3 leaf
POE wild oat growth stage	4 leaf	3-4 leaf	2-4 leaf	3-5 leaf	2-3 leaf	—	—

Table 2. Visual evaluations of Italian ryegrass control in winter wheat at seven locations in Western Oregon.

			Italian ryegrass control						
			Location						
Treatment[a]	Timing	Rate	Haugerud	Loop	Morris	Millhauser	Moritz	DeJong	McKee
Flufenacet-met/	PES/	0.42/	95	91	100	84	99	80	99
chlr-mets + metribuzin	EPOE	0.023 + 0.14							
Chlor-mets + metribuzin/	EPOE/	0.023 + 0.14/	93	38	97	70	38	63	89
tralkoxydim	POE	0.24							
AE F130060 +	POE	0.0135 +	97	0	85	95	89	84	85
AE F115008 +		0.0022 +							
AE F107892		0.0134							
Check		0	0	0	0	0	0	0	0

[a]Flufenacet-met is a commercial formulation of flufenacet and metribuzin. Chlr-mets is a commercial formulation of chlorsulfuron and metsulfuron.

Table 3. Visual evaluations of wild oat control in winter wheat at four locations in western Oregon.

			Location			
Treatment[a]	Timing	Rate	Haugerud[b]	Moritz	Millhauser	Loop
		lb/A	%			
Flufenacet-met/	PES/	0.42/	50	25	0	20
chlr-mets +	EPOE	0.023 + 0.14				
metribuzin						
Chlor-mets +	EPOE/	0.023 + 0.14/	100	99	100	88
metribuzin/	POE	0.24				
tralkoxydim						
AE F13006 +	POE	0.0135 +	100	99	95	99
AE F115008 +		0.0022 +				
AE F107892		0.0134				
Check		0	0	0	0	0

[a]Flufenacet-met is a commercial formulation of flufenacet and metribuzin. Chlr-mets is a commercial formulation of chlorsulfuron and metsulfuron.

[b]Volunteer oats

Table 4. Wheat grain yield following herbicide treatments at seven sites in western Oregon.

Treatment[a]	Timing	Rate	Wheat grain yield Location Haugerud	Loop	Morris	Millhauser	Moritz	DeJong	McKee
		lb/A	bu/A						
Flufenacet-met/ chlr-mets + metribuzin	PES/ EPOE	0.42/ 0.023 + 0.14	52	30	110	51	92	40	47
Chlor-mets + metribuzin/ tralkoxydim	EPOE/ POE	0.023 + 0.14/ 0.24	60	13	110	39	79	33	46
AE F13006 + AE F115008 + AE F107892	POE	0.0135 + 0.0022 + 0.0134	54	1	98	74	95	66	34
Check		0	37	2	48	1	51	0	4
		$LSD_{0.05}$	9	8	17	12	13	22	11

[a]Flufenacet-met is a commercial formulation of flufenacet and metribuzin. Chlr-mets is a commercial formulation of chlorsulfuron and metsulfuron.

Control of downy brome in winter wheat. Alvin J. Bussan, Susan B. Kelly. (Department of Land Resources and Environmental Sciences, Montana State University, Bozeman, MT 59717). Downy brome is a weed of concern in winter wheat crops in Montana. Until recently downy brome has been managed with crop rotation. The discovery and marketing of sulfosulfuron and MKH 6561 will allow for more consistant selective control of downy brome with less injury to winter wheat. Previous research has shown fall post applications of sulfosulfuron resulted in better downy brome control than applications made in the spring. However, selective herbicides for control of downy brome in winter wheat would fit the system better if applied in the spring in Montana, because the producer could better assess the potential productivity of the crop based on winter kill, moisture availability, etc and determine if the expenditure for herbicide application is warranted. Previous research at MSU has suggested potential synergy between metribuzin and sulfosulfuron or MKH 6561. This research attempted to quantify that synergy, and determine if spring applications of sulfosulfuron and MKH 6561 combined, were as effective as fall applications of either product alone.

Herbicide treatments were applied with a hand-held CO_2 backpack sprayer with 10 GPA water at 40 psi at 3mph. Site description information is summarized in Table 1. Application timings and climatic conditions at time of application are summarized in Table 2.

Table 1. Site description

Crop	Winter Wheat
Planting Date	September 1999
Planting Rate	60 lb\acre
Row spacing	10 inches
Previous Crop	Fallow
Soil Type	Silt loam
Plot Size	7' by 25'

Table 2. Application data and climatic conditions

Application Date	October 26, 1999	April 17, 2000
Application Timing	Fall Post-emergence	Spring Post-emergence
Time of Day	AM	AM
Air Temperature	60 F	52 F
Relative Humidity (%)	30	35
Wind Velocity	0-6 mph	0-5 mph
Soil Temperature	60	63
Cloud Cover (%)	10	60
Crop Stage at Application	2-3 leaves	tillering

Sulfosulfuron and MKH 6561 were post applied alone or in combination with metribuzin fall and spring. Crop injury and stunting were evaluated visually in the spring, and downy brome control ratings were taken during the summer. A 5' by 25' area was harvested with a plot combine to establish yield. All plots including the weedy check showed slight injury due to a Russian wheat aphid infestation (evident from low yields). Subsequently, plots were sprayed with chlorpyrifos at a rate of 1 pint per acre for aphid management. Injury and control ratings are shown in Table 3.

MKH 6561 and sulfosulfuron only provided moderate control when applied in the fall. Downy brome showed a rate response to metribuzin alone, with only 60% control provided at the highest rate when applied in the fall, and 40% control shown in the spring. Sequential MKH 6561 applications provided the best control seen at the study site. Spring application of MKH 6561 in combination with a fall application of sulfosulfuron was also moderately effective. It appears metribuzin may have antagonized sulfosulfuron or MKH 6561when tank mixed. Significant crop injury was seen with fall application of sulfosulfuron and metribuzin and spring application of MKH 6561 and sulfosulfuron, however this did not correspond with herbicide rate. Injury and corresponding yield loss of winter wheat treated with metribuzin was not as high as previous studies have shown. Overall yields were low because of Russian wheat aphid activity and drought stress to the crop. Drought stress and lack of any fall precipitation likely contributed to poor herbicide performance. Both MKH 6561 and sulfosulfuron activity is enhanced by root uptake, but paucity of fall precipitation resulted in lack of soil activity of both products.

Table 3. Effects of herbicide application on downy brome control near Three Forks Montana, 2000

			Downy Brome		Winter Wheat				
			Control		Phyto		Stunt		Yield
Treatment*	Rate	Timing	28-Apr	08-May	28-Apr	08-May	03-Aug	25-May	29-Jun
	(lb\a)		%						bushel/a
MKH 6561	0.027	F Post	56.3	53.8	0.0	0.0	0.0	0	11
MKH 6561	0.04	F Post	47.5	67.5	3.0	1.3	1.3	0	11
Sulfosulfuron	0.024	F Post	68.8	57.5	3.0	0.5	0.5	0	12
Sulfosulfuron	0.031	F Post	36.3	68.8	3.0	2.5	1.3	0	12
MKH 6561+ MKH 6561	0.027 + 0.027	F Post + S Post	86.3	80.0	3.0	3.0	4.5	0	8
Sulfosulfuron+ MKH 6561	0.031 + 0.027	F Post + S Post	92.5	72.5	3.0	0.8	1.8	0	14
MKH 6561+ Metribuzin	0.027 + 0.047	F Post	57.5	60.0	3.0	1.3	1.3	0	10
MKH 6561+ Metribuzin	0.027 + 0.094	F Post	61.3	62.5	3.0	1.3	1.3	0	11
MKH 6561+ Metribuzin	0.027 + 0.188	F Post	67.3	63.8	3.0	7.5	7.5	0	13
Sulfosulfuron+ Metribuzin	0.024 + 0.047	F Post	47.5	56.3	0.0	47.5	0.5	0	13.0
Sulfosulfuron+ Metribuzin	0.024 + 0.094	F Post	63.8	68.8	3.0	2.0	2.0	0	9
Sulfosulfuron+ Metribuzin	0.024 + 0.188	F Post	31.3	45.0	3.5	3.8	3.8	0	10
Metribuzin	0.047	F Post	22.5	0.0	3.0	0.5	0.5	0	12
Metribuzin	0.094	F Post	50.0	42.5	3.0	3.0	3.0	0	10
Metribuzin	0.188	F Post	43.8	60.0	3.0	3.8	4.3	0	10
MKH 6561+ Metribuzin	0.027 + 0.047	S Post	63.8	66.3	3.0	1.3	1.3	0	9
MKH 6561+ Metribuzin	0.027 + 0.094	S Post	51.5	57.5	0.0	51.3	0.0	0	12
MKH 6561+ Metribuzin	0.027 + 0.188	S Post	47.5	53.8	3.0	0.0	0.0	0	11
Sulfosulfuron+ Metribuzin	0.024 + 0.047	S Post	60.0	62.5	3.0	2.0	2.5	0	9
Sulfosulfuron+ Metribuzin	0.024 + 0.094	S Post	20.0	42.5	3.0	0.0	0.5	0	9
Sulfosulfuron+ Metribuzin	0.024 + 0.188	S Post	35.0	37.5	3.0	1.3	2.3	0	13
Metribuzin	0.047	S Post	32.5	35.0	3.0	1.3	1.3	0	12
Metribuzin	0.094	S Post	20.0	21.3	3.0	2.5	2.5	0	9
Metribuzin	0.188	S Post	40.0	38.8	3.0	0.5	0.5	0	9
Weedy Check			0.0	0.0	3.0	0.0	0.0	0	9
LSD (P=.05)			40.54	37.64	0.28	5.29	5.54	0.00	5.3

* NIS added at 0.25% v/v for all treatments

Control of feral rye in Clearfield winter wheat with imazamox. Alvin J. Bussan and Susan B. Kelly. (Department of Land Resources and Environmental Sciences, Montana State University, Bozeman, MT 59717). A field trial was conducted near Three Forks, Montana to evaluate application timing of imazamox for the control of feral rye in imazamox tolerant winter wheat. Clearfield winter wheat was seeded October 10th, 1999 into ten-inch rows at 60-lbs/ acre on a previously fallowed field. Three rates of imazamox were applied at six different timings that coincided with different growing stages of wheat. Application timing and climatic information are shown in Table 1. Applications F and G were applied at the same time due to the rapid advance of plant phenology during the growing season. Crop injury and feral rye control data is shown in Table 2.

Table 1. Application and timing data

Application	Date	Crop Stage	Feral Rye	Air Temp	Wind MPH
A	11/13/99	1 leaf	1.5-2.5 leaves	50	0
B	4/19/00	4 leaf	3 leaf, tillering	64	5-10
C	5/8/00	6 leaves, 1 tiller	3-5 tillers	70	5-10
D	5/19/00	Tillering	close to boot stage	75	0-8
E	6/5/00	Tillering	Heading	85	0-5
F	6/21/00	Heading	Anthesis	80	0
G	6/21/00	Heading	Anthesis	80	0

Table 2. Crop tolerance and feral rye control in Clearfield winter wheat.

			Winter Wheat					Feral Rye
			Phyto		Stunt	Height	Yield	Control
Treatment*	Rate	Timing	1 WAT	2 WAT	2 WAT	07/21/00	08/07/00	4 WAT
	(Oz A/A)			%		inches	bushel/a	%
Imazamox	0.325	A	0	0	0	25.8	32	91.3
Imazamox	0.64	A	0	0	0	26.3	33	88.8
Imazamox	0.76	A	0	0	0	26	32	96.3
Imazamox	0.325	B	0	0	0	25.7	33	91.7
Imazamox	0.64	B	0	0	0	24.3	33	75
Imazamox	0.76	B	0	0	0	27.3	34	88.8
Imazamox	0.325	C	0	0	0	24.7	33	97.5
Imazamox	0.64	C	0	0	0	26.7	35	95.8
Imazamox	0.76	C	0	0	1.3	25.3	31	97.5
Imazamox	0.325	D	1.3	1.3	2.5	26.3	27	92.5
Imazamox	0.64	D	0	0	0	26.7	34	75
Imazamox	0.76	D	1.3	2.5	0	26.7	33	100
Imazamox	0.64	E	2.5	1.3	0	27.3	17	0
Imazamox	0.76	E	1.3	0	1.3	25.3	17	0
Imazamox	0.64	F	0	0	0	26	28	0
Imazamox	0.76	F	1.3	1.3	0	26	28	0
Imazamox	0.64	G	0	0	0	26.8	25	0
Imazamox	0.76	G	0	0	0	25	25	0
Weedy Check			0	0	0	25.5	27	0
Weedy Check			0	0	0	26.8	28	0
LSD (P=.05)			1.83	1.64	1.43	2.31	7.0	21.95

*All treatments applied with 28-0-0 nitrogen fertilizer and mentholated seed oil at 1.25 v/v%

Winter kill decreased the crop stand by 10% at the field site (results not shown). No crop injury was observed in the fall applied treatments (timing A). Excellent to good feral rye control was achieved in all treatments through timing D if imazamox was applied by the boot stage. Similar control was achieved regardless of imazamox rate, indicating that the timing of imazamox application was more important for feral rye control. Zero control was achieved in all treatments applied after the feral rye began to head. Winter wheat yields decreased slightly when imazamox was applied after crop began tillering (timing D). Seeds were collected from feral rye plants that received imazamox during anthesis (timings F and G). Non-replicated greenhouse tests revealed that seed germination was delayed 6 to 10 days for feral rye seeds treated with imazamox when compared to seed from non-treated plants. Viability did not appear to be impacted as similar proportions of seed germinated from each lot.

Adjuvants affect broadleaf weed control in winter wheat. Joan Campbell and Donn Thill. (Department of Plant, Soil, and Entomological Sciences, University of Idaho, Moscow, ID 83844-2339) Several adjuvant-herbicide combinations were evaluated for broadleaf weed control in winter wheat. One experiment was near Fairfield, Washington and a second experiment was near Potlatch, Idaho. The experimental design was a randomized complete block with four replications for both experiments. Treatments were applied with a CO_2 pressurized backpack sprayer calibrated to deliver 10 gal/A at 32 psi. The experiment at Potlatch was treated with fenoxaprop at 0.083 lb/A for wild oat control on May 21, 2000. Broadleaf weed control was evaluated visually. Wheat grain was harvested at maturity with a small plot combine.

Table 1. Application data.

Experiment site	Fairfield, Washington	Potlatch, Idaho
Wheat growth stage	5 to 6 tiller	3 to 4 tiller
Weed growth stage	1 to 4 in. diameter	2 to 4 in. diameter
Air temperature (F)	62	62
Relative humidity (%)	58	58
Wind (mph)	2 to 3	0
Soil temperature at 2 in. (F)	50	50
Soil pH	5.2	4.9
Soil organic matter (%)	2.2	2.8
CEC (c mol/kg)	16	13
Soil texture	silt loam	silt loam

In the experiment near Fairfield, prickly lettuce (LACSE) and volunteer lentil (LENCU) control with thifensulfuron/tribenuron were not affected by adjuvant (Table 2). Mayweed chamomile (ANTCO) control was better with Hasten and R-11 (86 and 88% control, respectively) than with Silwet L-77 (80%) added to thifensulfuron/tribenuron. Mayweed chamomile control was better with Moract (88%) than Silwet L-77 (80%) added to thifensulfuron, and volunteer lentil control was better with Quad 7 (95%) than Moract (90%) added to thifensulfuron. Prickly lettuce control with thifensulfuron was not affected by adjuvant. Prickly lettuce control was better with R-11 (91%) than Silwet L-77 (85%) added to tribenuron, and mayweed chamomile control was better with Quad-7 (89%) than Hasten (83%) when added to tribenuron. Volunteer lentil control with tribenuron was not affected by adjuvant. Wheat grain yield was similar among all treatments.

In the experiment near Potlatch, Idaho, mayweed chamomile control was 100% in all treatments (Table 3). Wheat grain yield was lowest in the untreated control, but was not statistically lower than yield with thifensulfuron/ tribenuron + metsulfuron + fluroxypyr/2,4-D applied alone or with LI-130H. Wheat yield was highest with thifensulfuron/ tribenuron + metsulfuron + fluroxypyr/2,4-D applied with LI-130A, LI-130B, LI-130C, LI-130D, LI-130E, and LI-130F. Test weight was greater than the untreated check with all herbicide treatments.

Table 2. Broadleaf weed control and wheat grain yield affected by several adjuvants combined with thifensulfuron, thifensulfuron/tribenuron, and tribenuron at Fairfield, Washington.

Treatment[a]	Rate	Weed control			Wheat
		LACSE	ANTCO	LENCU	grain yield
	lb/A	---------- % of untreated control ----------			bu/A
Thifen/tribenuron + Silwet L-77	0.0141 + 0.125% v/v	80	80	94	81
Thifen/tribenuron + R-11	0.0141 + 0.25% v/v	81	88	91	86
Thifen/tribenuron + Quad 7	0.0141 + 1% v/v	85	85	91	83
Thifen/tribenuron + Hasten	0.0141 + 2.5% v/v	85	86	93	87
Thifen/tribenuron + Sun-It II	0.0141 + 1% v/v	83	83	90	80
Thifen/tribenuron + Moract	0.0141 + 1% v/v	83	85	91	83
Thifensulfuron + Silwet L-77	0.0234 + 0.125% v/v	84	80	93	80
Thifensulfuron + R-11	0.0234 + 0.25% v/v	83	85	92	83
Thifensulfuron + Quad 7	0.0234 + 1% v/v	83	84	95	78
Thifensulfuron + Hasten	0.0234 + 2.5% v/v	88	85	91	77
Thifensulfuron + Sun-It II	0.0234 + 1% v/v	86	85	93	76
Thifensulfuron + Moract	0.0234 + 1% v/v	88	88	90	75
Tribenuron + Silwet L-77	0.0078 + 0.125% v/v	85	85	93	78
Tribenuron + R-11	0.0078 + 0.25% v/v	91	85	94	72
Tribenuron + Quad 7	0.0078 + 1% v/v	88	89	93	75
Tribenuron + Hasten	0.0078 + 2.5% v/v	90	83	92	81
Tribenuron + Sun-It II	0.0078 + 1% v/v	90	86	96	83
Tribenuron + Moract	0.0078 + 1% v/v	90	86	93	83
Untreated control		--	--	--	78
LSD(0.05)		5	5	4	NS
Plant density (plants/ft^2)		5.4	5.8	2.4	--

[a] Thifen/tribenuron is the commercial formulation of thifensulfuron + tribenuron. Hasten is an ethylated seed oil plus surfactants, Moract is 85% crop oil concentrate, Quad 7 is 100% nonionic surfactant, R-11 is a 90% nonionic surfactant, Silwet L-77 is a 100% silicone-polyethercopolymer, and Sun-it II is a methylated seed oil plus surfactants.

Table 3. Mayweed chamomile control and winter wheat yield affected by several adjuvants combined with thifensulfuron/tribenuron, metsulfuron, and fluroxypyr/2,4-D at Potlatch, Idaho.

Treatment	Rate	Mayweed chamomile control	Wheat grain yield	Test weight
	lb/A	%	lb/A	lb/bu
Thifensulfuron/tribenuron + metsulfuron + fluroxypyr/2,4-D + LI-130A	0.019 + 0.006 + 1 0.25% v/v	100	4573	61.5
Thifensulfuron/tribenuron + metsulfuron + fluroxypyr/2,4-D + LI-130B	0.019 + 0.006 + 1 0.25% v/v	100	4327	61.2
Thifensulfuron/tribenuron + metsulfuron + fluroxypyr/2,4-D + LI-130C	0.019 + 0.006 + 1 0.25% v/v	100	4489	61.2
Thifensulfuron/tribenuron + metsulfuron + fluroxypyr/2,4-D + LI-130D	0.019 + 0.006 + 1 0.25% v/v	100	4072	61.6
Thifensulfuron/tribenuron + metsulfuron + fluroxypyr/2,4-D + LI-130E	0.019 + 0.006 + 1 0.25% v/v	100	4097	61.5
Thifensulfuron/tribenuron + metsulfuron + fluroxypyr/2,4-D + LI-130F	0.019 + 0.006 + 1 0.25% v/v	100	4149	61.4
Thifensulfuron/tribenuron + metsulfuron + fluroxypyr/2,4-D + LI-130G	0.019 + 0.006 + 1 0.25% v/v	100	3969	61.2
Thifensulfuron/tribenuron + metsulfuron + fluroxypyr/2,4-D + LI-130H	0.019 + 0.006 + 1 0.25% v/v	100	3939	61.0
Thifensulfuron/tribenuron + metsulfuron + fluroxypyr/2,4-D	0.019 + 0.006 + 1	100	3884	60.9
Untreated control	--	--	3495	59.8
LSD (0.05)			459	1
Plant density (plants/ft^2)		5 to 7	--	--

Interrupted windgrass control in winter wheat with postemergence herbicides. Joan Campbell and Donn Thill. (Department of Plant, Soil, and Entomological Sciences, University of Idaho, Moscow, ID 83844-2339) Several postemergence herbicides were evaluated for interrupted windgrass (APEIN) control in winter wheat east of Moscow, Idaho. Treatments were applied on April 12, 2000 with a CO_2 pressurized backpack sprayer calibrated to deliver 10 gal/A at 32 psi. Air and soil temperatures, wind, and relative humidity were 70 and 55 F, calm, and 58%, respectively. Soil type was a silt loam with 2.34% organic matter, 17 cmol/kg CEC, and 4.8 pH. Interrupted windgrass was in the 3 leaf stage and density was 7 to 12 plants/ft^2. The experiment was treated with bromoxynil at 0.25 lb/A + thifensulfuron/tribenuron at 0.014 lb/A + nonionic surfactant at 0.25% v/v on April 21 for broadleaf weed control. Interrupted windgrass control was evaluated on June 29. Wheat grain was harvested at maturity with a small plot combine.

Interrupted windgrass control was 100% with MKH6562 (Table). MKH6561 and sulfosulfuron controlled interrupted windgrass 94 and 93%, respectively. Wheat grain yield and test weights were not different among treatments.

Table. Interrupted windgrass control and winter wheat yield.

Treatment	Rate	APEIN control	Wheat grain yield	Test weight
	lb/A	%	lb/A	lb/bu
Untreated	0	0	3930	60
MKH6562[a]	0.04	100	4534	60
MKH6561[a]	0.04	93	4740	60
Sulfosulfuron[a]	0.031	94	4316	60
Imazamethabenz[a]	0.47	54	4242	60
Imazamethabenz +	0.47	73	4110	59
thifensulfuron[a]	0.0234			
Fenoxyprop/safener	0.083	63	4287	60
Clodinafop[b]	0.05	48	4050	60
Tralkoxydim[c]	0.24	23	4125	60
Metribuzin	0.25	73	4492	60
LSD (0.05)		22	NS	NS

[a] Applied with nonionic surfactant (R-11) at 0.25% v/v
[b] Applied with crop oil concentrate (Score) at 0.8% v/v
[c] Applied with crop oil concentrate/nonionic surfactant (Supercharge) at 0.5% v/v

Prickly lettuce and mustard control with sulfosulfuron in winter wheat. Joan Campbell and Donn Thill. (Department of Plant, Soil, and Entomological Sciences, University of Idaho, Moscow, ID 83844-2339) Sulfosulfuron alone and combined with other broadleaf herbicides were evaluated for broadleaf weed control in winter wheat southeast of Lewiston, Idaho. Treatments were applied on March 27, 2000 with a CO_2 pressurized backpack sprayer calibrated to deliver 10 gal/A at 32 psi. Air and soil temperatures, wind, and relative humidity were 56 and 55 F, NW at 3 mph, and 58%, respectively. Weeds present and plant growth stage at application are in the table. Wheat grain was harvested at maturity with a small plot combine.

Volunteer mustard control was good to excellent (>80%) with most treatment combinations, but sulfosulfuron alone and combined with dicamba controlled volunteer mustard 76 and 78%, respectively (Table). Prickly lettuce control was best (75%) with metribuzin + fluroxypyr + 2,4-D and poor with most sulfosulfuron combinations. Prickly lettuce control with sulfosulfuron alone and with thifensulfuron/tribenuron was zero. Lack of control is attributed to ALS (acetolactate synthase) resistant prickly lettuce which has been documented on this farm. Tansy mustard control ranged from 71 to 95%. Wheat grain yield was highest with sulfosulfuron in combination with bromoxynil (4778 lb/A) and bromoxynil/MCPA (4862 lb/A), and was lowest from the untreated check (3191 lb/A).

Table. Weed control and winter wheat yield.

Treatment[a]	Rate	Prickly lettuce	Volunteer mustard	Tansy mustard	Wheat yield
	lb/A	%	%	%	lb/A
Untreated	0	--	--	--	2766
Sulfosulfuron	0.031	0	76	71	3202
Sulfosulfuron +	0.031	61	100	75	3364
2,4-D ester	0.375				
Sulfosulfuron +	0.031	15	100	74	4141
bromoxynil	0.25				
Sulfosulfuron +	0.031	46	100	75	3950
MCPA ester	0.5				
Sulfosulfuron +	0.031	13	89	75	3871
fluroxypyr	0.125				
Sulfosulfuron +	0.031	0	81	73	3422
thifensulfuron/tribenuron	0.0141				
Sulfosulfuron +	0.031	13	98	71	3945
prosulfuron	0.0135				
Sulfosulfuron +	0.031	50	96	75	3716
triasulfuron/dicamba	0.159				
Sulfosulfuron +	0.031	50	94	95	3858
metribuzin	0.188				
Sulfosulfuron +	0.031	38	95	71	4214
bromoxynil/MCPA	0.5				
Sulfosulfuron +	0.031	18	78	75	3131
dicamba	0.125				
Metribuzin +	0.188	75	100	75	3971
fluroxypyr +	0.125				
2,4-D ester	0.375				
Growth stage at application		cotyledon -3 lf	1-3 in. diam.	1-3 in. diam.	5 tiller
Weed density (plants/ft^2)		1	5	2	
LSD (0.05)		47	11	NS	594

[a]All sulfosulfuron treatments were applied with nonionic surfactant at 0.5% v/v.

Wild oat and field brome control in wheat. Joan Campbell and Donn Thill. (Department of Plant, Soil, and Entomological Sciences, University of Idaho, Moscow, ID 83844-2339) Five graminicides were applied at three growth stages to evaluate wild oat and field brome control in winter wheat north of Potlatch, Idaho. Treatments were applied in May 2000 with a CO_2 pressurized backpack sprayer calibrated to deliver 10 gal/A at 32 psi (Table 1). Soil type was a silt loam with 4.9 pH, 3.25% organic matter, and 14 cmol/kg CEC. Thifensulfuron/tribenuron + nonionic surfactant at 0.014 lb/A + 0.25% v/v was applied on May 7 to control broadleaf weeds. Wheat grain was harvested at maturity with a small plot combine from a 4.5 by 27 ft area in each plot.

Table 1. Application data.

Application date	May 1	May 12	May 21
Growth stage			
wheat	1 to 2 leaf	3 to 4 leaf	5 leaf
wild oat	1 to 2 leaf	3 to 4 leaf	5 leaf
field brome	2 leaf	3 leaf	5 leaf
Air temperature (F)	62	62	60
Soil temperature (F)	62	62	60
Relative humidity (%)	50	55	58
Wind velocity (mph) and direction	0	0	3 SW
Cloud cover (%)	30	50	100

Clodinafop applied at any growth stage between 1 and 5 leaves, and fenoxaprop/safener applied at the 5 leaf stage controlled wild oat 100% (Table 2). Fenoxaprop/safener and tralkoxydim applied at the 3 to 4 leaf stage and flucarbazone-sodium applied at the 1 to 2 or 3 to 4 leaf growth stages controlled wild oat over 90%. Wild oat control with imazamethabenz was inadequate at all growth stages. Flucarbazone-sodium applied at any growth stage between 1 and 5 leaves controlled field brome 100%. Field brome was not controlled with any other treatment. Wheat grain yield was higher than the untreated check with all treatments except fenoxaprop/safener and imazamethabenz applied at the 5 leaf stage. Wheat test weight was higher than the untreated check with fenoxaprop/safener and tralkoxydim applied at the 3 to 4 leaf stage and clodinafop applied at both the 3 to 4 and 5 leaf stages of growth.

Table 2. Weed control and wheat yield.

Treatment	Wild oat growth stage at time of application	Rate	Wild oat control	Field brome control	Wheat yield	Wheat test weight
	leaf number	lb/A	%	%	lb/A	lb/bu
Untreated	--	0	--	--	2578	58.9
Clodinafop[a]	1 to 2	0.05	100	0	4061	60.3
Clodinafop[a]	3 to 4	0.05	100	5	3622	60.9
Clodinafop[a]	5	0.05	100	8	3532	61.0
Fenoxaprop/safener	1 to 2	0.083	79	5	3847	60.4
Fenoxaprop/safener	3 to 4	0.083	95	8	3673	61.0
Fenoxaprop/safener	5	0.083	100	8	3133	60.5
Tralkoxydim[b]	1 to 2	0.179	83	0	3760	60.1
Tralkoxydim[b]	3 to 4	0.179	91	5	3621	61.0
Tralkoxydim[b]	5	0.179	81	8	3466	59.0
Imazamethabenz[c]	1 to 2	0.41	63	0	3535	58.5
Imazamethabenz[c]	3 to 4	0.41	76	5	3575	59.4
Imazamethabenz[c]	5	0.41	53	5	3114	59.0
Flucarbazone-sodium [c]	1 to 2	0.027	95	100	3899	60.3
Flucarbazone-sodium [c]	3 to 4	0.027	93	100	3825	59.8
Flucarbazone-sodium [c]	5	0.027	89	100	3620	58.9
LSD(0.05)			12	9	699	1.6
Density (plants/ft^2)			11	2		

[a] Applied with crop oil concentrate (Score) at 0.64 pt/a.
[b] Applied with crop oil concentrate/nonionic surfactant (Supercharge) at 0.5% v/v and ammonium sulfate at 17 lb/100 gal.
[c] Applied with nonionic surfactant (R-11) at 0.25% v/v.

Evaluation of wild oat control in winter wheat. John O. Evans, Paul Haderlie, and R. William Mace. (Department of Plants, Soils, and Biometeorology, Utah State University, Logan, Utah 84322-4820). 'Madsen' winter wheat was planted September 27, 1999 on the Clair Allen farm near Cove, Utah. Herbicide treatments including tralkoxydim, clodinofop, fenoxaprop and thifensulfuron were applied to evaluate the effectiveness of controlling wild oats (AVEFA) in winter wheat. Individual treatments were applied to 7 by 20 foot plots with an CO_2 sprayer using flatfan 8002 nozzles providing a 7 foot spray width calibrated to deliver 26 gpa at 40 psi. The soil was a Steed gravelly loam with 7.6 pH and O.M. content of less than 3%. Treatments were applied postemergence in the spring (5-12-00), in a randomized block design, with three replications. Wheat ranged in size from 5 - 8 inches tall. Wild oats were 2 to 4 inches tall with 2-3 leaves. Visual evaluations for crop injury and weed control were completed June 8, and July 5, 2000. Plots were harvested August 10, 2000.

Yields were not significantly different among the treatments. All treatments provided satisfactory wild oat control and there were no indications of wheat injury. (Utah Agricultural Experiment Station, Logan, UT. 84322-4820)

Table. Evaluation of wild oat control in wheat.

Treatment		Wheat			Weed control	
		Injury		Yield	AVEFA	
	Rate	6/8	7/5	8/10	6/8	7/5
	lb /A	—%—		Bu/A	—%—	
Untreated		0	0	22	0	0
Tralkoxydim [a]	0.18	0	0	30.7	77	98
Tralkoxydim [a]	0.24	0	0	28.4	80	99
Clodinofop [b]	0.05	0	0	25.4	87	99
Clodinofop [b]	0.064	0	0	26.2	83	100
MKH 6562+	0.027+	0	0	29.2	70	88
2,4-D amine [c]	0.5					
MKH 6561+	0.04+	0	0	26.8	73	87
2,4-D amine [c]	0.5					
Fenoxaprop+	0.075+	0	0	28.0	85	100
MCPA ester+	0.25+					
thifensulfuron methyl	0.023					
Fenoxaprop+	0.075+	0	0	26.2	83	99
MCPA ester+	0.25+					
thifensulfuron methyl	0.019					
Fenoxaprop+	0.075+	0	0	27.6	83	100
MCPA ester+	0.375+					
fluroxypyr	0.124					
Fenoxaprop+	0.075+	0	0	24.6	80	98
MCPA ester	0.375					
$LSD_{(0.05)}$		0	0	9.1	9	12

[a] Supercharge 0.5% v/v added.
[b] Score added at 0.8% v/v.
[c] Activator 90 0.5% v/v added.

Effect of imazamox timing on feral rye control in imidazolinone-resistant winter wheat. Curtis R. Rainbolt and Donald C. Thill. (Plant Science Division, University of Idaho, Moscow, ID 83844-2339) A study was established near Culdesac, ID in imidazolinone-resistant winter wheat to evaluate feral rye control with two rates of imazamox at seven application timings. Plots were 8 by 28 ft arranged in a randomized complete block design 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). Weed control and crop injury were evaluated visually on May 18 and June 6, 2000. Wheat seed was harvested at maturity from a 4 by 25 ft area of each plot with a small plot combine on July 31, 2000.

Table 1. Application data.

Timing	A	B	C	D	E	F	G
Application date	March 1	March 8	March 22	March 29	April 6	April 11	April 18
Wheat growth stage	4-5 leaf	5 leaf	6 leaf	6-7 leaf	7-8 leaf	8-9 leaf	9 leaf
Feral rye growth stage	2-3 leaf	3-4 leaf	5-6 leaf	5-6 leaf	6-7 leaf	7 leaf	7-8 leaf
Air temperature (F)	54	40	58	42	49	76	60
Relative humidity (%)	64	90	55	70	52	32	85
Wind (mph)	0	0	0	2	3	5	2
Soil temperature at 2 in (F)	55	38	45	40	54	60	62

Imazamox applied at 0.048 lb/A at timing C reduced wheat height 13% on May 18 (Table 2), but on June 6 injury was no longer significant. On May 18 all treatments controlled feral rye (SECER) 90% or more. By June 6, control ranged from 88 to 98%. At both evaluation dates, control tended to be slightly better with earlier applications (A through E). Downy brome (BROTE) control was 90% or better on both evaluation dates for treatments made at application timings A through E, and control was lowest with treatments made at timing G (66 to 71%). Wild oat (AVEFA) control was evaluated on June 6 and was consistently good (95% or better) with all treatments applied at timings A through D. Control of catchweed bedstraw (GALAP) was similar on both evaluation dates, and ranged from 53 to 97%. GALAP control with both imazamox rates at timing G was significantly lower than all other treatments. Winter wheat grain yield was significantly better than the control with all imazamox treatments except 0.048 lb/A at timing E, in which yield was unexplainably low.

Table 2. Weed control and imidazolinone-resistant winter wheat response to different imazamox timings.

			Wheat			Weed control						
			Injury		Grain	May 18			June 6			
Treatment[a]	Rate	Timing	May 18	June 6	yield	SECER	BROTE	GALAP	SECER	BROTE	AVEFA	GALAP
	lb/A		--------%--------		bu/A	------------------------------%------------------------------						
Untreated control	--	--	--	--	69	--	--	--	--	--	--	--
Imazamox	0.04	A	0	0	97	90	95	95	88	95	97	95
Imazamox	0.048	A	0	0	110	97	91	95	97	92	96	97
Imazamox	0.04	B	0	0	108	95	96	96	93	95	97	97
Imazamox	0.048	B	0	0	109	97	95	94	97	97	97	96
Imazamox	0.04	C	0	0	105	97	95	94	93	96	97	95
Imazamox	0.048	C	13	2.5	111	95	93	90	97	93	95	93
Imazamox	0.04	D	0	0	101	97	93	94	98	93	95	95
Imazamox	0.048	D	0	0	104	95	93	93	98	93	96	95
Imazamox	0.04	E	0	0	105	97	91	93	97	90	91	94
Imazamox	0.048	E	0	0	77	95	91	91	95	91	94	91
Imazamox	0.04	F	0	0	98	90	86	86	93	85	89	88
Imazamox	0.048	F	0	0	97	93	83	80	95	86	90	81
Imazamox	0.04	G	0	0	95	90	70	66	93	69	75	56
Imazamox	0.048	G	0	0	93	90	71	53	88	66	81	65
LSD (0.05)			2	NS	23	5	7	10	6	8	5	10
Plant density (plants/ft^2)									0.5	2.2	1.3	0.7

[a]All treatments contained 32% UAN at 1.25% v/v and Sun-it II (a methylated seed oil) at 1.25% v/v.

Feral rye control in imidazolinone-resistant winter wheat with imazamox and adjuvant combinations. Curtis R. Rainbolt and Donald C. Thill. (Plant Science Division, University of Idaho, Moscow, ID 83844-2339) A study was established near Culdesac, ID in imidazolinone-resistant winter wheat to evaluate feral rye control with imazamox applied at two rates in combination with different adjuvants. Plots were 8 by 28 ft arranged in a randomized complete block design 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). Weed control and crop injury were evaluated visually on May 18 and June 6, 2000. Wheat seed was harvested at maturity from a 4 by 25 ft area of each plot with a small plot combine on July 31, 2000.

Table 1. Application data.

Application date	April 18, 2000
Wheat growth stage	9 leaf
Feral rye growth stage	7-8 leaf
Air temperature (F)	60
Relative humidity (%)	85
Wind (mph)	2
Soil temperature at 2 in (F)	62

Winter wheat was not visibly injured by herbicide treatment (data not shown). On the May 18, downy brome (BROTE) control ranged from 89 to 97% (Table 2), and was highest in both imazamox + 32% UAN + Silwet L-77 treatments, imazamox at 0.04 lb/A + AMS + R-11, and both imazamox + 32% UAN + Sun-it II treatments. By June 6 there were no significant differences in weed control between treatments. Winter wheat grain yield was not different among treatments.

Table 2. Feral rye control and wheat yield with imazamox and adjuvant combinations in imadazolinone-resistant winter wheat near Culdesac, ID in 2000.

		Weed control							Wheat
		May 18			June 6				grain
Treatment[a]	Rate	SECER	BROTE	GALAP	SECER	BROTE	GALAP	AVEFA	yield
	lb/A	%							bu/A
Untreated control	--	--	--	--	--	--	--	--	93
Imazamox + 32% UAN + Sun-it II	0.032 + 1.25% v/v + 1.25% v/v	95	97	91	90	91	94	89	96
Imazamox + 32% UAN + Sun-it II	0.04 + 1.25% v/v + 1.25% v/v	95	94	93	95	91	94	86	103
Imazamox + 32% UAN + R-11	0.032 + 1.25% v/v + 0.5% v/v	95	91	95	95	93	94	84	97
Imazamox + 32% UAN + R-11	0.04 + 1.25% v/v + 0.5% v/v	95	89	93	93	91	94	85	103
Imazamox + 32% UAN + Moract	0.032 + 1.25% v/v + 1.25% v/v	95	89	91	95	91	95	86	99
Imazamox + 32% UAN + Moract	0.04 + 1.25% v/v + 1.25% v/v	95	90	94	90	91	93	84	98
Imazamox + AMS + Sun-it II	0.032 + 5% v/v + 1.25% v/v	95	91	93	95	90	94	86	92
Imazamox + AMS + Sun-it II	0.04 +5% v/v + 1.25% v/v	95	89	94	95	89	94	88	95
Imazamox + AMS + R-11	0.032 + 5% v/v + 0.5% v/v	95	91	94	90	91	95	89	97
Imazamox + AMS + R-11	0.04 + 5% v/v + 0.5% v/v	95	96	94	93	91	94	86	89
Imazamox + 32% UAN + Silwet L-77	0.032 + 1.25% v/v + 0.25% v/v	95	95	94	95	91	94	86	97
Imazamox + 32% UAN + Silwet L-77	0.04 + 1.25% v/v + 0.25% v/v	95	96	93	90	89	93	86	92
LSD (0.05)		NS	4	NS	NS	NS	NS	NS	NS
Plant density (plant/ft^2)					0.4	2.4	0.4	0.8	

[a]Sun-it II is a methylated seed oil plus surfactant, R-11 is a 90% NIS, Moract is a crop oil concentrate, Silwet L-77 is a 100% silicone-polyether copolymer, AMS is Bronc ammonium sulfate, and 32% UAN is liquid urea-ammonium nitrate (32% N).

Annual grass weed control in imidazolinone-resistant winter wheat. Traci A. Rauch and Donald C. Thill. (Plant Science Division, University of Idaho, Moscow, ID 83844-2339) Four studies were established in 'Fidel' imidazolinone-resistant winter wheat (Clearfield™). In experiment one, grass weed control and wheat yield was examined at two timings of imazamox and other grass herbicides. Experiment two examined grass weed control and wheat yield with a reduced rate of imazamox combined with various adjuvants. 'Fidel' wheat was seeded on November 5, 1999 for experiments one and two near Tammany, ID. Wild oat control was examined with grass herbicides (experiment three) and with imazamox and sulfosulfuron at two timings (experiment four). Experiments three and four, near Bonners Ferry, ID, were reseeded on April 12, 2000 due to snow mold kill. In all experiments, plots were 8 by 30 ft arranged in a randomized complete block design with four replications. All herbicide treatments were applied using a CO_2 pressurized backpack sprayer calibrated to deliver 10 gpa at 30 psi and 3 mph (Table 1 and 2). Wheat injury for all experiments was evaluated 8 to 21 days after treatment and was not visible for any treatment (data not shown). Weed control for experiments one and two was evaluated on May 15 and June 20, 2000; and experiments three and four on June 26, 2000. Wheat seed was harvested with a small plot combine from a 4.1 by 27 ft area in each plot in experiments one and two on July 31, 2000. Experiments three and four were not harvested due to a poor wheat stand.

Table 1. Application and soil data for experiments one and two near Tammany, ID.

	Experiment one		Experiment two
Application date	March 21, 2000	April 5, 2000	April 5, 2000
Growth stage			
Wheat	3 to 4 leaf	1 to 2 tiller	1 to 2 tiller
Wild oat (AVEFA)	1 to 3 leaf	4 to 5 leaf	4 to 5 leaf
Downy brome (BROTE)	2 to 3 leaf	4 to 6 leaf	4 to 6 leaf
Volunteer barley (HORVX)	1 to 2 tiller	3 to 4 tiller	3 to 4 tiller
Air temperature (F)	59	50	56
Relative humidity (%)	45	51	45
Wind (mph, direction)	4, NW	5, SE	2, NW
Cloud cover (%)	60	70	99
Soil temperature at 2 in (F)	45	44	50
pH		5.4	
OM (%)		3.3	
CEC (meq/100g)		23	
Texture		silt loam	

Table 2. Application and soil data for experiments three and four near Bonners Ferry, ID.

	Experiment three	Experiment four	
Application date	May 8, 2000	May 16, 2000	May 24, 2000
Growth stage			
Wheat	1 to 3 leaf	3 to 4 leaf	4 to 5 leaf
Wild oat (AVEFA)	1 to 3 leaf	3 to 4 leaf	4 to 5 leaf
Air temperature (F)	68	72	80
Relative humidity (%)	36	45	40
Wind (mph, direction)	4, S	4, NE	3, SW
Cloud cover (%)	25	30	50
Soil temperature at 2 in (F)	65	64	65
pH	7.3		
OM (%)	10.0		
CEC (meq/100g)	25		
Texture	loam		

In experiment one, the 4 to 5 leaf timing of imazamox at 0.032 lb/A and both timings of imazamox at 0.04 lb/A controlled volunteer barley (HORXV) better (98 to 99%) than both timings of sulfosulfuron and procarbazone-sodium alone and the earlier timing of procarbazone-sodium + metribuzin (58 to 76%) (Table 3). Downy brome (BROTE) control was highest with any timing or rate of imazmox (92 to 99%) and lowest with either timing of sulfosulfuron and the 1 to 3 leaf timing of procarbazone-sodium (58 to 78%). The 4 to 5 leaf timings of imazamox controlled wild oat (AVEFA) better (88 and 95%) than the 1 to 3 leaf timing of procarbazone-sodium alone or in combination with metribuzin and both sulfosulfuron treatments (22 to 56%). Wheat yield of all treatments was greater than the untreated check except both sulfosulfuron treatments and the 1 to 3 leaf timing of procarbazone-sodium.

Table3. Grass weed control and wheat yield at two timings of imazamox and other grass herbicides (experiment one).

Treatment[a]	Rate	Application timing[b]	Weed control HORVX[c]	BROTE[c]	AVEFA[d]	Wheat yield
	lb/A			%		lb/A
Imazamox	0.032	1 to 3 leaf	90	92	79	5400
Imazamox	0.04	1 to 3 leaf	98	98	82	5288
Sulfosulfuron	0.031	1 to 3 leaf	58	58	22	4824
Procarbazone-sodium	0.04	1 to 3 leaf	70	78	51	5118
Procarbazone-sodium + metribuzin	0.04 + 0.188	1 to 3 leaf	76	86	56	5368
Imazamox	0.032	4 to 5 leaf	98	98	88	5410
Imazamox	0.04	4 to 5 leaf	99	99	95	5402
Sulfosulfuron	0.031	4 to 5 leaf	71	65	32	4808
Procarbazone-sodium	0.04	4 to 5 leaf	81	90	82	5394
Procarbazone-sodium + metribuzin	0.04 + 0.188	4 to 5 leaf	84	85	72	5324
Untreated check	--	--	--	--	--	4686
LSD (0.05)			15	14	27	532
Density (plants/ft^2)			1	1	24	

[a]90% nonionic surfactant (R-11) was applied at 0.5% v/v with sulfosulfuron and 0.25 % v/v with all other treatments. 32% urea ammonium nitrate was applied at 1 qt/A with all imazamox treatments.
[b]Application timing based on wild oat growth stage.
[c]May 15, 2000 evaluation date.
[d]June 20, 2000 evaluation date.

In experiment two, imazamox at 0.023 lb/A combined with NIS-AMS, 9804, and AMS + 9920 controlled volunteer barley 78 to 91%, while all other treatments controlled volunteer barley 96 to 99% (Table 4). Imazamox (0.023 lb/A) combined with NIS-AMS, 9804, AMS + 9920, and imazamox (0.031 lb/A) + AMS + NIS (soy) controlled downy brome 90 to 97%, while all other treatments controlled downy brome 99%. Wild oat control was less with imazamox (0.023 lb/A) combined with NIS-AMS, 9804, AMS + 9920 and AMS + NIS (soy) (78 to 84 %) than all other treatments (93 to 96%). Wheat yield for all treatments was greater than the untreated check, but did not differ among herbicide treatments.

Table 4. Grass weed control and wheat yield with imazamox combined with different adjuvants (experiment two).

Treatment[a]	Rate	Weed control HORVX[b]	BROTE[b]	AVEFA[c]	Wheat yield
	lb/A		%		lb/A
Imazamox + AMS + NIS (soy)	0.023 + 14 lb/100 gal + 0.25% v/v	96	99	80	5261
Imazamox + NIS-buffer-N	0.023 + 1% v/v	99	99	96	5648
Imazamox + MSO-buffer-N	0.023 + 1% v/v	96	99	94	5615
Imazamox + AMS + MSO (soy)	0.023 + 14 lb/100 gal + 1% v/v	99	99	93	5477
Imazamox + NIS-AMS	0.023 + 3.5% v/v	82	90	79	5384
Imazamox + 9804	0.023 + 2.5% v/v	78	91	78	5427
Imazamox + AMS + NIS (soy) + 9955	0.023 + 14 lb/100 gal + 0.25% v/v + 1% v/v	99	99	94	5425
Imazamox + AMS + 9920	0.023 + 1% v/v	91	97	84	5241
Imazamox + AMS + NIS (soy)	0.031 + 14 lb/100 gal + 0.25% v/v	96	97	94	5250
Untreated check	--	--	--	--	4360
LSD (0.05)		9	6	8	541
Density (plants/ft^2)		1	1	28	

[a]AMS is liquid ammonium sulfate. NIS (soy) is a soybean activated non-ionic surfactant (Preference). NIS-buffer-N is a nitrogen, non-ionic surfactant and buffer mixture (Newtone). MSO-buffer-N is a nitrogen, methylated seed oil, and buffer mixture (Firstmate). MSO (soy) is a methylated soybean oil (Destiny). NIS-AMS is liquid ammonium sulfate and a non-ionic surfactant (Class Act II).
[b]May 15, 2000 evaluation date.
[c]June 20, 2000 evaluation date.

Imazamox with and without AMS controlled wild oat 95% in experiment three (Table 5). No other treatments controlled wild oat (0 to 32%).

Table 5. Wild oat control with imazamox and different grass herbicides (experiment three).

Treatment[a]	Rate	Wild oat control
	lb/A	%
Imazamethabenz	0.47	0
Imazamethabenz + difenzoquat	0.235 + 0.5	1
Imazamethabenz + AMS	0.47 + 17 lb/100 gal	1
Imazamethabenz + difenzoquat + AMS	0.235 + 0.5 + 17 lb/100 gal	1
Diclofop	1.0	1
Fenoxaprop/safener	0.082	5
Clodinafop	0.05	0
Tralkoxydim + AMS	0.24 + 17 lb/100 gal	1
Flucarbazone-sodium	0.027	32
Sulfosulfuron	0.031	6
Imazamox	0.032	95
Imazamox + AMS	0.032 + 17 lb/100 gal	95
Untreated check	--	--
LSD (0.05)		8
Density (plants/ft^2)		98

[a]90% nonionic surfactant (R-11) was applied at 0.5% v/v with sulfosulfuron and 0.25 % v/v with imazamethabenz, difenzoquat and flucarbazone-sodium. AMS is liquid ammonium sulfate. TF8035 (Supercharge) is a crop oil and nonionic surfactant blend applied at 0.5% v/v with tralkoxydim. Crop oil concentrate (Score) was applied at 0.32 qt/A with clodinafop. Methylated seed oil (Sun it II) was applied at 2% v/v with imazamox.

In experiment four, wild oat was controlled by both timings of imazamox (95 and 96%), but not by either timing of sulfosulfuron (6 and 8%).

Table 6. Wild oat control at two timings of imazamox and sulfosulfuron (experiment four).

Treatment[a]	Rate	Application timing[b]	Wild oat control
	lb/A		%
Imazamox	0.048	3 to 4 leaf	96
Sulfosulfuron	0.031	3 to 4 leaf	8
Imazamox	0.048	4 to 5 leaf	95
Sulfosulfuron	0.031	4 to 5 leaf	6
Untreated check	--	--	--
LSD (0.05)			6
Density (plants/ft^2)			110

[a]90% nonionic surfactant (R-11) was applied at 0.25 % v/v with imazamox and 0.5 % v/v with sulfosulfuron. 32% urea ammonium nitrate at 1 qt/A was also applied with imazamox.
[b]Application timing based on wild oat growth stage.

Grass weed control in winter wheat with triallate and various sulfosulfuron timings. Traci A. Rauch and Donald C. Thill. (Plant Science Division, University of Idaho, Moscow, ID 83844-2339) A study was established in 'Symphony' hard red winter wheat near Tammany, ID to examine grass weed control with triallate combined with various sulfosulfuron timings. Plots were 12 by 30 ft arranged in a randomized complete block design with four replications. Sulfosulfuron treatments were applied with a CO_2 pressurized backpack sprayer calibrated to deliver 10 gpa at 30 psi and 3 mph (Table 1). Granular triallate was applied with a screw-type drop spreader and incorporated the same day with a no-till drill. Wheat injury was evaluated visually on March 24, April 5 and 26, 2000. Volunteer barley (HORVX), downy brome (BROTE), and wild oat (AVEFA) control was evaluated on April 26, May 15, and June 20, 2000. Wheat seed was harvested with a small plot combine from a 4.1 by 27 ft area in each plot on July 31, 2000.

Table 1. Application and soil data.

Application date	October 21, 1999	November 1, 1999	March 24, 2000	April 5, 2000
Application equipment	hand-held boom	drop spreader	hand-held boom	hand-held boom
Wheat growth stage	preplant	preplant	3 to 4 leaf	1 to 2 tiller
HORVX growth stage	preemergence	preemergence	4 to 5 leaf	3 to 4 tiller
BROTE growth stage	preemergence	preemergence	2 to 3 leaf	4 to 6 leaf
AVEFA growth stage	preemergence	preemergence	1 to 3 leaf	4 to 5 leaf
Air temperature (F)	53	50	52	52
Relative humidity (%)	53	40	47	49
Wind (mph, direction)	0	1, NW	2, SE	1, SE
Cloud cover (%)	0	5	5	60
Soil temperature at 2 in (F)	45	42	40	45
pH		5.4		
OM (%)		3.3		
CEC (meq/100g)		23		
Texture		silt loam		

No treatment visbly injured wheat (data not shown). Triallate + sulfosulfuron applied preplant controlled volunteer barley 75% (Table 2). Volunteer barley was not controlled adequately by any other treatment. Downy brome control was similar (74 to 89%) for all treatments except triallate alone (5%). Triallate alone or in combination with sulfosulfuron at either postemergence timing controlled wild oat better (80 to 85%) than the 1 to 2 tiller timing of sulfosulfuron alone (21%). Wheat seed yield ranged from 4647 to 5742 lb/A and did not differ among treatments or from the untreated check.

Table 2. Grass weed control and wheat yield with triallate and sulfosulfuron.

Treatment[a]	Rate	Application timing[b]	Weed control[c] HORVX	BROTE	AVEFA	Wheat yield
	lb/A		%			lb/A
Triallate	1.5	preplant	0	5	80	4647
Triallate + sulfosulfuron	1.5 + 0.031	preplant + preplant	75	86	55	5742
Triallate + sulfosulfuron	1.5 + 0.031	preplant + 3 to 4 leaf	42	88	85	5124
Sulfosulfuron	0.031	3 to 4 leaf	42	74	55	5226
Triallate + sulfosulfuron	1.5 + 0.031	preplant + 1 to 2 tiller	30	82	84	5266
Sulfosulfuron	0.031	1 to 2 tiller	32	89	21	5235
Untreated check	--	--	--	--	--	4756
LSD (0.05)			34	18	40	NS
plants/ft^2			3	2	10	

[a]A 90% nonionic surfactant (R-11) was applied at 0.5 % v/v with all postemergence sulfosulfuron applications.
[b]Application timing based on wheat growth stage.
[c]June 20, 2000 evaluation.

Soil persistence of imazamox in dry land winter wheat production systems. Traci A. Rauch and Donald C. Thill. (Plant Science Division, University of Idaho, Moscow, ID 83844-2339) A study was established at the University of Idaho Plant Science Farm near Moscow, Idaho to examined soil persistence of imazamox. Imazamox was applied to 'Pioneer 45A71' imidazolinone-resistant (Clearfield™) canola in spring 1999. Plots were 8 by 21 ft and arranged in a randomized complete block with four replications. Herbicide treatments in 1999 were applied with a CO_2 pressurized backpack sprayer calibrated to deliver 10 gpa at 32 psi and 3 mph (Table 1). 'Madsen' winter wheat was seeded into a conventionally prepared seedbed on October 11, 1999. In spring 2000, 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 May 12, 2000. Wheat seed was harvested with a small plot combine from a 4 by 18 ft area in each plot on August 3, 2000.

Table 1. Application data and soil analysis.

Application date	June 4, 1999
Canola growth stage	3 to 4 leaf
Air temperature (F)	62
Relative humidity (%)	68
Wind (mph, direction)	0 to 2, NE
Cloud cover (%)	50
Soil temperature at 2 in (F)	55
pH	4.9
OM (%)	5.8
CEC (meq/100g)	39.8
Texture	loam

No treatment visually injured winter wheat (data not shown). Wheat yield ranged from 5910 (highest imazamox rate) to 7039 (untreated check) lb/A and did not differ among treatments or from the untreated check (Table 2).

Table 2. Winter wheat seed yield in 2000 following imazamox applied to canola in 1999.

Treatment[a]	Rate	Wheat yield
	lb/A	lb/A
Imazamox	0.024	6835
Imazamox	0.032	6852
Imazamox	0.040	6887
Imazamox	0.048	6800
Imazamox	0.080	5910
Untreated check	–	7039
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.

Italian ryegrass control in Clearfield™ wheat. Traci A. Rauch, Bryan S. Hawley, and Donald C. Thill (Plant Science Division, University of Idaho, Moscow, ID 83844-2339) Two studies were established near Moscow, Idaho in 'Fidel' Clearfield™ (imidazolinone resistant) winter wheat. Crop response, Italian ryegrass control, and wheat yield were evaluated with imazamox and other herbicides in experiment one and with clodinafop in combination with various broadleaf herbicides in experiment two. All plots were 8 by 30 ft arranged in a randomized complete block design with four replications. All herbicide treatments were applied using a CO_2 pressurized backpack sprayer calibrated to deliver 10 gpa at 32 psi and 3 mph. Wheat injury was evaluated visually on April 11 and 21, 2000 in experiment one; and on April 25, May 1, and May 25, 2000 in experiment two. Weed control was evaluated visually on June 13, 2000 in experiment one; and on May 1, May 18, and June 13, 2000 in experiment two. Wheat seed in both experiments was harvested August 4, 2000.

Table 1. Application data.

	Experiment one			Experiment two
Application date	September 30, 1999	November 18, 1999	April 12, 2000	April 18, 2000
Wheat growth stage	preemergence	1 to 3 leaf	3 to 4 tiller	4 to 5 tiller
Italian ryegrass growth stage	preemergence	1 leaf	4 to 8 leaf	1 to 3 tiller
Air temperature (F)	59	39	65	52
Relative humidity (%)	51	79	53	66
Wind (mph, direction)	0	4, E	2, SW	0
Cloud cover (%)	0	0	75	5
Soil temperature at 2 in (F)	50	36	52	45
pH	5.4			
OM (%)	3.0			
CEC (meq/100g)	21			
Texture	silt loam			

In experiment one, both preemergence flufenacet/metribuzin treatments injured wheat 11 and 14% on April 11, 2000 (Table 2). On April 21, no injury was visible for any treatment (data not shown). Triasulfuron at 0.026, flufenacet/metribuzin at 0.34, and imazamox at 0.048 lb/A controlled Italian ryegrass 99%. Pendimethalin and metribuzin suppressed Italian ryegrass 60 and 52%, respectively. All other treatments controlled Italian ryegrass 77% or better. Wheat yield ranged from 8,317 to 9,022 lb/A and did not differ among treatments or from the untreated check.

In experiment two, all clodinafop combinations injured wheat 1 to 3% on April 25, 2000 (Table 3). By May 1, no injury was visible for any treatment (data not shown). Clodinafop in combination with thifensulfuron reduced Italian ryegrass control 14 to 20% compared to clodinafop alone. Italian ryegrass control increased 8% with clodinafop + prosulfuron + MCPA compared to clodinafop alone. All other combinations did not differ from clodinafop alone. Wheat yield did not differ between treatments or from the untreated check.

Table 2. Crop injury, Italian ryegrass control and wheat yield in experiment one.

Treatment[a]	Rate	Application timing	Wheat[b] injury	Italian ryegrass control	Wheat yield
	lb/A		----------%	----------	lb/A
Flufenacet/metribuzin	0.34	preemergence	11	99	8684
Flufenacet/metribuzin	0.425	preemergence	14	90	8317
Triasulfuron	0.016	preemergence	0	84	8392
Triasulfuron	0.026	preemergence	0	99	8393
Chlorsulfuron	0.016	preemergence	0	88	8457
Flufenacet/metribuzin + chlorsulfuron	0.34 + 0.016	preemergence	0	98	8338
Pendimethalin	0.5	preemergence	0	60	8436
Flufenacet/metribuzin	0.425	1 leaf	--	94	8735
Metribuzin	0.25	4 to 8 leaf	--	52	8497
Flucarbazone-sodium + NIS	0.027 + 0.25 % v/v	4 to 8 leaf	--	77	8953
Sulfosulfuron + NIS	0.031 + 0.5 % v/v	4 to 8 leaf	--	77	9022
Diclofop	1.0	4 to 8 leaf	--	86	8753
Clodinafop	0.05	4 to 8 leaf	--	89	8552
Tralkoxydim	0.24	4 to 8 leaf	--	96	8524
Tralkoxydim + AMS	0.24	4 to 8 leaf	--	97	8486
Imazamox + NIS + UAN	0.032 + 0.25% v/v	4 to 8 leaf	--	94	8448
Imazamox + NIS + UAN	0.040 + 0.25% v/v	4 to 8 leaf	--	97	8681
Imazamox + NIS +UAN	0.048 + 0.25% v/v	4 to 8 leaf	--	99	8593
Untreated check	--	--	--	--	8514
LSD (0.05)			3	13	NS
Density (plants/ft^2)				2	

[a]NIS (R-11) is a 90% nonionic surfactant. TF8035 (Supercharge) is a crop oil and nonionic surfactant blend applied at 0.5% v/v with tralkoxydim treatments. Crop oil concentrate (Score) was applied at 0.32 qt/A with clodinafop. AMS is liquid ammonium sulfate and was applied at 17 lb/100 gal. UAN (32% urea ammonium nitrate) was applied at 1.25 % v/v.
[b]April 11, 2000 evaluation.

Table 3. Crop response, Italian ryegrass control and wheat yield in experiment two.

Treatment[a]	Rate[b]	Wheat injury[c]	Italian ryegrass control[d]	Wheat yield
	lb/A	----------%	----------	lb/A
Clodinafop	0.06	0	88	8374
Clodinafop + thifensulfuron	0.06 + 0.028	2	76	8236
Clodinafop + prosulfuron	0.06 + 0.018	3	92	8268
Clodinafop + bromoxynil	0.06 + 0.375	1	91	8869
Clodinafop + bromoxynil/MCPA	0.06 + 0.75	1	94	8662
Clodinafop + thifensulfuron + MCPA	0.06 + 0.028 + 0.375	3	70	8216
Clodinafop + prosulfuron + MCPA	0.06 + 0.018 + 0.375	3	96	8410
Untreated check	--	--	--	8474
LSD (0.05)	--	NS	11	NS
Density (plants/ft^2)			7	

[a]Crop oil concentrate (Score) was applied with all treatments at 0.4 qt/A.
[b]MCPA ester rates are given in lb ae/A.
[c]April 25, 2000 evaluation date.
[d]June 13, 2000 evaluation date.

Weed control in imidazolinone-resistant winter wheat. Traci A. Rauch and Donald C. Thill. (Plant Science Division, University of Idaho, Moscow, ID 83844-2339) Three studies were established in 'Fidel' imidazolinone-resistant winter wheat (Clearfield™) to examine weed control with imazamox and other grass herbicides. 'Fidel' wheat was seeded on October 14 (experiment one) and November 5, 1999 (experiment two). Experiment three was reseeded on April 12, 2000 due to snow mold kill. In all experiments, plots were 16 by 30 ft arranged in a randomized complete block design with four replications. All herbicide treatments were applied using a CO_2 pressurized backpack sprayer calibrated to deliver 10 gpa at 30 psi and 3 mph (Table 1). Experiment two was oversprayed with thifensulfuron/tribenuron at 0.016 lb/A and bromoxynil /MCPA at 0.5 lb ae/A on April 10, 2000 for broadleaf weeds. Wheat injury for experiment one was evaluated visually on April 18 and May 12, 2000; experiment two on April 26, 2000; and experiment three on May 24, 2000. Weed control for experiment one was evaluated on June 19, 2000; experiment three on June 26, 2000; and experiment two on May 15 and June 20, 2000. Wheat seed was harvested with a small plot combine from a 4.1 by 27 ft area in each plot on July 31 (experiment two) and August 3, 2000 (experiment one). Experiment three was not harvested due to a poor wheat stand. In spring 2001, the entire plot area in all experiments will be planted to spring barley to evaluate soil persistence of all herbicides treatments.

Table 1. Application and soil data for experiment one, two, and three.

	Experiment one		Experiment two	Experiment three
Location	Moscow, Idaho		Tammany, Idaho	Bonners Ferry, Idaho
Application date	November 18, 1999	April 18, 2000	April 5, 2000	May 16, 2000
Growth stage				
Wheat	1 to 2 leaf	3 to 5 tiller	1 to 2 tiller	3 to 4 leaf
Wild oat (AVEFA)	--	--	1 to 3 leaf	3 to 4 leaf
Downy brome (BROTE)	--	--	4 to 6 leaf	--
Interrupted windgrass (APEIN)	preemergence	1 to 3 leaf	--	--
Pineapple-weed (MATMT)	preemergence	1 to 2 in	--	--
Volunteer barley (HORVX)	--	--	3 to 4 tiller	--
Air temperature (F)	39	61	50	72
Relative humidity (%)	79	58	49	45
Wind (mph, direction)	4, E	2, W	1, SE	4, NE
Cloud cover (%)	0	5	75	30
Soil temperature at 2 in (F)	36	52	44	64
pH	5.2		5.4	7.3
OM (%)	2.7		3.3	10.0
CEC (meq/100g)	20		23	25
Texture	silt loam		silt loam	loam

In experiment one, no treatment visibly injured wheat on April 18 or May 12, 2000 (data not shown). No treatment adequately controlled pineapple-weed (MATMT) (Table 2). All treatments controlled interrupted windgrass (APEIN) 99%. Wheat seed yield did not differ among treatments or from the untreated check.

No treatment injured wheat on April 26, 2000 in experiment two (data not shown). Both rates of imazamox controlled volunteer barley (HORVX) better than all other treatments (99%) (Table 3). Downy brome control was greater with both imazamox rates (99%) compared to the low rates of flucarbazone-sodium (76%) and sulfosulfuron (80%). Imazamox treatments and flucarbazone-sodium at 0.054 lb/A controlled wild oat (92 to 97%) better than sulfosulfuron and procarbazone-sodium treatments (0 to 71%). Wheat seed yield of sulfosulfuron and procarbazone-sodium treatments was similar to the untreated check, while imazamox and flucarbazone-sodium treatments yielded more grain than the untreated check. Seed yield of imazamox treatments (5243 and 5354 lb/A) was greater than sulfosulfuron treatments (4462 and 4636 lb/A).

In experiment three, no treatment injured wheat on May 24, 2000 (data not shown). Imazamox at 0.04 and 0.08 lb/A controlled wild oat 94 and 99%, respectively (Table 3). No other treatments controlled wild oat (10 to 54%).

Table 2. Weed control and wheat yield in experiment one.

Treatment[a]	Rate	Application timing	Weed control MATMT	Weed control APEIN	Wheat yield
	lb/A		%		lb/A
Imazamox	0.04	fall	31	99	8437
Imazamox	0.08	fall	45	99	8186
Imazamox	0.04	spring	68	99	8292
Imazamox	0.08	spring	76	99	8136
Untreated check	--	--	--	--	8207
LSD (0.05)			18	NS	NS
Density (plants/ft^2)			5	2	

[a]90% nonionic surfactant (R-11) at 0.25 % v/v and 32% urea ammonium nitrate at 1.25 % v/v were applied with all treatments.

Table 3. Weed control and wheat yield in experiment two and three.

Treatment[a]	Rate	Experiment three AVEFA control	Experiment two Weed control HORVX[b]	Experiment two Weed control BROTE[b]	Experiment two Weed control AVEFA[c]	Experiment two Wheat yield
	lb/A					lb/A
Imazamox	0.04	94	99	99	92	5243
Imazamox	0.08	99	99	99	97	5354
Sulfosulfuron	0.031	10	79	80	0	4636
Sulfosulfuron	0.062	24	85	92	16	4462
Flucarbazone-sodium	0.027	46	84	76	81	5205
Flucarbazone-sodium	0.054	54	81	85	94	5148
Procarbazone-sodium	0.04	25	89	94	71	4939
Procarbazone-sodium	0.08	40	90	97	71	4774
Untreated check	--	--	--	--	--	4523
LSD (0.05)		16	8	15	19	565
Density (plants/ft^2)		123	2	2	5	

[a]90% nonionic surfactant (R-11) was applied at 0.5% v/v with sulfosulfuron and 0.25 % v/v with all other treatments. 32% urea ammonium nitrate was applied at 1 qt/A with all imazamox treatments.
[b]May 15, 2000 evaluation date.
[c]June 20, 2000 evaluation date.

Feral rye and jointed goatgrass control with imazamox. Philip H. Westra, Tim J. D'Amato, and Mark R. Collins. (Weed Research Laboratory, Colorado State University, Ft. Collins, CO 80523). Feral rye and jointed goatgrass are major weed problems in Colorado winter wheat production. There are currently no labeled herbicides that will selectively control these two winter annual grasses effectively in winter wheat. Imazamox can be safely applied on Clearfield (imi-resistant) wheat to provide selective control of winter annual grasses. This trial was designed to evaluate the effectiveness of three rates of imazamox and a standard rate of sulfosulfuron applied at three different timings for control of jointed goatgrass and feral rye in Clearfield wheat.

Early fall treatments were applied on October 5, 1999 when the wheat was 2 to 3 inches tall with two leaves. The feral rye was 1 to 2 inches tall with 1 to 2 leaves. The jointed goatgrass was 1 to 2 inches tall at the one leaf stage. Late fall treatments were applied November 2, 1999 to 4 inch tall wheat with two tillers. The feral rye was 3 to 4 inches tall with 2 to 4 tillers. Jointed goatgrass was 2 to 3 inches tall at the 1 to 3 tiller stage. Spring treatments were applied March 27, 2000 when the wheat was 2 to 4 inches tall and fully tillered. Feral rye was fully tillered and 3 to 5 inches tall. The jointed goatgrass was 1 to 2 inches tall with 2 to 4 tillers. All treatments were applied with a CO_2 pressured backpack sprayer delivering 13 gallons per acre through 11001LP nozzles. The plot size was 10 by 30 feet with three replications per treatment. Control ratings are based on visual evaluations.

Sulfosulfuron, labeled for downy brome control, did not control feral rye or jointed goatgrass. Imazamox treatments controlled jointed goatgrass at all three rates and timings. Three rates of imazamox controlled feral rye when applied early fall, but control decreased in plots treated late fall and spring. No crop injury was observed.

Table.

Treatment[1]	Rate	Growth Stage	AEGCY	SECCE
	Lb/A		-----% Control-----	
Imazamox	0.03	Early Fall	97.0 a	94.0 a
Imazamox	0.04	Early Fall	97.0 a	95.7 a
Imazamox	0.05	Early Fall	97.3 a	96.7 a
Sulfosulfuron	0.03	Early Fall	10.0 d	0.0 e
Imazamox	0.03	Late Fall	88.3 bc	35.0 cd
Imazamox	0.04	Late Fall	95.0 ab	56.7 b
Imazamox	0.05	Late Fall	97.0 a	48.3 bc
Sulfosulfuron	0.03	Late Fall	0.0 e	0.0 e
Imazamox	0.03	Spring	81.7 c	21.7 d
Imazamox	0.04	Spring	95.0 ab	45.0 bc
Imazamox	0.05	Spring	91.7 ab	43.3 bc
Sulfosulfuron	0.03	Spring	0.0 e	0.0 e

[1]0.25% v/v nonionic surfactant added to all treatments

Downy brome control in winter wheat. Joseph P. Yenish. (Washington State University, Pullman, WA 99164-6420) The study was conducted at Lind, WA to determine downy brome control and winter wheat response to several herbicides that are currently labeled or expected to be labeled soon in winter wheat. The study was designed as a randomized complete block with 4 replications. Application timings included FPOST = Fall postemergence applications on 12/10/99 and SPOST = Spring postemergence applications on 3/8/00. All herbicides were applied using a CO_2 backpack sprayer calibrated to deliver 10 gallons per acre at 35 psi. An imidazolinone-resistant wheat variety was used to ensure crop safety with imazamox.

Fall applications of sulfosulfuron, imazamox, and combinations of metribuzin plus sulfosulfuron, imazamox, and MKH 6561 controlled downy brome the best. Generally, fall applications provided better control that spring applications with the control being greater through downy brome maturity. Wheat yield was greatest with fall applications of sulfosulfuron, imazamox, MKH6561, metrizubin, and combinations of metribuzin with imazamox or MKH6561 and a spring sulfosulfuron application. Test weight was not affected by herbicide treatment.

Table. Downy brome control and wheat injury, yield, and test weight.

			Downy Brome Control		Winter Wheat	
Treatment	Rate	Timing	3/22/00	6/7/00	Yield	Test weight
	lbs/a		%		bu/a	lbs/bu
Weedy check			0	0	82	62
Flufenacet + metribuzin	0.34 + 0.085	PRE	69	60	86	62
Flufenacet + metribuzin	0.272 + 0.068	FPOST	77	55	85	62
Sulfosulfuron[a]	0.031	FPOST	91	93	95	62
Imazamox[b]	0.04	FPOST	94	95	88	62
MKH6561[c]	0.04	FPOST	67	70	88	62
MKH6562[c]	0.04	FPOST	48	44	85	61
Metribuzin	0.28	FPOST	78	74	88	62
Sulfosulfuron + metribuzin[a]	0.023 + 0.14	FPOST	91	89	83	62
Imazamox + metribuzin[b]	0.032 + 0.14	FPOST	94	94	93	62
MKH 6561 + metribuzin[c]	0.032 + 0.14	FPOST	86	88	88	62
MKH 6562 + metribuzin[c]	0.032 +0.14	FPOST	80	64	82	62
Flufenacet + metribuzin	0.272 + 0.068	SPOST	21	29	84	62
Sulfosulfuron[a]	0.031	SPOST	60	45	89	62
Imazamox[b]	0.04	SPOST	52	76	84	62
MKH6561[c]	0.04	SPOST	53	58	87	62
MKH6562[c]	0.04	SPOST	40	10	86	62
Metribuzin	0.375	SPOST	40	63	83	62
LSD (p=0.05)			24	15	7	ns

[a]applied with 0.5% v/v nonionic surfactant.
[b]applied with 0.25% v/v nonionic surfactant and 1 qt/a Solution 32 nitrogen fertilizer.
[c]applied with 0.25% v/v nonionic surfactant.

PROJECT 4: TEACHING & TECH TRANSFER

Pamela Hutchinson, Chair

Newly reported weed species; potential weed problems in Idaho. Lawrence W. Lass, Donn C. Thill, Timothy S. Prather, and Don W. Morishita. (Idaho Agricultural Experiment Station, University of Idaho, Moscow, Idaho, 83844-2339) The Lambert C. Erickson Weed Diagnostic Laboratory received 215 specimens for identification of which seven were on the Idaho Noxious Weed List, 115 were invaders not from North America, 54 were native plants, and 18 were horticultural and cultivated plants. The lab received an additional 21 specimens that were identified to genus but not to species because critical features for identification were not present. Increased interest in using Geographic Information Systems to map invasive species has changed reporting requirements to include location data in the form of Latitude/Longitude, Universal Transverse Mercator (UTM), or Public Land Survey. The complete identification records for the Erickson Weed Diagnostic Laboratory are downloadable from http://plantain.ag.uidaho.edu.

One species, horse purslane (*Trianthema portulacastrum* L.) was found to be new to the Pacific Northwest and is in the Aizoaceae Family. This tropical plant is a weedy species of California and was collected in Kootenai County in a flower bed. The lab received 48 specimens considered to be weedy or escaped cultivated that were new county records according to the Invaders database (Table). Ventenata (*Ventenata dubia* (Leers) Cross & Dur) and interrupted windgrass (*Apera interrupta* (L.) Beauv.) were the most common grasses submitted for identification. Ventenata was of interest to the cattle industry and interrupted windgrass was of interest to the grass seed industry. Needle leaf navarretia (*Navarretia intertexta* (Benth.) Hook.) of the Polemoniaceae family was the most common broadleaf plant sent in. Three plants listed as native species, blazing star mentzelia (*Mentzelia laevicaulis* (Dougl.)T&G); varileaf phacelia (*Phacelia heterophylla* Prush (Brand) Cronq.); and coyote tobacco (*Nicotiana attenuata* Torr.) were sent in for identification. Blazing star was found growing in a county rock pit and along a gravel road in two counties in south central Idaho. Varileaf phacelia is common along many roads in northern Idaho. Coyote tobacco was found to be aggressive in Owyhee county following a rangeland fire. Berteroa (*Berteroa incana* (L.) DC) is a weed established on beaches of the upper Snake River and is spreading along the upper Salmon River in Lemhi County. Garden orache (*Atriplex hortensis* L.) was identified in Bannock County in 1999 and Power County on American Falls Reservoir in 2000. Garden orache can reach heights of 2 m and normally is associated with old farmsteads. Ramtil or Ramtilla (*Guizotia abyssinica* (L.F.) Cass) is a cultivated plant from Africa and is sold as bird thistle seed. Ramtil has established as a weedy species in parts of California. The Ramtil bird seed sample was contaminated with flixweed (*Descurainia sophia* (L.) Web. ex Prantl.).

Table. Identified weeds new to a county based on the Invaders database.

County	Family	Scientific Name	Common Name
Ada, ID	Liliaceae	Veratrum parviflorum Michx	Hellebore, false
Ada, ID	Onagraceae	Epilobium minutum L.	
Ada, ID	Scrophulariaceae	Veronica anagallis-aquatica L	Speedwell, water
Bear Lake, ID	Asteraceae	Ambrosia, tomentosa L.	Bursage, skeletonleaf
Benewah, ID	Brassicaceae	Rorippa curvisiliqua (Hook) Bessey	Yellowcress, western
Benewah, ID	Poaceae	Phalaris arundinaceae L	Canarygrass, reed
Boundary, ID	Asteraceae	Onopordum acanthium L.	Thistle, Scotch
Boundary, ID	Boraginaceae	Echium vulgare L	Blueweed, common
Boundary, ID	Caryophyllaceae	Dianthus armeria L	Pink, grass
Boundary, ID	Poaceae	Apera interrupta (L.) Beauv.	Windgrass, interrupted
Boundary, ID	Poaceae	Poa bulbosa L.	Bluegrass, bulbous
Boundary, ID	Poaceae	Polypogon monspeliensis	Rabbitfoot grass
Boundary, ID	Polygonaceae	Rumex crispus L.	Curly dock
Butte, ID	Asteraceae	Centaurea solstitialis L.	Starthistle, yellow
Butte, ID	Chenopodiaceae	Salsola iberica Sennen	Thistle, Russian
Butte, ID	Ranunculaceae	Ranunculus cymbralaria Pursh	Buttercup, seaside
Caribou, ID	Asteraceae	Iva axillaris Pursh	Sumpweed, poverty
Clearwater, ID	Lythraceae	Lythrum salicaria L.	Loosestrife, purple
Elmore, ID	Boraginaceae	Symphytum officinale L.	Comfrey, common
Elmore, ID	Polygonaceae	Rumex acetosella L.	Sorrel, red
Fremont, ID	Asclepiadaceae	Asclepias speciosa Torr.	Milkweed, showy
Fremont, ID	Brassicaceae	Barbarea vulgaris R. Br.	Wintercress, bitter
Gem, ID	Poaceae	Fescue myuros L.	Fescue, rattail
Idaho, ID	Boraginaceae	Amsinckia intermedia Fisch. & Mey	Fiddleneck, coast
Jerome, ID	Euphorbiaceae	Euphorbia myrsinites L	Spurge, myrtle
Kootenai, ID	Aizoaceae	Trianthema prortulacastrum L.	Purslane, horse
Kootenai, ID	Asteraceae	Conyza canadensis (L.) Cronq.	Horseweed
Kootenai, ID	Asteraceae	Senecio jacobaea L.	Ragwort, tansy
Kootenai, ID	Caryophyllaceae	Lychnis coronaria (L.) Desr	Campion, rose
Kootenai, ID	Poaceae	Apera interrupta L.	Windgrass, interrupted
Kootenai, ID	Scrophulariaceae	Veronica arvensis L.	Speedwell, corn
Kootenai, ID	Scrophulariaceae	Veronica persica Poir	Speedwell, Persian
Latah, ID	Asteraceae	Chondrilla juncea L.	Skeletonweed, rush
Latah, ID	Asteraceae	Senecio jacobaea L.	Ragwort, tansy
Latah, ID	Fabaceae	Vicia tetrasperma L.	Vetch, slender
Latah, ID	Poaceae	Apera interrupta (L.) Beauv.	Windgrass, interrupted
Latah, ID	Poaceae	Elytrigia repens (L) Nevski	Quackgrass
Latah, ID	Solanaceae	Hyoscyamus niger L.	Henbane, black
Latah, ID	Violaceae	Viola palustris L	Marsh violet
Lewis, ID	Poaceae	Apera interrupta (L.) Beauv.	Windgrass, interrupted
Lewis, ID	Poaceae	Ventenata dubia (Leers) Cross & Dur	Ventenata
NezPerce, ID	Asteraceae	Artemisia biennis Willd	Wormwood, annual
NezPerce, ID	Poaceae	Aegilopis cylindrica Host.	Goatgrass, jointed
NezPerce, ID	Rubiaceae	Galium aparine L.	Bedstraw, catchweed
Power, ID	Chenopodiaceae	Atriplex hortensis L.	Orache, garden
Twin Falls, ID	Brassicaceae	Cardamine occidentalis (Watts) Howell	Bittercress, western
Twin Falls, ID	Umbelliferae	Aethusa cynapium L	Parsley, fool's

PROJECT 5: WEEDS OF WETLANDS & WILDLANDS

Glen Secrist, Chair

Evaluation of imazapic applied alone or with 2,4-D for perennial weed control. Rodney G. Lym (Department of Plant Science, North Dakota State University, Fargo, ND 58105). Imazapic has provided good long-term leafy spurge control when fall applied. However, previous research at North Dakota State University has shown that imazapic alone provided poor leafy spurge control when applied in the spring and only fair to poor Canada thistle and spotted knapweed control regardless of application date. The purpose of this research was to evaluate the effect of imazapic applied alone or with 2,4-D (commercial formulation) for leafy spurge, Canada thistle, and spotted knapweed control.

The first experiment was established near Buffalo, ND with spring treatments applied on June 21, 1999, when leafy spurge was 24 to 34 inches tall and in the true flower growth stage. The herbicides were applied using a hand-held boom sprayer delivering 8.5 gpa at 35 psi. The air temperature was 72 F with a dewpoint of 67 F. Fall treatments were applied on September 15, 1999, when leafy spurge was in the fall growth stage with 4 to 6 inches regrowth from the main stem. The air temperature was 64 F. The plots were 10 by 30 feet, and treatments were 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.

Imazapic provided better long-term leafy spurge control when fall-applied than spring-applied and the addition of 2,4-D generally decreased control compared to imazapic applied alone (Table 1). For instance, imazapic applied at 2 oz/A with a methylated seed oil in September provided 75% leafy spurge control 12 months after treatment (MAT) compared to only 34% control with the same treatment applied in June and evaluated 12 MAT. While initial leafy spurge control was similar or higher when imazapic was applied with 2,4-D compared to imazapic alone, long-term control was less. Leafy spurge control with imazapic at 3 oz/A fall-applied averaged 92% control 12 MAT compared to only 58% control when the same treatment was applied with 2,4-D. Imazapic fall-applied tended to provide better long-term leafy spurge control than the standard of picloram plus 2,4-D, but grass injury was also higher. Grass injury (cool season species) averaged over fall applications of imazapic was 41% in June and 22% in August 2000 compared to little or no grass injury from the same treatments applied in June.

An experiment to evaluate Canada thistle control with imazapic applied alone or with 2,4-D was established near Fargo, ND. Treatments were applied on June 16, 1999, to Canada thistle in the vegetative growth stage and beginning to bolt (6 to 14 inches tall) or on September 20, 1999, when Canada thistle was in the rosette growth stage. The air temperature was 62 F and dew point was 51 F on the June application date and 68 F and 58 F in September, respectively. Experimental design and evaluation were similar to the first experiment.

Imazapic provided better Canada thistle control 12 MAT when applied in June than in September, and control was similar whether applied alone or with 2,4-D (Table 2). For instance, control 12 MAT with imazapic applied alone or with 2,4-D in June 1999 averaged 61 and 78%, respectively, compared to 11 and 20%, respectively, with the same treatments applied in September. Picloram plus 2,4-D provided the best long-term Canada thistle control and averaged 96% 12 MAT regardless of application date.
The spotted knapweed experiment was established on July 8, 1999, near Hawley, MN, when spotted knapweed was beginning to bolt. The weather was clear and very humid with an air temperature of 70 F and a dewpoint of 67 F. Experimental design and evaluation were similar to the leafy spurge experiment.

Imazapic applied alone or with 2,4-D (commercial mixture) did not provide satisfactory spotted knapweed control and averaged 38% 1 MAT. When the commercial mixture of imazapic plus 2,4-D was applied with 2,4-D ester initial control averaged 86% 1 MAT but only 52% the following growing season. By comparison, both picloram treatments averaged 94% spotted knapweed control 11 MAT.

In summary, the addition of 2,4-D to imazapic did not improve long-term Canada thistle or spotted knapweed control and decreased long-term leafy spurge control compared to imazapic applied alone. Leafy spurge control was best when imazapic was applied in the fall compared to spring, but Canada thistle control was better when treatments were applied in June compared to September. Imazapic applied alone or with 2,4-D did not control spotted knapweed.

Table 1. Leafy spurge control with imazapic alone or with 2,4-D applied in the spring or fall.

Application time and treatment	Rate	Evaluation: Sept 1999 Control	June 2000 Control	June 2000 Grass injury	Aug 2000 Control	Aug 2000 Grass injury
	— oz/A —	%				
June 1999 application						
Imazapic + MSO[a]	2 + 1 qt	71	34	0	3	0
Imazapic + MSO[a]	3 + 1 qt	74	63	0	30	0
Imazapic + 2,4-D[b] + MSO[a]	2 + 4 + 1 qt	90	56	0	55	5
Imazapic + 2,4-D[b] + MSO[a]	3 + 6 + 1 qt	91	47	0	15	0
Picloram + 2,4-D	8 + 16	99	74	0	54	0
September 1999 application						
Imazapic + MSO[a]	2 + 1 qt	--	92	35	75	9
Imazapic + MSO[a]	3 + 1 qt	--	95	48	92	24
Imazapic + 2,4-D[b] + MSO[a]	2 + 4 + 1 qt	--	95	31	48	28
Imazapic + 2,4-D[b] + MSO[a]	3 + 6 + 1 qt	--	91	50	58	25
Picloram + 2,4-D	8 + 16	--	94	30	55	0
LSD (0.05)		9	16	29	37	23

[a] Methylated seed oil was Sunit by AGSCO, Grand Forks, ND.
[b] Commercial formulation - Oasis by American Cyanamid, Princeton, NJ (now BASF).

Table 2. Canada thistle control with imazapic alone or with 2,4-D applied in the spring or fall.

Treatment/application time	Rate	Control: Sept 1999	June 2000	Aug 2000
	—— oz/A ——	%		
June 1999 application				
Imazapic + MSO[a]	2 + 1 qt	19	56	15
Imazapic + MSO[a]	3 + 1 qt	16	65	18
Imazapic + 2,4-D[b] + MSO[a]	2 + 4 + 1 qt	21	84	16
Imazapic + 2,4-D[b] + MSO[a]	3 + 6 + 1 qt	46	72	31
Picloram + 2,4-D	8 + 16	96	95	70
September 1999 application				
Imazapic + MSO[a]	2 + 1 qt	--	82	6
Imazapic + MSO[a]	3 + 1 qt	--	90	15
Imazapic + 2,4-D[b] + MSO[a]	2 + 4 + 1 qt	--	80	21
Imazapic + 2,4-D[b] + MSO[a]	3 + 6 + 1 qt	--	88	19
Picloram + 2,4-D	8 + 16	--	99	96
LSD (0.05)		13	21	23

[a] Methylated seed oil was Sunit by AGSCO, Grand Forks, ND.
[a] Commercial formulation - Oasis by American Cyanamid, Princeton, NJ (now BASF).

Table 3. Spotted knapweed control with imazapic alone or with 2,4-D applied in the spring or fall.

Treatment	Rate	Evaluation/MAT[a]: 1 Control	1 Grass injury	11 Control
	—— oz/A ——	%		
Imazapic + MSO[b]	2 + 1 qt	35	13	3
Imazapic + 2,4-D[c] + MSO[b]	1 + 2 + 1 qt	25	5	9
Imazapic + 2,4-D[c] + MSO[b]	2 + 4 + 1 qt	41	15	4
Imazapic + 2,4-D[c] + MSO[b]	3 + 6 + 1 qt	52	12	20
Imazapic + 2,4-D[c] + 2,4-D ester + MSO[b]	1 + 2 + 14 + 1 qt	81	6	62
Imazapic + 2,4-D[c] + 2,4-D ester + MSO[b]	2 + 4 + 12 + 1 qt	87	11	35
Imazapic + 2,4-D[c] + 2,4-D ester + MSO[b]	3 + 6 + 10 + 1qt	91	29	60
Picloram + MSO[b]	4 + 1 qt	75	9	91
Picloram + 2,4-D + MSO[b]	4 + 16 + 1 qt	92	0	96
LSD (0.05)		22	13	22

[a] Months after treatment
[b] Methylated seed oil was Sunit by AGSCO, Grand Forks, ND.
[c] Commercial formulation Oasis by American Cyanamid, Princeton, NJ (now BASF).

Biological control of purple loosestrife in North Dakota. Rodney G. Lym and Katheryn M. Christianson. (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 biological control agents included two leaf beetles, *Galerucella calmariensis* and *G. pusilla,* released in Grand Forks and Valley City, ND, and *Hylobius transversevittatus,* a root feeding weevil in Grand Forks. The objective of this research was to evaluate purple loosestrife control with *Galerucella* spp. along a river in an urban area.

The experiment was established in Chautauqua Park along the Sheyenne River in Valley City, North Dakota. A mixed population of about 4000 *Galerucella calmariensis* and 10,000 *G. pusilla* were released at a single release point in June 1998 and 1999, respectively. The number of *Galerucella* spp. adults and egg masses, as well as purple loosestrife stems, plant height, and spike length were recorded at the release point and at 25 foot increments both up and down stream from the release point. In a 1 m^2 area the number of eggs, larvae, and adults was estimated by counting for 60 seconds, height the five tallest stems and five longest flower spikes were measured, and the total number of stems was counted.

Galerucella spp. established at Valley City as both adults and egg masses were found in 1999, 1 yr after release (Tables 1 and 2). *Gallerucella* began to decrease the loosestrife stem height and flower spike length 2 yr after release (2000). For instance, stem height was reduced at the release pole from 1.4 m to 0.4 m in 1999 and 2000, respectively. Also the average flower spike length in 2000 was reduced to zero at the release pole and 25 feet from the pole. The number of stems increased following the *Galerucella* spp. release even though the number of flowering plants and stem length decreased. In general, the plants were short and remained in the vegetative growth stage 2 years after the first biocontrol agent was released.

The number of eggs observed increased from an average of 1/m^2 in 1998 to 27/m^2 in 2000. However, there was no increase in the number of larvae observed and only a slight increase in adults. The reason for the large increase in eggs observed compared to the small increase in adults may be due to the adults moving to purple loosestrife further down stream from the experiment site. Also, since the area is in a city park, some of the reduction may be due to loss from insecticide spraying conducted for mosquito control.

In this study, *Galerucella* spp. established and began to reduce the purple loosestrife infestation 2 yr following release. Biological control of purple loosestrife can be an alternative to chemical control in urban areas as long as mosquito control programs are restricted in the release area.

Table 1. Purple loosestrife control with *Galerucella* spp. released in 1998 in Valley City, ND[a].

	Flowering stems		Stem			Stem height		Spike length	
Distance from release	1998	2000	1998	1999	2000	1999	2000	1999	2000
	— No. —		— No. —			— m —		— cm —	
0 (release)	0	0	10	15	58	1.4	0.4	0	0
25 feet	6	0	14	19	22	1.2	0.5	10	0
50 feet	0	0	35	14	50	0.9	0.8	6	10

[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 Valley City, ND[a].

Distance from release[a]	1998			1999			2000		
	Eggs	Larvae	Adults	Eggs	Larvae	Adults	Eggs	Larvae	Adults
	— No./m^2 —								
0 (release)	0	2	1	0	0	0	40	0	4
25 feet	2	1	0	2	0	2	11	0	1
50 feet	0	1	0	6	0	2	30	0	2

[a] Estimates of *Galerucella* adults and egg masses were made in July of each year.

PROJECT 6: BASIC SCIENCES

Ian Heap, Chair

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HERBICIDE PREMIXES

Product (Manufacturer)	Ingredients
Accent Gold (DuPont)	6.5% nicosulfuron (Accent), 6.5% rimsulfuron, 19.1% flumetsulam (Python), and 51.7% clopyralid (Stinger)
Axiom (Bayer)	54.4% flufenacet and 13.6% metribuzin (Sencor)
Axiom AT (Bayer)	19.6% flufenacet, 4.9% metribuzin (Sencor) and 50.5% atrazine
Backdraft (BASF)	0.25 lb imazaquin (Scepter) and 1.25 lb glyphosate (Roundup) per gal.
Basis (DuPont)	50% rimsulfuron and 25% thifensulfuron (Pinnacle)
Basis Gold (DuPont)	1.34% rimsulfuron, 1.34% nicosulfuron (Accent), and 87% atrazine
Bicep II MAGNUM (Syngenta)	3.1 lb atrazine and 2.4 lb *S*-metolachlor (Dual II MAGNUM) per gal.
Bicep MAGNUM TR (Syngenta)	2.0 lb atrazine, 2.5 lb *S*-metolachlor (Dual MAGNUM) and 0.09 lb flumetsulam (Python) per gal.
Bicep Lite II MAGNUM (Syngenta)	2.67 lb atrazine and 3.33 lb *S*-metolachlor (Dual II MAGNUM) per gal.
Bison (Agriliance)	2 lb bromoxynil (Moxy) and 2 lb MCPA per gal.
Boundary (Syngenta)	6.3 lb *S*-metolachlor (Dual MAGNUM) and 1.52 lb metribuzin (Sencor) per gal.
Broadstrike + Treflan (Dow)	0.25 lb flumetsulam (Broadstrike, Python) and 3.4 lb trifluralin per gal.
Bronate (Aventis)	2 lb bromoxynil (Buctril) and 2 lb MCPA per gal.
Brozine (Platte Chemical)	1 lb bromoxynil (Broclean) and 2 lb atrazine per gal.
Buctril + Atrazine (Aventis)	1 lb bromoxynil (Buctril) and 2 lb atrazine per gal.
Bullet (Monsanto)	2.5 lb microencapsulated alachlor (Micro-Tech) and 1.5 lb atrazine per gal.
Canopy 75DF (DuPont)	64% metribuzin (Lexone) and 11% chlorimuron (Classic)
Canopy XL (DuPont)	46.9% sulfentrazone (Authority) and 9.4% chlorimuron (Classic)
Canvas (DuPont)	37.5% thifensulfuron & 18.8% tribenuron (Harmony Extra) and 15% metsulfuron (Ally)
Celebrity Plus (BASF)	10.6 % nicosulfuron (Accent), 46.6 % sodium salt of dicamba (Banvel SGF) and 18.1% diflufenzopyr (ingredient of Distinct)
Command Xtra (FMC)	4 lb sulfentrazone (Authority) per gal. and 3 lb clomazone (Command) per gal. co-pack
Commence EC (Dow, FMC)	3 lb trifluralin (Treflan) and 2.25 lb clomazone (Command) per gal.
Conclude B & G (BASF)	2.7 lb bentazon plus 1.3 lb acifluorfen (Storm) per gal. and 1.5 lb sethoxydim (Poast) per gal. co-pack
Crossbow (Dow AgroSciences)	2 lb 2,4-D and 1 lb triclopyr (Remedy) per gal.
Curtail (Dow AgroSciences)	2 lb 2,4-D and 0.38 lb clopyralid (Stinger) per gal.
Degree Xtra (Monsanto)	2.7 lb microencapsulated acetolchlor (Degree) and 1.34 lb atrazine per gal.
Distinct (BASF)	20% diflufenzopyr and 50% dicamba (Banvel SGF)
Domain (Bayer)	24% flufenacet and 36% metribuzin (Sencor);
DoublePlay (Syngenta)	1.4 lb acetochlor (Surpass) and 5.6 lb EPTC (Eradicane) per gal.
Epic (Bayer)	48% flufenacet (Axiom) and 10% isoxaflutole (Balance)
Exceed (Syngenta)	28.5% primisulfuron (Beacon) and 28.5% prosulfuron (Peak)
Extreme (BASF)	0.17 lb imazethapyr (Pursuit) and 2 lb glyphosate (Roundup) per gal.
Fallow Master BS (Monsanto)	2.2 lb glyphosate (Roundup) and 0.4 lb dicamba (Clarity) per gal.
Field Master (Monsanto)	0.75 lb glyphosate (Roundup), 2 lb acetochlor (Harness), and 1.5 lb atrazine per gal.
Finesse (DuPont)	62.5% chlorsulfuron (Glean) and 12.5% metsulfuron (Ally)

Freedom (Monsanto)	2.67 lb alachlor (Lasso EC) and 0.33 lb trifluralin per gal.
FulTime (Dow AgroSciences)	2.4 lb microencapsulated acetochlor (TopNotch) and 1.6 lb atrazine per gal.
Fusion (Syngenta)	2 lb fluazifop (Fusilade) and 0.66 lb fenoxaprop (Option II) per gal.
Galaxy (BASF)	3 lb bentazon (Basagran) and 0.67 lb acifluorfen (Blazer) per gal.
Gauntlet (FMC)	75 % sulfentrazone (Authority) and 84% cloransulam (FirstRate) co-pack
Grazon P&D (Dow AgroSciences)	2 lb 2,4-D and 0.54 lb picloram (Tordon) per gal.
Guardsman (BASF)	2.3 lb dimethenamid (Frontier) and 2.7 lb atrazine per gal.
Harmony Extra (DuPont)	50% thifensulfuron (Harmony) and 25% tribenuron (Express)
Harness Xtra (Monsanto)	4.3 lb acetochlor (Harness) and 1.7 lb atrazine per gal.
Harness Xtra 5.6L (Monsanto)	3.1 lb acetochlor (Harness) and 2.5 lb atrazine per gal.
Hornet 85.6 (Dow AgroSciences)	23.1 % flumetsulam (Python) and 62.5 % clopyralid (Stinger)
Hornet 78.5 WDG (Dow AgroSci)	18.5 % flumetsulam (Python) and 60.0 % clopyralid (Stinger)
Laddok S-12	2.5 lb bentazon (Basagran) and 2.5 lb atrazine per gal.
Landmaster BW (Monsanto)	1.2 lb glyphosate (Roundup) and 1.5 lb ae 2,4-D amine per gal.
Lariat (Monsanto)	2.5 lb alachlor (Lasso) and 1.5 lb atrazine per gal.
Leadoff (DuPont)	2.3 lb dimethaenamid (Frontier) and 2.7 lb atrazine per gal.
Liberty ATZ (Aventis)	3.34 lb atrazine and 1.0 lb glufosinate (Liberty) per gal.
Lightning (BASF)	52.5% imazethapyr (Pursuit) and 17.5% imazapyr (Contain)
Marksman (BASF)	1.1 lb potassium salt of dicamba and 2.1 lb atrazine per gal.
Moxy + Atrazine (Agriliance)	1 lb bromoxynil (Moxy) and 2 lb atrazine per gal.
NorthStar (Syngenta)	7.5% primisulfuron (Beacon) and 36.3% dicamba(Banvel)
Pursuit Plus (BASF)	2.7 lb pendimethalin (Prowl) and 0.2 lb imazethapyr (Pursuit) per gal.
Ramrod/Atrazine F (Monsanto)	3 lb propachlor (Ramrod) and 1 lb atrazine per gal.
Rave (Syngenta)	8.8% triasulfuron (Amber) and 50% dicamba (Banvel)
ReadyMaster ATZ (Monsanto)	2.0 lb glyphosate and 2.0 lb atrazine per gal.
Rezult B&G (BASF)	4 lb bentazon (Basagran) per gal. and 1 lb sethoxydim (Poast Plus) per gal. co-pack1 delivery system
Sahara (BASF)	7.8% imazapyr(Arsenal) and 62.2% diuron (Karmex)
Scepter OT (BASF)	0.5 lb imazaquin (Scepter) and 2.0 lb acifluorfen (Blazer) per gal.
Shotgun (United Agri Products)	2.25 lb atrazine and 1 lb iso-octyl ester of 2,4-D per gal.
Spirit (Syngenta)	42.8% primisulfuron (Beacon) and 14.2% prosulfuron (Peak)
Squadron (BASF)	2 lb pendimethalin (Prowl) and 0.33 lb imazaquin (Scepter) per gal.
Steadfast (DuPont)	50% nicosulfuron (Accent) and 25% rimsulfuron (ingredient of Basis and Basis Gold)
Starane Plus Salvo (UAP)	0.75 lb fluroxypyr (Starane) and 3 lb 2,4-D (Salvo) per gal.
Starane Plus Sword (UAP)	0.71 lb fluroxypyr (Starane) and 2.84 lb MCPA (Sword) per gal.
Stellar (Valent)	2.4 lb lactofen (Cobra) and 0.7 lb flumiclorac (Resource) per gal.
Steel (BASF)	0.17 lb imazaquin (Scepter), 0.17 lb imazethapyr (Pursuit), and 2.25 lb pendimethalin (Prowl) per gal.
Storm (BASF)	2.67 lb bentazon (Basagran) and 1.33 lb acifluorfen (Blazer) per gal.
Synchrony STS (DuPont)	32% chlorimuron (Classic) and 10% thifensulfuron (Pinnacle)
Tordon RTU (Dow AgroSciences)	3% acid equivalent picloram (Tordon) and 11.2%, 2,4-D ae per gal.
Tri-Scept (BASF)	2.57 lb trifluralin (Treflan) and 0.43 lb imazaquin (Scepter) per gal.
Weedmaster (BASF)	1.0 lb ae dicamba and 2.87 lb ae 2,4-D amine