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FORWARD

The 2003 Research Progress Report of the Western Society of Weed Science (WSWS) is a compilation of research investigations contributed by weed scientists in the western United States of America. The objective of the Research Progress Report is to provide an avenue for presentation and exchange of on-going research to the weed science community. The information in this report is preliminary; therefore, it is not for the development of endorsements or recommendations.

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

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

This issue is dedicated to Barbra Mullin, WSWS Progress Report Editor 1999-2002.

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

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

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

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

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

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

Table 2. Downy brome control in a Colorado pasture with imazapic.

		Downy brome control		
Herbicide[a]	Rate	May 30	June 30	October 18
	oz ai/A	---	%	---
Imazapic	0.5	85	84	51
Imazapic	1.0	100	96	63
Imazapic	1.5	100	99	63
Imazapic	2.0	100	100	67
Imazapic	3.0	100	100	74
Control		0	0	0
LSD (0.05)		1	5	10

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

Downy brome control with imazapic on arid rangeland. Steven A. Dewey, R. William Mace, and Travis M. Osmond. (Department of Plants, Soils, and Biometeorology, Utah State University, Logan, Utah 84322-4820). Downy brome (BROTE) dominates many rangeland areas in Utah providing little useful forage compared to more desirable grass species. Imazapic compared to two other standard treatments was evaluated for downy brome control in conjunction with reseeding at two heavily infested sites; one location near Tintic, Utah, and the other further south near Beaver, Utah. Treatments were applied to 10 by 30 foot plots with a backpack CO_2 sprayer using T-jet 015 nozzles providing a 10 foot spray width calibrated to deliver 25 gpa at 40 psi. The soil at the Tintic site was a fine sandy loam with 7 pH and O.M. content of less than 1%. Soil at the Beaver site was a silty clay with 7 pH and O. M. content of less than 1%. All imazapic and sulfometuron treatments were applied at both sites on October 28, 2000. Treatments were applied in a randomized block design with three replications. Glyphosate was applied April 6, 2001. Downy brome was 1 inch tall at the time of fall application and 2 to 3 inches high when treated with glyphosate. The plots were seeded to Syn A Russian Wild Rye, Secar Snake River Wheat Grass and forage kochia on April 6, of 2001. Both sites were evaluated for downy brome and annual mustard species control on July 19, 2001 and October 24, 2002. The first seeding failed and the plots were seeded again on April 4, 2002. The second planting largely failed and plots were seeded again October 24, 2002.

Evaluations in 2001 showed excellent control of downy brome from all treatments at both locations. By October of 2002 control from the lowest rate of imazapic, imazapic+2,4-D and glyphosate had dropped below 70 percent at Tintic, but remained above 95 percent for all treatments at Beaver. Weedy mustard's had begun to invade the plots by October, 2002, at both locations. Severe drought conditions throughout the entire experiment undoubtedly played a key role in the results. Evaluations will continue for the next several years.

Table 1 Downy brome control with imazapic.

		Beaver				Tintic		
		BROTE		Mustard		BROTE		Mustard
Treatment	Rate	7-19-01	10-2-02	7-19-01	10-2-02	7-19-01	10-24-02	10-24-02
	lb ai/A	% Control						
Untreated		0	0	0	0	0	0	0
Imazapic[a]	0.125	100	100	77	65	57	67	30
Imazapic[a]	0.25	100	100	92	63	50	89	40
Imazapic[a]	0.375	100	99	98	84	83	96	53
Imazapic[a]	0.5	100	99	97	90	87	98	83
Imazapic[a]	0.625	100	100	100	90	92	98	92
Imazapic+2,4-D[a]	0.375	95	100	67	32	17	37	20
Sulfometuron	0.035	100	97	68	17	70	88	10
Glyphosate	0.5	99	100	52	20	77	50	7
LSD (0.05)		33	44	--	35	26	37	35

[a] NIS at 0.25%.

Downy brome control with imazapic applied on heavy and light thatch . Steven A. Dewey, R. William Mace, and Travis M. Osmond. (Department of Plants, Soils, and Biometeorology, Utah State University, Logan, Utah 84322-4820). Downy brome (BROTE) control with imazapic was evaluated in conjunction with reseeding on adjacent light and heavily thatched downy brome pastures near Mt. Pleasant, UT. Downy brome thatch was estimated to cover approximately 10 to 15 percent of the soil surface at the lightly thatched location, and 95 to 100 percent (1 inch deep) at the heavily thatched site. Treatments were applied to 10 by 30 foot plots with a backpack CO_2 sprayer using T-jet 015 nozzles providing a 10 foot spray width calibrated to deliver 25 gpa at 40 psi. The soil was a loam texture with 7.7 pH and O.M. content of less than 2%. Imazapic, imazapic + 2,4-D, and sulfometuron treatments were applied on February 7, 2002 in a randomized block design with three replications. Glyphosate was applied on March 28, 2002. Downy brome was 1 inch high on February 7, and 1.5 inches high for the glyphosate treatment. The plots were seeded to Syn A Russian Wild Rye, Secar Snake River Wheat Grass and forage kochia on February 28, 2002. Both sites were evaluated for downy brome control on October 7, 2002.

All treatments except glyphosate provided excellent control of downy brome, with no apparent differences due to surface thatch. Due to severe drought conditions none of the seeded grasses and forage kochia emerged or survived . Plots were planted again on October 25, 2002. Evaluations will continue for the next several years.

Table 1 Downy brome control with imazapic.

Treatment	Rate	Heavy Thatch	Light Thatch
		BROTE Control	
	Lb ai/A	-----------%-----------	
Untreated		0	0
Imazapic[a]	0.125	100	97
Imazapic[a]	0.25	100	100
Imazapic[a]	0.375	100	100
Imazapic[a]	0.5	100	100
Imazapic[a]	0.625	100	100
Imazapic+2,4-D[a]	0.375	100	100
Sulfometuron	0.035	100	98
Glyphosate	0.5	0	10
LSD (0.05)		NA	7.2

[a] NIS at 0.25%.

Evaluation of various herbicide mixtures applied in May or September for Canada thistle control. Rodney G. Lym. (Department of Plant Sciences, North Dakota State University, Fargo, ND 58105) Canada thistle has increased rapidly in North Dakota during the last decade and currently is estimated to infest over 1.4 million acres, compared to 822,000 acres in 1992. The increase has occurred in cropland, pasture and rangeland, and wildland. The increase is due in part to the much above average precipitation received in the state since 1993. Although many people apply herbicides to control Canada thistle in July and August during flowering and seed-set, research at North Dakota State University has shown that the optimum timing for herbicide application is during the rosette growth stage in late-spring or fall. The purpose of this research was to compare various herbicide mixtures, especially those that contain clopyralid, for Canada thistle control when applied in the spring or fall.

The experiments were established in dense Canada thistle patches located near Fargo or Valley City, ND. Separate spring and fall studies were established on May 30 and 31, 2001, or September 18 and 13, 2001, at Fargo and Valley City, respectively. The Fargo location was former cropland that had been allowed to become weedy, while the Valley City location was wildland that was neither hayed nor grazed. The spring treatments were applied to Canada thistle in the rosette growth stage with an average of six leaves. The fall treatments were applied to Canada thistle in the post-bloom growth stage with numerous fall rosettes beginning growth within the canopy. The Canada thistle was 18 to 36 inches tall at Valley City but only 6 inches tall at Fargo because the area had been mowed in July. The experiments were in a randomized complete block design with three replicates at Valley City and four replicates at Fargo. Plots were 10 by 25 or 10 by 30 feet at Fargo and Valley City, respectively. Herbicides were applied with a hand-held sprayer delivering 8.5 gpa at 35 psi. Treatments were visually evaluated with control based on percent stand reduction compared to the untreated control.

All spring-applied herbicide treatments provided good Canada thistle control 3 months after treatment (MAT) except 2,4-D applied alone and metsulfuron (Table 1). Treatments that contained clopyralid or picloram provided the best control 12 MAT, especially at Fargo. For instance, Canada thistle control averaged over both locations was 85% when clopyralid was applied with triclopyr or 2,4-D, 87% when picloram was applied alone or with 2,4-D, but only 62% with dicamba applied alone or with 2,4-D. Control was similar when clopyralid was applied with triclopyr or 2,4-D at comparable clopyralid rates of 4 or 6.4 oz/A. 2,4-D plus triclopyr did not provide satisfactory Canada thistle control.

Canada thistle control 9 MAT generally was greater than 90% with all fall applied treatments except 2,4-D and dicamba plus 2,4-D at Fargo (Table 2). Control declined rapidly at both locations 12 MAT, and as in the first study, treatments that contained clopyralid or picloram provided the best control. Also, clopyralid plus 2,4-D provided similar control to clopyralid plus triclopyr and control 12 MAT increased as the clopyralid rate increased. Picloram at 6 oz/A applied alone generally provided better long-term Canada thistle control than picloram at 2 or 4 oz/A applied with 2,4-D.

In summary, clopyralid applied at greater than 5 oz/A with triclopyr or 2,4-D and picloram at 6 oz/A provided the best long-term Canada thistle control. Dicamba or picloram applied alone provided better control than the same herbicides applied at reduced rates with 2,4-D. Although not directly comparable, similar treatments applied in the spring provided better Canada thistle control 12 MAT compared to fall application.

Table 1. Canada thistle control by various herbicide mixtures applied in May 2001.

		Control/MAT[a]					
		3		12		15	
Treatment	Rate	Fargo	Valley City	Fargo	Valley City	Fargo	Valley City
	—— oz/A ——	——	——	—— % ——	——	——	——
Clopyralid + triclopyr[b] + X-77	4 + 11+ 0.25%	81	84	62	93	45	50
Clopyralid + triclopyr[b] + X-77	4.8 + 13.2 + 0.25%	91	98	70	93	39	76
Clopyralid + triclopyr[b] + X-77	5.6 + 15.4 + 0.25%	94	96	83	96	62	80
Clopyralid + triclopyr[b] + X-77	6.4 + 17.6 + 0.25%	97	96	83	96	79	60
Clopyralid + 2,4-D[c]	4 + 24	91	96	85	83	56	59
Clopyralid + 2,4-D[c]	6.4 + 36	89	98	78	98	35	86
2,4-D + triclopyr[d] + X-77	16 + 8	76	74	62	83	35	23
2,4-D + X-77	32 + 0.25%	53	64	55	58	0	7
Dicamba + X-77	24 + 0.25%	70	78	28	92	23	13
Dicamba + 2,4-D[e]	12 + 36	75	89	57	71	28	12
Picloram + X-77	6 + 0.25%	98	96	89	93	80	77
Picloram + 2,4-D	2 + 8	79	84	80	92	50	48
Picloram + 2,4-D	4 + 16	89	94	74	94	33	72
Metsulfuron + X-77	0.18 + 0.25%	15	69	7	93	8	35
LSD (0.05)		17	17	17	15	36	20

[a] Months after treatment.

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

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

[d] Commercial formulation - Crossbow by Dow AgroSciences, Indianapolis, IN.

[e] Commercial formulation - Weedmaster by BASF, Research Triangle Park, NC.

Table 2. Canada thistle control by various herbicide mixtures applied in September 2001.

		Control/MAT[a]			
		9		12	
Treatment	Rate	Fargo	Valley City	Fargo	Valley City
	—— oz/A ——	——	—— % ——	——	——
Clopyralid + triclopyr[b] + X-77	4 + 11+ 0.25%	92	99	60	73
Clopyralid + triclopyr[b] + X-77	4.8 + 13.2 + 0.25%	93	99	61	73
Clopyralid + triclopyr[b] + X-77	5.6 + 15.4 + 0.25%	97	99	68	82
Clopyralid + triclopyr[b] + X-77	6.4 + 17.6 + 0.25%	99	99	88	85
Clopyralid + 2,4-D[c]	4 + 24	88	98	49	70
Clopyralid + 2,4-D[c]	6.4 + 36	99	99	79	79
2,4-D + X-77	32 + 0.25%	23	85	12	2
Dicamba + X-77	24 + 0.25%	97	99	84	52
Dicamba + 2,4-D[d]	12 + 36	46	94	21	40
Picloram + X-77	6 + 0.25%	99	100	97	83
Picloram + 2,4-D	2 + 8	85	99	55	61
Picloram + 2,4-D	4 + 16	90	99	67	70
LSD (0.05)		10	3	20	20

[a] Months after treatment.

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

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

[d] Commercial formulation - Weedmaster by BASF, Research Triangle Park, NC.

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

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

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

Study 1. Metsulfuron controlled 50 to 70% CLEOR control approximately 70 days after treatment (DAT). Metsulfuron at 3 oz ai/a controlled only about 50% of CLEOR 70 DAT and 1 YAT. However, metsulfuron at 0.5 to 0.9 oz ai/a controlled more than 90% of CLEOR 1 YAT. Clopyralid failed to control CLEOR, but 2,4-D amine at 32 oz ai/a controlled 100% of CLEOR 70 DAT and 1 YAT, respectively.

Study 2. Imazapic controlled CLEOR slowly. Imazapic at 3 oz ai/a controlled only 36% of CLEOR 70 DAT, but controlled 96% of CLEOR 1 YAT. Quinclorac failed to control CLEOR, whereas diflufenzopyr controlled 84 to 90% of CLEOR 70 DAT and 100% 1 YAT. Picloram at 8 oz ai/a controlled 100% of CLEOR at both evaluation dates.

All treatments prevented seedset 70 DAT in both studies. Picloram was the only treatment that caused grass injury (leaf curling). Snowberry and common gooseberry was killed by 2,4-D, picloram, diflufenzopyr, and imazapic + 2,4-D treatments. Metulfuron imazapic, and clopyralid treatments injured snowberry and common gooseberry. CLEOR was growing over the tops of much of this brush and likely would have killed it over time anyway. Evaluations will continue through the 2003 growing season to provide an indication of long term CLEOR control.

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

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

Application date	Species	Growth stage	Height (in)
July 25, 2001	CLEOR	Early flower	36 to 72
	AGRSM	Flower	12 to 18
	BROIN	Flower	18 to 26

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

Herbicide[a]	Rate	Oxeye daisy control October 3, 2001	Oxeye daisy control July 25, 2002
	(oz ai/a)	(%)	
Metsulfuron	0.3	50	52
Metsulfuron	0.5	64	94
Metsulfuron	0.6	65	93
Metsulfuron	0.9	70	95
2,4-D amine	32.0	89	100
Clopyralid	4.0	26	36
Control		0	0
LSD (0.05)		11	35

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

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

Herbicide[a]	Rate	Oxeye daisy control October 3, 2001	Oxeye daisy control July 23, 2002
	(oz ai/a)	(%)	
Imazapic	3	36	96
Imazapic	6	55	100
+2,4-D	12		
Quinclorac	6	20	38
Diflufenzopyr	4	84	100
Diflufenzopyr	6	90	100
Picloram	8	100	100
Control		0	0
LSD (0.05)		12	13

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

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

The studies were established in 1999 and 2000 at adjacent locations. Herbicides (Table 2) were applied on July 27, 1999 (first study) and July 19, 2000 (second study) when 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 and 14 psi. Other application information is presented in Table 1. Plot size was 10 by 30 feet.

Visual evaluations for control compared to non-treated plots were collected each fall from 1999 through 2002 for study 1. Evaluations were taken 1 and 2 years after treatment (YAT) for the second study. Metsulfuron treatments controlled CHRLE faster than others in study 1. For example, CHRLE control from metsulfuron 60 DAT was 73 to 84% whereas picloram controlled 53% of CHRLE. Metsulfuron treatments controlled 90 to 100% of CHRLE 1 and 2 YAT in both studies. CHRLE control dropped to approximately 70% from all metsulfuron treatments 3 YAT in study 1. Picloram at 4 oz ai/a controlled 60 to 74% of CHRLE 1 to 3 YAT in study 1, and 90 and 73% of CHRLE 1 and 2 YAT, respectively, in study 2. Clopyralid plus 2,4-D, clopyralid plus triclopyr, and 2,4-D Amine controlled less than 70% of CHRLE at all evaluation dates in both studies. Imazapic controlled less than 60% of CHRLE 1 YAT and control deteriorated thereafter. Grass injury from imazapic was 36% 1YAT; injury persisted through the study and was 44% 3 YAT.

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

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

Application date	Species	Growth stage	Height (in.)
July 27, 1999	CHRLE	Full bloom	12 to 27
July 19, 2000	CHRLE	Full bloom	12 to 22

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

Herbicide[a]	Rate	Oxeye daisy control 1999	2000	2001	2002	Grass injury 2000	2001	2002
	(oz ai/a)	(%)				(%)		
Metsulfuron	0.3	73	100	97	73	3	5	0
Metsulfuron	0.45	81	100	100	76	4	0	0
Metsulfuron	0.6	84	100	100	74	3	0	0
Metsulfuron + nitrogen fertilizer[a]	0.45 +32.0	80	100	100	73	4	0	0
Picloram	4.0	53	74	73	60	4	5	0
Clopyralid + 2,4-D amine	1.5 +8.0	30	13	8	0	5	0	0
Clopyralid + 2,4-D amine	3.0 +16.0	41	23	14	10	0	0	0
Clopyralid + 2,4-D amine	6.0 +32.0	55	54	65	55	0	0	0
Imazapic	8.0	58	54	34	10	36	34	44
2,4-D amine	16.0	45	16	14	5	0	0	0
2,4-D amine	32.0	54	36	36	28	0	0	0
Nitrogen fertilizer[a]	32.0	0	0	0	0	0	0	0
Control		0	0	0	0	0	0	0
LSD (0.05)		10	10	12	21	7	6	14

[a] Nitrogen fertilizer is liquid nitrogen solution 32.

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

Herbicide[a]	Rate	Oxeye daisy control 2001	2002
	(oz ai/a)	(%)	
Metsulfuron	0.3	94	66
Metsulfuron	0.45	96	90
Metsulfuron	0.6	100	98
Metsulfuron	0.9	100	100
Picloram	4.0	90	73
Clopyralid +triclopyr	6.0 18.0	46	10
Control		0	0
LSD (0.05)		10	27

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

Control of medusahead following fall and spring herbicide applications. Travis M. Osmond and Steven A. Dewey (Department of Plants, Soils, and Biometeorology, Utah State University, Logan, Utah 84322-4820). Two experiments were conducted near Avon, Utah to evaluate the effectiveness of a combination of burning, herbicide treatments (timing and rate), and re-seeding of desirable forages (timing and species) for medusahead (ELYCM) control on rangelands and pastures. Herbicides were applied with a CO_2 pressurized backpack sprayer calibrated to deliver 15 gpa at 40 psi. All treatments included a 0.25% v/v non-ionic surfactant. Both locations were burned October 20, 2000. Herbicides were applied at Location 1 on October 28, 2000 and April 11, 2001. The plots were evaluated June 25-26, 2001 and June 19-20, 2002. At Location 2, the herbicides were applied on October 31, 2000 and April 11, 2001 with evaluations being conducted June 12, 2001 and June 17-18, 2002. Each location was designed as a randomized split-block design replicated four times with plots being 10 by 160 ft.

In the first season after treatment, only fall-applied sulfometuron provided greater than 75 percent control of medusahead at either location (Tables 1 and 2). By the second season, control from most treatments had declined. The most notable exception was the high rate of spring-applied imazapic, which at Location 1 had improved to 54 percent and at Location 2 to 90 percent control. Extreme drought conditions existed at both locations for the full duration of the study, and may have been a major factor in the disappointing performance of most herbicide treatments and failure of seeded species to establish.

Table 1. Effects of herbicides on 2001 and 2002 midsummer medusahead populations at Location 1.

Treatment	Timing	Rate	Visual Control	
			2001	2002
		g/ha	--%	--
Sulfometuron	Fall	39	77	40
Sulfometuron	Fall	79	98	56
Imazapic	Fall	70	15	26
Imazapic	Fall	140	58	53
Sulfometuron	Spring	39	20	19
Sulfometuron	Spring	79	21	20
Imazapic	Spring	70	18	35
Imazapic	Spring	140	26	54
Glyphosate + metsulfuron	Spring	55 + 11	23	16
Untreated[1]			0	0
LSD $_{(P=0.05)}$			17	34

[1]Not included in ANOVA.

Table 2. Effects of herbicides on 2001 and 2002 midsummer medusahead populations at Location 2.

Treatment	Timing	Rate	Visual Control	
			2001	2002
		g/ha	--%	--
Sulfometuron	Fall	39	90	24
Sulfometuron	Fall	79	99	55
Imazapic	Fall	70	55	37
Imazapic	Fall	140	64	45
Sulfometuron	Spring	39	37	48
Sulfometuron	Spring	79	48	56
Imazapic	Spring	70	45	41
Imazapic	Spring	140	65	90
Glyphosate + metsulfuron	Spring	55 + 11	46	-7
Untreated[1]			0	0
LSD $_{(P=0.05)}$			14	25

[1]Not included in ANOVA.

African rue control with imazapyr. Kirk C. McDaniel Department of Animal and Range Sciences, New Mexico State University, Las Cruces, NM 88003. African rue was introduced into New Mexico in the 1930s and has continually increased its presence throughout the southern portion of the state. It is particularly common in disturbed and barren areas such as abandoned crop fields, oil pads, stock yards and corrals, secondary roads, parking lots, and roadsides. This experiment was conducted in an abandoned livestock corral on the county fairgrounds in Deming, NM. Treatments were applied to African rue in both early vegetative (spring) and post bloom growth stages (autumn). Plots were 10 by 30 ft arranged in a randomized complete block design with three replications. Plots were entirely sprayed with imazapyr at 0.25, 0.5, and 0.75 lb ae/A; and imazapyr + glyphosate at 0.25 + 0.25 lb ae/A. Herbicides were applied using a CO_2 handheld pressurized sprayer calibrated to deliver 21 gpa at 60 psi. Treatments were made on April 14, 1998 (air temp 67 F, soil temp @ 6 inch 65 F, relative humidity 28%, wind 8 to 12 mph); October 1, 1998 (air temp 81 F, soil temp @ 6 inch 64 F, relative humidity 38%, wind 1 to 3 mph); April 20, 1999 (air temp 76 F, soil temp @ 6 inch 64 F, wind 4 to 7 mph); and October 21, 1999 (air temp 76 F, soil temp @ 6 inch 62 F, wind 10 mph). African rue control was estimated by three observers comparing top growth in treated plots relative to untreated plots with results averaged in the table.

Treatments generally provided high first year top growth control of African rue with most canopies destroyed and little or no green foliage on sprayed plants (Table). However, African rue produced new foliage from subsurface growing points the second or third year after most treatments indicating plant kill was low. An exception was after the April 1998 experiment where the 0.75 lb ae/A imazapyr rate gave >90% plant control for three years after spraying. Initial plant control was not different by spray time for any single imazapyr rate. Imazapyr + glyphosate provided better initial plant control when applied in autumn compared to spring, but treatments were generally ineffective by the second growing season after spraying.

Table. African rue control near Deming, NM.

Spray date	Treatment	Rate	African rue control by evaluation date 10/98	4/99	10/99	4/00	10/00	10/01
		lb ae/A	---	---	---	% ---	---	---
4/98	Imazapyr	0.25	70	73	17	0	0	0
	Imazapyr	0.50	93	74	80	80	0	20
	Imazapyr	0.75	98	100	90	99	98	90
	Imazapyr + glyphosate	0.25 + 0.25	75	50	15	0	0	0
10/98	Imazapyr	0.25	-	10	35	30	10	10
	Imazapyr	0.5	-	12	90	88	85	20
	Imazapyr	0.75	-	25	85	88	85	45
	Imazapyr + glyphosate	0.25 + 0.25	-	13	80	30	0	0
4/99	Imazapyr	0.25	-	-	50	50	0	0
	Imazapyr	0.5	-	-	75	50	0	0
	Imazapyr	0.75	-	-	75	75	0	0
	Imazapyr + glyphosate	0.25 + 0.25	-	-	45	30	0	0
10/98	Imazapyr	0.25	-	-	-	70	30	20
	Imazapyr	0.5	-	-	-	80	30	15
	Imazapyr	0.75	-	-	-	80	25	0
	Imazapyr + glyphosate	0.25 + 0.25	-	-	-	90	25	0
	Check	-	0	0	0	0	0	0

Control of Russian olive and saltcedar resprouts with early and late summer herbicides applications. Kirk C. McDaniel, Todd Caplan, and John P. Taylor. (Department of Animal and Range Sciences, New Mexico State University, Las Cruces NM 88003; Santa Ana Pueblo, Bernallio, NM; Bosque del Apache National Wildlife Refuge, Socorro, NM 87801). In winter 1998, mature Russian olive and saltcedar trees were cut with chainsaws to a 6 inch stubble height and surfaces were sprayed with a formulated triclopyr (Chopper®) solution on the Santa Ana Pueblo near Bernallio, NM. An evaluation of the area in spring 2000 revealed that regrowth from portions of stumps and buried roots was common for both species in this riparian area that bordered the edge of the Rio Grande. This experiment was conducted in summer 2000 to determine the effectiveness of spraying the Russian olive and saltcedar regrowth (1 to 4 ft height). Plots were 30 by 30 ft arranged in a randomized complete block design with six replications when treatments were applied on June 14 (spray time 9:30 to10:30 am, air temp. 80F, soil temp. @ 6 inch 80F, relative humidity 22%, wind 1 to 3 mph SW) and three replications when treatments were applied on August 30 (spray time 9:30 to 11:00 am, air temp. 80F, soil temp. @ 6 inch 78F, relative humidity 23%, wind still). Glyphosate (5% v/v), imazapyr (1% v/v), metsulfuron (1 gm product per 1 gal water), and the amine formulation of triclopyr (25% v/v) were mixed in water with a 0.25% v/v nonionic surfactant. Applications were made with backpack sprayers fitted with nozzles that delivered fine to moderate sized spray droplets that completely wetted the foliage. Resprouts were counted during spraying and averaged about 150 Russian olive per plot and about 25 saltcedar per plot. Counts of live versus dead resprouts in each plot were made September 26, 2001 to determine plant control.

Glyphosate provided >90% Russian olive control when applied in June and late August 2000, but saltcedar was poorly controlled during both spray periods (Table). Imazapyr was effective for Russian olive and saltcedar control when applied in August (88 and 93%, respectively), but control of both species was poor when imazapyr was applied in June. Triclopyr gave better control of Russian olive when applied in June (91%) than August (78%) but this herbicide was effective on saltcedar only in August. Metsulfuron was effective on Russian olive and saltcedar when applied in August but not June.

Table. Russian olive and saltcedar control with individual plant herbicide treatments near Bernallio, NM.

Species & treatment	Rate[1]	Control after 6/14/00 spray date	Control after 8/30/00 spray date
		----(%)----	
Russian olive			
Glyphosate	5%	91	93
Imazapyr	1%	40	88
Triclopyr	25%	91	78
Metsulfuron	1 gm/gal	56	75
Check	-	0	0
Saltcedar			
Glyphosate	5%	0	39
Imazapyr	1%	0	93
Triclopyr	25%	0	82
Metsulfuron	1 gm/gal	0	74
Check	-	0	0

[1] All herbicides except metsulfuron were mixed v/v in water.

Russian olive regrowth control with herbicides. Kirk C. McDaniel, John P. Taylor and Todd Caplan. (Department of Animal and Range Sciences, New Mexico State University, Las Cruces NM 88003; Bosque del Apache National Wildlife Refuge, Socorro, NM 87801; Santa Ana Pueblo, Bernallio, NM). In summer 1998, Russian olive top growth was removed by mechanical dozing on the Bosque del Apache National Wildlife Refuge near Socorro, NM. However, roots were not destroyed and regrowth was abundant throughout the treated area when this study was initiated in 2000. In this experiment the effectiveness of individual plant foliar sprays were compared on Russian olive regrowth that was 4 to 8 ft in height. Plots were 30 by 30 ft arranged in a randomized complete block with three replications. Treatments were applied on June 13 (spray time 4:00 to 5:15 pm; air temp. 93 F; soil temp. @ 6 inch 78 F; relative humidity 19%; wind 3 to 6 mph SW) and on Sept. 2 (spray time 9:30 to 11:00; air temp. 80 F; soil temp. @ 6 inch 78 F; relative humidity 22%; wind still). Herbicides compared included glyphosate (5% v/v), imazapyr (1% v/v), glyphosate + imazapyr (0.5 + 0.5% v/v), metsulfuron (1 gm. product per 1 gal. water), and the amine formulation of triclopyr (25% v/v). All herbicides were mixed in water with a 0.25% v/v nonionic surfactant. Applications were made with backpack sprayers fitted with nozzles that delivered a fine to moderate sized droplet and care was taken to completely wet all foliage. At the time of spraying treated plants were counted and Russian olive density averaged about 25 plants per plot. Counts of live versus dead plants in each plot were made on Sept. 25, 2001 to determine plant control.

Glyphosate and triclopyr treatments provided >85% Russian olive control after spraying in June but both herbicides were less effective when applied in September (Table). Conversely, imazapyr was less effective when applied in June (24%) compared to September (72%). Metsulfuron provided visible plant injury but plant control was low after both spray dates.

Table. Russian olive control with individual plant herbicide treatments near Socorro, NM.

Treatment	Rate[1]	Control after 6/13 spray date	Control after 9/2 spray date
		(%)	
Glyphosate	5%	86	34
Triclopyr	25%	92	0
Imazapyr	1%	24	72
Imazapyr + glyphosate	0.5 + 0.5%	61	0
Metsulfuron	1 gm/gal	5	0

[1] All herbicides except metsulfuron were mixed v/v in water.

Evaluation of metsulfuron for perennial sowthistle control. Rodney G. Lym. (Department of Plant Sciences, North Dakota State University, Fargo, ND 58105) Metsulfuron is often used for general weed and brush control on industrial non-crop sites and for control of certain weeds in pasture and roadsides. Perennial weeds that favor moist growing conditions, such as perennial sowthistle, Canada thistle, and dock, have increased rapidly in North Dakota since the mid 1990s following several years of above average precipitation. The purpose of this research was to evaluate metsulfuron for control of perennial sowthistle, Canada thistle, and other weeds commonly found during moist growing conditions.

The first experiment was established at Fargo in a dense perennial sowthistle stand with an under story of Kentucky bluegrass and weedy annual grasses and broadleaf species such as foxtails and ragweed. Herbicides were applied on July 11, 2000, when perennial sowthistle was in the bolted to flowering growth stage and 10 to 36 inches tall. The treatments were applied with a CO_2-pressurized backpack sprayer delivering 8.5 gpa at 35 psi. The plots were 10 by 30 feet, and the experiment was a randomized complete block design with four replicates. The air temperature was 72 F, the dew point 68 F, and the soil temperature was 72 F at the 1 inch depth. Perennial sowthistle control and bare ground evaluations were based on a visual assessment of stand reduction compared to the untreated control.

Metsulfuron provided excellent perennial sowthistle control at all application rates evaluated (Table 1). Control with metsulfuron at 0.6 oz/A or less tended to increase between the 2 and 11 month after treatment (MAT) evaluations. Metsulfuron at 1.2 to 1.8 oz/A provided 100% perennial sowthistle control and 78 and 72% for all plants present (bare ground) 11 and 14 MAT, respectively. Perennial sowthistle control averaged from 91 to 100% 26 MAT as the metsulfuron application rate increased from 0.3 to 1.8 oz/A, respectively. Clopyralid plus 2,4-D at 3 + 16 oz/A provided similar perennial sowthistle control as metsulfuron at 0.3 oz/A for 23 MAT but control declined to 79% by 26 MAT. Clopyralid alone and dicamba plus diflufenzopyr generally did not provide satisfactory perennial sowthistle control. Metsulfuron at 0.3 oz/A, the lowest rate evaluated, provided the most cost-effective perennial sowthistle control and the least injury to other species.

The second experiment was established on May 30, 2001, near Fargo to evaluate control of perennial sowthistle, Canada thistle, swamp smartweed, and dandelion with metsulfuron compared to auxin herbicides. Perennial sowthistle and Canada thistle were in the rosette growth stage with 4 to 6 leaves; swamp smartweed was approximately 8 inches tall; and dandelion was flowering. The experimental design was the same as the first experiment, and treatments were applied as previously described. The air temperature was 72 F with moist soil and good growing conditions.

As in the first study, metsulfuron provided excellent perennial sowthistle control at all application rates evaluated (Table 2). However, control declined much faster in the second compared to the first experiment (Table 1). For instance, metsulfuron at 0.3 oz/A provided 90% perennial sowthistle control 12 MAT, but control declined to 60% 15 MAT. The same treatment provided over 90% control for 2 yr in the first study. Treatments that contained clopyralid provided less long-term perennial sowthistle control than those that contained metsulfuron. For instance, perennial sowthistle control averaged across metsulfuron at all rates was 94% compared to 86% with all treatments that contained clopyralid. Dicamba plus diflufenzopyr did not provide acceptable perennial sowthistle control.

In general, swamp smartweed and dandelion were easily controlled by the herbicides evaluated in this study (Table 2). Metsulfuron at 0.3 oz/A and clopyralid at 4 oz/A only provided 77 and 68% swamp smartweed control 1 MAT, and clopyralid alone and dicamba plus diflufenzopyr provided less than 50% initial dandelion control. However, all treatments provided 100% control of these weeds by 3 MAT, so these species were not further evaluated (data not shown). Treatments that contained clopyralid provided better Canada thistle control than dicamba plus diflufenzopyr and metsulfuron at all application rates evaluated except 0.9 oz/A (Table 2). Canada thistle control 12 MAT was 95% averaged over all treatments with clopyralid and metsulfuron at 0.9 oz/A compared to 78% or less with all other treatments. Canada thistle control rapidly declined by 15 MAT with all treatments except clopyralid at 4 oz/A, which averaged 85%.

The third experiment was also established on May 30, 2001, to further evaluate swamp smartweed control with metsulfuron. There was a dense stand of swamp smartweed, which ranged from 8 to 18 inches tall with 3 to 15 leaves. There also was a moderate density of perennial sowthistle and Canada thistle, which were in the rosette growth stage. The treatments were applied as previously described.

As in the previous studies, metsulfuron at all rates applied provided near complete control of swamp smartweed and perennial sowthistle (Table 3). However, in this study metsulfuron provided better Canada thistle control than clopyralid or with 2,4-D or triclopyr. For instance, Canada thistle control was 80% 15 MAT averaged over all metsulfuron treatments compared to 52% or less with treatments that contained clopyralid.

In summary, metsulfuron provided excellent long-term control of swamp smartweed and perennial sowthistle. Clopyralid provided better Canada thistle control than metsulfuron in two of the three studies. Further research is needed to determine if swamp smartweed and perennial sowthistle can be controlled with metsulfuron at rates less than 0.3 oz/A.

Table 1. Perennial sowthistle (PEST) control and bareground (BG) with metsulfuron applied in July 2000 at Fargo, ND.

		Control/MAT[a]								
		2	11		14		23		26	
Treatment	Rate	PEST	PEST	BG	PEST	BG	PEST	BG	PEST	BG
	--------oz/A--------									0
Metsulfuron + X-77	0.3 + 0.25%	88	99	20	96	3	98	17	91	0
Metsulfuron + X-77	0.45 + 0.25%	96	96	53	100	21	97	1	96	0
Metsulfuron + X-77	0.6 + 0.25%	92	99	76	100	38	97	13	96	0
Metsulfuron + X-77	0.9 + 0.25%	100	99	58	100	49	99	20	100	0
Metsulfuron + X-77	1.2 + 0.25%	100	100	80	100	76	100	17	99	0
Metsulfuron + X-77	1.8 + 0.25%	100	10	76	100	67	99	16	100	0
Clopyralid + X-77	4 + 0.25%	63	85	1	57	1	63	14	49	0
Clopyralid + 2,4-D[b] + X-77	3 + 16 + 0.25%	84	90	5	89	0	80	10	79	0
Dicamba + diflufenzopyr[c] + X-77	3 + 1.2 + 0.25%	60	47	0	13	0	43	16	45	0
LSD (0.05)		14	6	24	21	25	20	NS	29	NS

[a]Months after treatment.
[b]Commercial formulation – Curtail by Dow AgroSciences, Indianapolis, IN.
[c]Commercial formulation – Distinct by BASF, Research Triangle Park, NC.

Table 2. Evaluation of metsulfuron and auxin herbicides for perennial sowthistle (PEST), swamp smartweed, Canada thistle (CT), and dandelion control applied in May 2001 near Fargo, ND.

		Control/MAT[a]									
		1				3		12		15	
Treatment	Rate	PEST	Swamp smartweed	CT	Dandelion	PEST	CT	PEST	CT	PEST	CT
	-----oz/A-----	--				%				--	
Metsulfuron + X-77	0.3 + 0.25%	70	77	64	92	97	45	90	69	60	3
Metsulfuron + X-77	0.45 + 0.25%	91	93	78	92	93	78	91	78	65	23
Metsulfuron + X-77	0.6 + 0.25%	96	80	58	93	100	78	97	74	67	13
Metsulfuron + X-77	0.9 + 0.25%	99	98	65	98	100	99	99	95	55	5
Clopyralid	4	86	68	87	35	95	99	88	95	57	85
Clopyralid + 2,4-D[b]	4 + 16	98	97	92	75	85	88	80	95	33	56
Clopyralid + triclopyr[c]	4 + 11	99	95	91	88	94	89	89	95	52	63
Dicamba + diflufenzopyr[d] + X-77	3 + 1.2	46	90	51	45	54	49	72	74	38	23
LSD (0.05)		19	27	20	23	18	27	11	NS	NS	53

[a]Months after treatment.. Control of swamp smartweed and dandelion was 100% 3 MAT regardless of treatment and were not further evaluated.
[b]Commercial formulation – Curtail by Dow AgroSciences, Indianapolis, IN.
[c]Commercial formulation – Redeem by Dow AgroSciences, Indianapolis, IN.
[d]Commercial formulation – Distinct by BASF, Research Triangle Park, NC.

Table 3. Metsulfuron and auxin herbicides for swamp smartweed (SWSW), perennial sowthistle (PEST), and Canada thistle (CT) control near Fargo, ND .

		Control/Months after treatment										
		1		3			12			15		
Treatment	Rate	SWSW	PEST	SWSW	PEST	CT	SWSW	PEST	CT	SWSW	PEST	CT
	— oz/A —	% control										
Metsulfuron + X-77	0.3 + 0.25%	77	74	99	99	99	87	92	83	99	96	83
Metsulfuron + X-77	0.45 + 0.25%	89	97	100	100	97	88	97	76	100	99	78
Metsulfuron + X-77	0.6 + 0.25%	92	86	98	100	100	86	97	73	100	98	78
Metsulfuron + X-77	0.9 + 0.25%	93	99	98	100	99	95	95	32	100	100	80
Clopyralid	4	52	84	99	100	98	24	24	39	99	60	42
Clopyralid + 2,4-D[a]	4 + 16	99	98	100	100	97	97	53	48	100	21	34
Clopyralid + triclopyr[b]	4 + 11	92	96	100	100	97	93	32	51	95	34	52
Dicamba + diflufenzopyr[c] + X-77	3 + 1.2 + 0.25%	95	85	98	65	50	87	0	18	100	0	0
LSD (0.05)		24	NS	NS	9	19	26	31	40	4	31	34

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

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

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

Evaluation of herbicide mixtures for increased leafy spurge control. Rodney G. Lym. (Department of Plant Sciences, North Dakota State University, Fargo, ND 58105) Research at North Dakota State University has shown that long-term leafy spurge control can be improved when a mixture of herbicides are applied compared to a single herbicide applied alone. For instance, picloram applied with 2,4-D has provided more cost-effective leafy spurge control compared to picloram applied alone at the same or higher application rates. Also, glyphosate applied with 2,4-D provided approximately 70% leafy spurge control 1 yr after treatment with minimal grass injury compared to glyphosate alone which provided less than 10% control with 70% or greater grass injury. The purpose of this research was to evaluate various herbicide mixtures for leafy spurge control compared to the same herbicides applied alone.

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

The combinations of picloram plus 2,4-D with imazapic or with imazapic plus diflufenzopyr provided better leafy spurge control than picloram plus 2,4-D applied alone (Table 1). For instance, leafy spurge control averaged over both locations was 78% with picloram plus 2,4-D 12 months after treatment (MAT) compared to 92% when picloram plus 2,4-D were applied with imazapic or imazapic plus diflufenzopyr. The addition of quinclorac or quinclorac plus diflufenzopyr to picloram plus 2,4-D only tended to increase control 12 MAT compared to picloram plus 2,4-D alone and averaged 84%. In general, leafy spurge control was similar when quinclorac was applied alone or with diflufenzopyr, dicamba, or dicamba plus diflufenzopyr and averaged 88% 12 MAT over both locations. The combination of quinclorac plus dicamba plus diflufenzopyr plus imazapic tended to provided the best long-term leafy spurge control, which averaged 88% 15 MAT on the SNG and 51% at Walcott. However, this treatment would cost over $50/A and would likely not be cost-effective.

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

In general, dicamba plus diflufenzopyr provided similar leafy spurge control when applied alone or with imazapic or imazapic plus 2,4-D at comparable application rates regardless of evaluation date (Table 2). Also, quinclorac applied alone generally provided similar leafy spurge control compared to quinclorac applied with dicamba plus diflufenzopyr. Imazapic applied alone provided the best long-term leafy spurge control, which averaged 99% over both application rates 12 months after a fall treatment. However, grass injury 9 MAT averaged over both locations was 11 and 22% when imazapic was applied at 2 and 3 oz/A, respectively. Grass injury only slightly declined by 12 MAT.

The third experiment compared picloram plus 2,4-D plus imazapic applied with both an MSO and 28%N to the same treatments without 28%N, without 2,4-D and 28%N, and a reduced imazapic rate. The experiment was established as previously described on the SNG in mid-June 2001.

The combination of picloram plus 2,4-D plus imazapic provided better leafy spurge control than the standard treatment of picloram plus 2,4-D 12 and 15 MAT (Table 3). Control was similar whether or not 28%N and 28%N plus 2,4-D were included in the combination treatment at comparable application rates. However, leafy spurge control tended to decline when the imazapic rate was reduced from 1 to 0.5 or 0.25 oz/A, especially when evaluated 15 MAT.

In summary, imazapic applied with picloram plus 2,4-D improved long-term leafy spurge control compared to the standard treatment of picloram plus 2,4-D. Leafy spurge control was similar when picloram plus imazapic were applied alone or with 28%N or 2,4-D plus 28%N. In general, the addition of diflufenzopyr to various treatments that included picloram, 2,4-D, or imazapic did not improve leafy spurge control compared to herbicide treatments applied alone. Herbicide mixtures that included quinclorac generally provided similar control to quinclorac applied alone. Dicamba plus diflufenzopyr did not provide long-term leafy spurge control when applied alone or with other herbicides.

Table 1. Leafy spurge control from various herbicide mixtures applied in June 2001 near Walcott and on the Sheyenne National Grassland (SNG) in North Dakota.

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

[a]Months after treatment.
[b]Methylated seed oil was Scoil by AGSCO, Grand Forks, ND.
[c]Commercial formulation of dicamba plus diflufenzopyr - Distinct, by BASF Corp., Research Triangle Park, NC.

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

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

[a] Months after treatment; spring/fall.

[b] Grass injury.

[c] Methylated seed oil was Scoil by AGSCO, Grand Forks, ND at 1 qt/A for all treatments.

[d] Commercial formulation of dicamba plus diflufenzopyr - Distinct by BASF Corp., Research Triangle Park, NC.

[e] Commercial formulation of imazapic plus 2,4-D - Oasis by BASF Corp., Research Triangle Park, NC.

Table 3. Evaluation of various mixtures of picloram plus 2,4-D plus imazapic for leafy spurge control on the Sheyenne National Grassland in June 2001.

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

[a] Months after treatment.

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

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

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

Visual evaluations for control compared to non-treated plots were collected on June 12, July 11, and September 23, 2002. Herbicides controlled DIPFU slowly, although metsulfuron at 0.5 and 0.6 oz ai/a applied at rosette controlled about 80% of teasel 7 weeks after treatments (WAT) were applied. Metsulfuron appeared to control teasel better when applied during the bolting growth stage. For example, metsulfuron at 0.3 oz ai/a applied at rosette controlled 56% of teasel by the September evaluation date, but when this rate was applied when teasel was bolting 96% of it was controlled by September. Metsulfuron at 0.5 and 0.6 oz ai/a controlled 93 to 100% of teasel by the September evaluation regardless of application timing.

Clopyralid at 6 oz ai/a controlled about 90% of teasel by September 23, regardless of application timing. Bolting appeared to be a better timing to apply imazapic for teasel control. Imazapic 12.0 oz ai/a controlled 40 to 79% of teasel by September 23, when applied at rosette and bolting growth stages, respectively. Teasel was not controlled by 2,4-D ester effectively when applied at 16 oz ai/a.

Evaluations will continue through the 2003 growing season and will provide an indication of long term DIPFU control.

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

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

Application date	Species	Growth stage	Height (in.)
May 16, 2002	DIPFU	1st year rosettes	3 to 6 diameter
	DIPFU	2nd year rosettes	10 to 18 diameter
June 12, 2002	DIPFU	1st year rosettes	5 to12 diameter
	DIPFU	2nd year plants	12 to 30 tall

Table 2. Teasel control on Colorado rangeland.

Herbicide[a,b]	Rate	Application timing	Teasel control June 12	July 10	September 23
	(oz ai/a)		----------	(%)	----------
Metsulfuron	0.3	Rosette	51	66	56
Metsulfuron	0.5	Rosette	66	83	93
Metsulfuron	0.6	Rosette	74	81	98
Imazapic	8.0	Rosette	59	63	61
Imazapic	10.0	Rosette	59	55	35
Imazapic	12.0	Rosette	59	60	40
Clopyralid	6.0	Rosette	46	75	89
2,4-D ester	16.0	Rosette	41	34	24
Metsulfuron	0.3	Bolting	.	39	96
Metsulfuron	0.5	Bolting	.	54	99
Metsulfuron	0.6	Bolting	.	46	100
Imazapic	8.0	Bolting	.	35	53
Imazapic	10.0	Bolting	.	48	68
Imazapic	12.0	Bolting	.	45	79
Clopyralid	6.0	Bolting	.	43	93
2,4-D ester	16.0	Bolting	.	46	40
Control			0	0	0
LSD (0.05)			13	21	23

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

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

Postemergence herbicide screening in Apiaceae seed crops. Timothy W. Miller, Carl R. Libbey, and Robert K. Peterson. (Washington State University, Mount Vernon, WA 98273) A greenhouse study was conducted during 2002 at WSU Mount Vernon to evaluate several herbicides for postemergence (POST) use in various Apiaceae seed crops. Early-flowering and long-standing cilantro, coriander, carrot, dill, parsnip, and parsley were seeded May 13 and August 8 into 10 by 20 in. flats filled with moist potting soil (Sunshine mix). Supplemental light was used (12 hr per d) and temperature was held at approximately 70 F. Plants were thinned to ten per cultivar per flat at about ten d after seeding then sprayed POST with one of 14 herbicides at two growth stages: early (cotyledon to 3 inches, approx. three weeks after seeding) and late (3 to 5 inches, approx. four weeks after seeding). Early applications were made May 31 and August 26 and late applications June 10 and September 4, respectively, for the two iterations. A CO_2-pressurized backpack sprayer delivering 32.4 gpa at 30 psi was used to make all applications. Plants were sprayed outdoors and returned to the greenhouse after one hr drying time. Most herbicides were applied in both iterations, but azafenidin was only tested in the first iteration and pendimethalin only in the second. Visible crop injury was visually evaluated at 3 and 10 d after treatment (DAT; 0 = no crop injury, 100 = plant death). Plants were then grown until 7 wk after seeding (WAS; July 1 and September 30, respectively) at which time plants were counted, cut at the soil surface, and dry weights measured. The experimental design was a randomized complete block with four replicates. Data were analyzed using a general linear models procedure (SAS) and means separated using Fisher's Protected LSD (P = 0.05). Crop injury results are presented in Tables 1 to 5, dry weights and final counts in Table 6.

Products causing severe (> 30%) injury to all tested Apiaceae crops at both POST timings were oxyfluorfen, lactofen, sulfentrazone, isoxaflutole, azafenidin, and fomesafen. Prometryne caused severe injury to cilantro/coriander, parsley, early carrot and early parsnip, and moderate (20 to 29%) injury to late dill and late parsnip, and slight (10-19%) injury to late carrot. Linuon caused severe injury to early dill and early parsley, moderate injury to late dill and early parsnip, and slight injury to cilantro/coriander and late parsley. Metribuzin + flufenocet caused severe injury to cilantro/coriander, dill, parsnip, and parsley, and slight injury to early carrot. Flumioxazin cause severe injury to cilantro/coriander, carrot, parsnip, and parsley, and moderate injury to late dill, and slight injury to early dill. Pendimethalin caused slight injury to parsnip, early cilantro/coriander, early carrot, early dill, and late parsley. Napropamide or thiazopyr caused moderate injury to early cilantro, but not to other Apiaceae crops including long-standing cilantro or coriander.

Products causing < 10% foliar injury in any Apiaceae crop were bensulide at either POST timing or napropamide or thiazopyr early. Other low injury combinations include linuron early or late in carrot or late in parsnip, metribuzin + flufenocet late in carrot, napropamide or thiazopyr early or late in long-standing cilantro, coriander, carrot, dill, parsnip, or parsley or early in early-flowering cilantro, and pendimethalin early or late in carrot and dill or early in cilantro/coriander and parsley.

Mean dry weight and plant count give some indication of lasting crop damage or recovery. Early-flowering cilantro treated early with prometryne, linuron, oxyfluorfen, napropamide, or thiazopyr were equal or higher than non-treated plants in mean dry weight and plant count. For long-standing cilantro, treatment early with prometryne, linuron, oxyfluorfen, thiazopyr, or flumioxazin or late with bensulide were equal to non-treated plants. For coriander, best treatments were early with prometryne, linuron, oxyfluorfen, bensulide, napropamide, or flumioxazin or late with thiazopyr. For carrot, best treatments were early or late with linuron or metribuzin + flufenocet or late with oxyfluorfen, napropamide, or thiazopyr. For dill, best treatments were early or late with bensulide, napropamide, flumioxazin, or sulfentrazone, early with prometryne, or late with thiazopyr, azafenidin, or fomesafen. For parsnip, best treatments were early or late with linuron, bensulide, napropamide, thiazopyr, azafenidin, or pendimethalin or late with prometryne, oxyfluorfen, flumioxazin, or sulfentrazone. For parsley, best treatments were with early pendimethalin or with late bensulide, napropamide or thiazopyr.

Based on these results, testing of prometryne, linuron, bensulide, napropamide, thiazopyr, or pendimethalin applied POST to field-grown Apiaceae seed crops is warranted. In addition, specific combinations of interest include metribuzin + flufenocet in carrot, oxyfluorfen or flumioxazin in coriander, flumioxazin, sulfentrazone, or fomesafen in dill, and oxyfluorfen, flumioxazin, or sulfentrazone in parsnip.

Table 1. Crop injury from herbicides applied postemergence to Apiaceae seed crops in the greenhouse (Pr > F = < 0.0001).

	Injury from prometryne (1.5 lb/a)[1]				Injury from linuron (1.125 lbs/a)[1]				Injury from oxyfluorfen (0.25 lb/a)[1]			
	Cotyledon to 3 in.		3 to 5 in.		Cotyledon to 3 in.		3 to 5 in.		Cotyledon to 3 in.		3 to 5 in.	
Crop	3 DAT	10 DAT	3 DAT	10 DAT	3 DAT	10 DAT	3 DAT	10 DAT	3 DAT	10 DAT	3 DAT	10 DAT
	--------- % --------		--------- % --------		--------- % --------		--------- % --------		--------- % --------		--------- % --------	
Early cilantro	3	56	4	36	2	12	4	14	68	68	43	52
Long-stand. cilantro	3	59	2	31	3	13	3	11	66	59	41	49
Coriander	3	56	2	28	3	8	3	5	65	49	38	42
Carrot	1	33	0	13	0	0	1	0	66	56	52	38
Dill	6	25	1	21	8	34	2	11	69	60	61	61
Parsnip	11	70	0	24	6	18	4	4	79	71	53	46
Parsley	11	83	1	36	9	54	4	14	81	76	39	50

[1]Percent crop injury visually estimated at 3 and 10 days after treatment (DAT).

Table 2. Crop injury from herbicides applied postemergence to Apiaceae seed crops in the greenhouse (Pr > F = < 0.0001).

	Injury from lactofen (0.25 lb/a)[1]				Injury from bensulide (5 lbs/a)[1]				Injury from metribuzin + flufenocet (0.5 lb/a)[1]			
	Cotyledon to 3 in.		3 to 5 in.		Cotyledon to 3 in.		3 to 5 in.		Cotyledon to 3 in.		3 to 5 in.	
Crop	3 DAT	10 DAT	3 DAT	10 DAT	3 DAT	10 DAT	3 DAT	10 DAT	3 DAT	10 DAT	3 DAT	10 DAT
	--------- % --------		--------- % --------		--------- % --------		--------- % --------		--------- % --------		--------- % --------	
Early cilantro	74	91	53	92	4	2	4	3	14	81	6	44
Long-stand. cilantro	80	88	49	89	5	1	3	1	18	81	3	34
Coriander	79	83	49	91	7	2	3	1	21	74	1	30
Carrot	83	90	73	88	1	1	1	0	5	16	1	4
Dill	89	94	61	84	9	3	1	2	27	78	1	37
Parsnip	89	96	58	85	2	1	1	1	38	100	3	63
Parsley	92	96	49	89	7	1	2	1	34	93	1	43

[1]Percent crop injury visually estimated at 3 and 10 days after treatment (DAT).

Table 3. Crop injury from herbicides applied postemergence to Apiaceae seed crops in the greenhouse (Pr > F = < 0.0001).

	Injury from napropamide (2 lbs/a)[1]				Injury from thiazopyr (0.25 lb/a)[1]				Injury from flumioxazin (0.07 lb/a)[1]			
	Cotyledon to 3 in.		3 to 5 in.		Cotyledon to 3 in.		3 to 5 in.		Cotyledon to 3 in.		3 to 5 in.	
Crop	3 DAT	10 DAT	3 DAT	10 DAT	3 DAT	10 DAT	3 DAT	10 DAT	3 DAT	10 DAT	3 DAT	10 DAT
	--------- % --------		--------- % --------		--------- % --------		--------- % --------		--------- % --------		--------- % --------	
Early cilantro	3	4	15	26	1	3	11	11	44	74	43	74
Long-stand. cilantro	2	6	7	8	1	1	8	4	49	51	38	68
Coriander	1	4	2	1	2	1	4	1	42	42	39	57
Carrot	0	3	1	1	1	2	1	1	36	58	31	56
Dill	1	1	1	1	0	1	3	1	19	11	18	29
Parsnip	1	4	1	1	1	1	2	2	56	68	37	55
Parsley	2	4	2	1	1	2	4	1	69	79	38	63

[1]Percent crop injury visually estimated at 3 and 10 days after treatment (DAT).

Table 4. Crop injury from herbicides applied postemergence to Apiaceae seed crops in the greenhouse (Pr > F = < 0.0001).

	Injury from sulfentrazone (0.25 lb/a)[1]				Injury from isoxaflutole (0.12 lbs/a)[1]				Injury from azafenidin (0.15 lb/a)[1]			
	Cotyledon to 3 in.		3 to 5 in.		Cotyledon to 3 in.		3 to 5 in.		Cotyledon to 3 in.		3 to 5 in.	
Crop	3 DAT	10 DAT	3 DAT	10 DAT	3 DAT	10 DAT	3 DAT	10 DAT	3 DAT	10 DAT	3 DAT	10 DAT
	--------- % --------		--------- % --------		--------- % --------		--------- % --------		--------- % --------		--------- % --------	
Early cilantro	51	76	31	73	13	79	18	55	50	75	33	84
Long-stand. cilantro	48	76	31	69	13	84	14	49	65	73	30	81
Coriander	50	74	30	68	14	82	9	56	65	73	30	83
Carrot	38	55	25	34	9	87	1	64	55	78	30	70
Dill	42	35	26	33	18	86	6	61	46	68	13	51
Parsnip	44	61	23	42	9	90	4	58	50	70	33	69
Parsley	11	83	1	36	24	96	8	64	70	85	40	76

[1]Percent crop injury visually estimated at 3 and 10 days after treatment (DAT).

Table 5. Crop injury from herbicides applied postemergence to Apiaceae seed crops in the greenhouse ($Pr > F = < 0.0001$).

Crop	Injury from fomesafen (0.2 lb/a)[1]				Injury from pendimethalin (1 lb/a)[1]			
	Cotyledon to 3 in.		3 to 5 in.		Cotyledon to 3 in.		3 to 5 in.	
	3 DAT	10 DAT	3 DAT	10 DAT	3 DAT	10 DAT	3 DAT	10 DAT
	--------- % --------		--------- % --------		--------- % --------		--------- % --------	
Early cilantro	71	93	48	89	5	4	14	14
Long-stand. cilantro	66	93	44	84	5	4	11	11
Coriander	66	87	42	84	5	4	11	11
Carrot	55	71	29	62	6	0	10	4
Dill	54	49	31	58	6	4	13	6
Parsnip	59	79	33	68	10	10	16	11
Parsley	75	82	36	70	10	9	16	14

[1]Percent crop injury visually estimated at 3 and 10 days after treatment (DAT).

Table 6. Mean dry weight and plant population of several Apiaceae seedlings at seven weeks after seeding and following application of postemergence herbicides in the greenhouse ($Pr > F = < 0.0001$).

Herbicide	Rate	Early-flowering cilantro		Long-standing cilantro		Coriander		Carrot		Dill		Parsnip		Parsley	
		early[1]	late[1]	early[1]	late[1]	early[1]	late[1]	early[1]	late[1]	early[1]	late[1]	early[1]	late[1]	early[1]	late[1]
	lb/a	---------- g/plant (no. plants) ----------													
Prometryne	1.5	0.8 (5)	0.3 (6)	0.5 (5)	0.3 (6)	0.7 (5)	0.4 (6)	0.7 (9)	0.8 (10)	1.1 (9)	0.7 (8)	0.2 (2)	0.3 (5)	0.1 (1)	0.2 (5)
Linuron	1.125	0.6 (8)	0.4 (7)	0.6 (9)	0.4 (9)	0.9 (9)	0.7 (9)	1.3 (9)	1.0 (11)	0.6 (8)	0.6 (9)	0.2 (7)	0.2 (9)	0.1 (2)	0.1 (7)
Oxyfluorfen	0.25	0.5 (6)	0.4 (5)	0.5 (7)	0.4 (7)	0.8 (7)	0.5 (7)	0.6 (10)	0.9 (10)	0.5 (9)	0.4 (9)	0.1 (5)	0.2 (8)	0.1 (6)	0.2 (10)
Lactofen	0.25	0.3 (1)	0.1 (<1)	0.6 (2)	0.3 (<1)	0.7 (3)	0.4 (<1)	0.7 (2)	0.2 (6)	0.4 (2)	0.3 (5)	0.2 (1)	0.1 (2)	0.1 (1)	0.1 (2)
Bensulide	5.0	0.4 (9)	0.5 (9)	0.4 (9)	0.5 (10)	0.8 (10)	0.7 (10)	0.8 (10)	0.8 (11)	0.8 (10)	0.8 (10)	0.2 (9)	0.3 (9)	0.3 (13)	0.3 (11)
Metribuzin + flufenocet	0.5	0.3 (2)	0.3 (2)	0.9 (2)	0.4 (5)	0.7 (4)	0.5 (6)	1.0 (10)	1.2 (10)	0.3 (2)	0.4 (6)	0 (0)	0.1 (4)	0.2 (<1)	0.1 (4)
Napropamide	2.0	0.5 (9)	0.4 (8)	0.4 (9)	0.4 (9)	0.7 (9)	0.6 (10)	0.6 (10)	1.0 (9)	0.8 (9)	0.9 (9)	0.2 (9)	0.3 (9)	0.3 (10)	0.3 (12)
Thiazopyr	0.25	0.5 (9)	0.5 (10)	0.4 (10)	0.5 (10)	0.6 (9)	0.8 (9)	0.8 (10)	0.9 (10)	0.8 (11)	0.6 (10)	0.2 (9)	0.2 (8)	0.2 (12)	0.4 (10)
Flumioxazin	0.07	0.4 (7)	0.4 (3)	0.6 (8)	0.3 (6)	0.8 (8)	0.4 (7)	0.4 (10)	0.4 (11)	1.3 (10)	1.0 (10)	0.2 (4)	0.2 (6)	0.1 (4)	0.2 (8)
Sulfentrazone	0.25	0.2 (1)	0.2 (2)	0.7 (<1)	0.2 (4)	0.2 (1)	0.2 (5)	0.5 (10)	0.7 (11)	0.8 (10)	0.9 (9)	0.1 (5)	0.2 (8)	<0.1 (2)	0.1 (8)
Isoxaflutole	0.12	0 (0)	0.2 (4)	0.2 (<1)	0.2 (5)	0.1 (<1)	0.3 (5)	0 (0)	0.4 (8)	0.2 (<1)	0.2 (5)	0 (0)	0.1 (4)	0 (0)	0.1 (6)
Azafenidin	0.15	0.3 (4)	0.4 (2)	0.3 (5)	0.3 (5)	0.4 (4)	0.3 (5)	0.3 (10)	0.4 (10)	0.5 (8)	1.1 (6)	0.2 (5)	0.2 (7)	0.2 (4)	0.1 (6)
Fomesafen	0.2	0.1 (<1)	0.1 (1)	0.2 (<1)	0.2 (2)	0.2 (<1)	0.2 (2)	0.2 (8)	0.5 (10)	0.6 (9)	0.9 (9)	0.1 (2)	0.1 (6)	0.1 (4)	0.1 (8)
Pendimethalin	1.0	0.4 (9)	0.3 (9)	0.4 (9)	0.3 (7)	0.5 (9)	0.3 (10)	0.7 (10)	0.7 (10)	0.6 (10)	0.5 (10)	0.2 (9)	0.2 (10)	0.4 (11)	0.2 (13)
None	—	0.5 (10)	0.7 (9)	0.5 (10)	0.5 (10)	0.7 (10)	0.8 (10)	0.9 (10)	0.9 (11)	0.7 (10)	0.8 (10)	0.2 (9)	0.2 (8)	0.4 (11)	0.3 (12)

[1]Dry weight per plant and (plant population) after POST herbicide applications at cotyledon to 3 inches (early) or at 3 to 5 inches (late).

Halosulfuron effect on cucurbits and rotational crops in northwestern Washington. Timothy W. Miller, Carl R. Libbey, Robert K. Peterson, and Brian G. Maupin. (Washington State University, Mount Vernon, WA 98273) Two studies were conducted to determine the effect of halosulfuron in cucurbits and on rotational crops in the maritime climate of northwestern Washington.

Cucurbit trial. Cucumber (cv. 'Turbo'), winter squash (cv. 'Delicata'), and mini-pumpkin (cv. 'Wee-B-Little') were planted at WSU Mount Vernon June 14, 2002. One row of each cultivar was seeded on a 24 in. rowspacing in plots measuring 8 by 20 ft. Halosulfuron was applied preemergence (PRE) June 15 and postemergence (POST) July 2 using a CO_2-pressurized backpack sprayer delivering 31.3 gpa at 30 psi (Table 1). Crop injury and weed control were visually estimated to the nearest 5% (0 = no crop or weed injury, 100 = plant death) July 2 and 13. Five average plants per cultivar were cut at soil level August 12, then dried for 2 d at 150 F and weighed. The experimental design was a randomized complete block with four replicates. Data were analyzed using a general linear models procedure (SAS) and means separated using Fisher's Protected LSD (P = 0.05).

Table 1. Herbicide application data, cucurbit trial.

4:00 p.m., June 15, 2002	10:00 a.m., July 2, 2002
Broadcast, PRE	Broadcast, POST
No cloud cover, sunny	No cloud cover, sunny
winds 5 to 7 mph, from SW	winds 1 to 3 mph, from N
air temp. = 66 F; soil temp (4") = 67 F	air temp. = 60 F; soil temp (4") = 59 F
relative humidity = 70%	relative humidity = 67%
soil surface was dry	soil surface was dry
no weeds present	weeds 1 to 3 in.

Rotational crop trials. Halosulfuron at four rates was applied to bare soil in separate trials at WSU Mount Vernon July 10, 2001 and May 30, 2002 (Table 2). Soil was roto-tilled to a depth of approximately 4 in. the same day and in the same direction as herbicide application. Rotational crops commonly grown in northwestern Washington were then seeded at 90 degree angles to the direction of herbicide application. Main plots (herbicide rate) measured 10 by 70 ft, and split-plots (rotational crop) measured 10 by 10 feet. Rotational crops included red beet, spinach, and cauliflower (two rows per split-plot), potato (one row per split-plot), and green pea (15 rows per split-plot). Pickling cucumber, the crop in which halosulfuron will most commonly be used, was also seeded (four rows per split-plot). The first seedings were July 12, 2001 and June 3, 2002. All plants within 3 ft of all rows within a split-plot were cut at the soil line after 34 d, dried for 2 d at 150 F and weighed. Plots were roto-tilled as before, and a second seeding conducted September 11, 2001 and July 19, 2002 at approximately 2 months after treatment (MAT). Rotational crops were as before except no cucumbers were seeded. Plots from 2001 were maintained with no additional cultivation through the winter, then roto-tilled and seeded for a third time June 3, 2002 (approximately 11 MAT). Rotational crops were the same as in the second seeding. The third biomass evaluation was conducted as before except plants were 44 d old. Plots were again roto-tilled as before and seeded for a fourth time July 19, 2002 (approximately 12.5 MAT). Rotational crops were as before, except green pea and potato were not seeded. The fourth biomass evaluation was conducted as before except plants were 81 d old.

The experimental design was a split-plot randomized complete block with four replicates. Biomass data were pooled across years and analyzed using a general linear models procedure (SAS) and means separated using Fisher's Protected LSD (P = 0.05). Plots initiated in 2002 are being maintained with no additional cultivation through the winter and will be seeded for a third and fourth time at approximately 11 and 12.5 MAT as before.

Table 2. Herbicide application data, rotational crop trial.

4:00 p.m., July 10, 2001	10:00 a.m., May 30, 2002
Broadcast, PPI	Broadcast, PPI
No cloud cover, sunny	No cloud cover, sunny
winds 5 to 7 mph, from SW	winds 1 to 3 mph, from N
air temp. = 66 F; soil temp (4") = 67 F	air temp. = 60 F; soil temp (4") = 59 F
relative humidity = 70%	relative humidity = 67%
soil surface was dry	soil surface was dry
no weeds present	no weeds present

Results: Cucurbit trial. There was no significant crop injury due to halosulfuron within any cultivar (data not shown). Early season weed control was excellent with halosulfuron at all rates and timings, ranging from 94 to 100% through mid-July (Table 3). Weed control was noticeably poorer by August, however, with common lambsquarters becoming predominant in POST treatments and pale smartweed and ladysthumb predominant in PRE treatments (data not shown). Timing did not significantly affect biomass but cucurbit weight tended to be slightly greater when halosulfuron was applied POST than PRE (Table 3). Biomass was reduced by the split application, although nonsignificantly so.

Results: Rotational crop trials. Red beet seedling biomass was significantly reduced by halosulfuron residual in soil until 12.5 MAT (Table 4). Spinach and cauliflower biomass was reduced until 11 MAT, and pea and potato biomass was reduced until 2 MAT. A nonsignificant treatment effect was still apparent in spinach and cauliflower until 12.5 MAT, however, and in potato until 11 MAT. Cucumber biomass was relatively unaffected by halosulfuron rate, even when seeded into soil residuals of 2 times the use rate (0.094 lb/a). Initial results indicate that current rotational crop restrictions for halosulfuron could be reduced to approximately 12 months for red beet, spinach, and cauliflower (from the current 24, 24, and 18 months for these crops, respectively) when grown in the mild maritime climate of northwestern Washington. Similarly, the current 9 month restrictions for seeding green pea or cucumber may be overly stringent in our climate.

Table 3. Weed control and biomass of cucumber, squash, and pumpkin following halosulfuron application.

Timing[1]	Rate	Weed control July 2	Weed control July 13	Biomass Cucumber	Biomass Squash	Biomass Pumpkin
	lb/a	%	%	g	g	g
PRE	0.024	100	96	6.0	19.8	27.8
PRE	0.031	99	94	8.3	16.5	22.8
PRE	0.047	100	97	7.0	17.3	22.5
POST[2]	0.023	-	96	6.3	20.8	35.5
POST[2]	0.031	-	95	6.8	24.3	48.0
POST[2]	0.047	-	97	6.5	21.5	36.8
PRE + POST[2]	0.031 + 0.031	100	99	5.0	15.0	22.8
Weedy check	—	0	0	2.0	7.5	15.0
$LSD_{0.05}$	—	1	3	3.3	7.7	16.0

[1]PRE = preemergence (June 15, 2002); POST = postemergence (July 2, 2002).
[2]POST applications mixed with nonionic surfactant at 0.25%, v/v.

Table 4. Rotational crop biomass after seeding in soil treated with halosulfuron.

Rate	Beet	Spinach	Cauli-flower	Green pea	Cucum-ber	Potato
lb/a	g	g	g	g	g	g
1st Planting (July 12, 2001 and June 3, 2002; shortly after treatment)[1]						
0.024	0.3	0.4	0.2	14.7	36.3	11.1
0.047	0.1	0.6	0.1	11.6	37.2	7.6
0.071	0.5	0.3	0.0	10.0	32.8	4.2
0.094	0.1	0.2	0.0	7.0	31.1	3.2
0	7.6	25.1	5.5	20.5	41.2	21.6
$LSD_{0.05}$	1.4	7.9	1.0	4.5	ns	4.6
2nd Planting (September 11, 2001 and July 19, 2002; approx. 2 MAT)[2]						
0.024	4.7	8.1	17.5	198.2	—	29.2
0.047	2.7	1.7	10.6	207.8	—	29.2
0.071	2.3	0.7	4.7	169.4	—	26.7
0.094	1.8	2.7	1.3	172.5	—	18.6
0	69.0	186.0	140.4	179.4	—	39.6
$LSD_{0.05}$	11.3	59.6	32.2	ns	—	ns
3rd Planting (June 3, 2002; approx. 11 MAT)[3]						
0.024	0.8	10.7	0.8	21.1	—	34.5
0.047	0.5	6.8	0.9	20.9	—	20.1
0.071	0.6	4.0	0.8	23.4	—	17.2
0.094	0.3	2.0	0.9	29.5	—	17.0
0	3.5	13.6	1.9	26.8	—	20.0
$LSD_{0.05}$	1.4	ns	ns	ns	—	ns
4th Planting (July 19, 2002; approx. 12.5 MAT)[4]						
0.024	202.8	186.5	234.0	—	—	—
0.047	167.5	185.3	163.5	—	—	—
0.071	156.0	166.0	120.8	—	—	—
0.094	155.0	211.3	166.5	—	—	—
0	186.3	128.8	136.3	—	—	—
$LSD_{0.05}$	ns	ns	ns	—	—	—

[1]Plants harvested at 36 DAP, approx. 1 MAT).
[2]Plants harvested at 80 DAP, approx. 4.5 MAT).
[3]Plants harvested at 44 DAP, approx. 12.5 MAT).
[4]Plants harvested at 81 DAP, approx. 15 MAT).

Preemergence herbicide combinations for weed control in cantaloupes. Kai Umeda. (University of Arizona Cooperative Extension, Maricopa County, 4341 E. Broadway, Phoenix, AZ 85040) A small plot experiment was conducted at the University of Arizona Maricopa Agricultural Center, Maricopa, Arizona. Cantaloupe cv. Sol Dorado was planted on every other raised and shaped 40-inch bed such that the single seedlines were 80-inches apart. The melons were furrow irrigated with water running in only the north furrow as opposed to every furrow to prevent salt build up in the seedline of the beds. Each plot consisted of one 40-in bed measuring 30 ft in length. Herbicide treatments were replicated four times in a randomized complete block design. All herbicide treatment applications were made using a backpack CO_2 sprayer equipped with a hand-held boom consisting of two flat fan 8002 nozzles spaced 20-in apart. All herbicides were applied in 30 gpa water at 40 psi. Preemergence (PREE) herbicide applications were made on 26 March 2002, one day after planting. At the time of applications, the weather was clear with no wind, the air temperature was 70°F and the dry soil was 68°F at a depth of 2-in. Furrow irrigation was applied within a day of treatments and the beds were sub-irrigated to wet the soil surface nearly completely across the bed top to activate the herbicides. Cantaloupe injury and weed control was visually rated at 3 and 12 weeks after treatment of PREE applications of herbicides.

Halosulfuron, flumioxazin, and dimethenamid-p provided promising results in different combinations applied PREE. The combination of bensulide plus halosulfuron gave 95% control of pigweed and continued to control lambsquarters at 90% late in the season. Bensulide combined with flumioxazin gave acceptable pigweed control and lambsquarters were controlled at acceptable levels of 88 and 86%, respectively. Dimethenamid-p combined with flumioxazin was safe and gave good early season pigweed control and long term control of lambsquarters. Clomazone + ethafluralin premix at either low or high rates did not provide acceptable levels of weed control without POST treatments but no significant crop injury was observed.

Table. Preemergence herbicide combinations for weed control in cantaloupes.

Treatment	Rate	Melon injury	Weed control		
			Prostrate pigweed		Lambsquarters
			3 WAT	12 WAT	12 WAT
	lb ai/A	%	------------ % ------------		
Untreated check		0	0	0	0
Bensulide + halosulfuron	4.0 + 0.05	15	95	80	90
Bensulide + flumioxazin	4.0 + 0.05	15	88	55	86
Bensulide + *s*-metolachlor	4.0 + 0.25	19	84	33	86
Bensulide + dimethenamid-p	4.0 + 0.25	24	93	30	83
s-metolachlor + halosulfuron	0.25 + 0.05	21	76	35	75
s-metolachlor + flumioxazin	0.25 + 0.05	16	83	18	74
Dimethenamid-p + halosulfuron	0.25 + 0.05	18	88	76	74
Dimethenamid-p + flumioxazin	0.25 + 0.05	10	88	30	79
Clomazone + ethafluralin	0.063 + 0.2	14	76	0	75
Clomazone + ethafluralin	0.125 + 0.4	8	61	0	71
Clomazone + ethafluralin + halosulfuron	0.063 + 0.2 + 0.05	18	89	75	85
Halosulfuron	0.05	19	88	78	84
LSD (p=0.05)		15.9	13.4	33.0	11.2

Herbicides applied 26 March 2002

Efficacy and safety of combinations of preemergence and postemergence herbicides in cantaloupes. Kai Umeda. (University of Arizona Cooperative Extension, Maricopa County, Phoenix, AZ 85040) A small plot experiment was conducted at the University of Arizona Maricopa Agricultural Center, Maricopa, Arizona. Cantaloupe cv. Cruiser was planted on every other raised and shaped 40-in bed such that the single seedlines were 80-in apart. The melons were furrow irrigated with water running in only the north furrow of the east to west oriented beds as opposed to every furrow to prevent salt build up in the seedline of the beds. Each plot consisted of one 40-in bed measuring 30 ft in length. Herbicide treatments were replicated four times in a randomized complete block design. All herbicide treatments were made with a backpack CO_2 sprayer equipped with a hand-held boom consisting of two flat fan 8002 nozzles spaced 20-in apart. All herbicides were applied in 30 gpa water at 40 psi. Preemergence (PREE) herbicide applications were made on 25 March 2002, one day after the planting. At the time of applications, the weather was clear with a slight breeze of less than 2 mph, air temperature was 72°F, and the dry soil was 68°F at a depth of 2-in. Furrow irrigation was applied within a day and the beds were sub-irrigated to wet the soil surface nearly completely across the bed tops to activate the herbicides. The postemergence (POST) herbicides were applied on 18 April, 24 days after the PREE applications. The weather was clear with no wind and the air temperature was 80°F. The cantaloupe was at the 2 to 3 leaf stage of growth, prostrate pigweed was at the 4 to 12 leaf stage, lambsquarters was at the cotyledon stage, and a few annual yellow sweetclover and junglerice were present. All POST herbicide treatments included an adjuvant, Latron CS-7 added at 0.25% v/v. Cantaloupe injury and weed control were rated visually at various intervals after PREE and POST applications of herbicides.

Halosulfuron at 0.03 lb ai/A combined with rimsulfuron at 0.02 lb ai/A gave exceptionally good control of prostrate pigweed and lambsquarters at 98% and 96%, respectively, when applied POST in cantaloupes. Halosulfuron applied POST in a tank-mix with increasing rates of rimsulfuron showed marginally acceptable to unacceptable crop injury. All POST applications of halosulfuron following PREE herbicides or applied alone provided 90% or better control of lambsquarters. Halosulfuron and clomazone plus ethafluralin gave unacceptable control of pigweed and lambsquarters at 60-70% control relative to the standard, bensulide. Halosulfuron applied alone POST was less effective against pigweed than lambsquarters. A treatment of a PREE herbicide followed by halosulfuron was not as efficacious as the halosulfuron plus rimsulfuron tank-mix applied POST for the control of both pigweed and lambsquarters.

Table. Efficacy and safety of preemergence and postemergence herbicides in cantaloupes

Treatment	Rate	Timing	Crop Injury			Weed control					
			3 WAT-PREE	2 WAT-POST	8 WAT-POST	3 WAT-PREE		2 WAT-POST		8 WAT-POST	
						AMABL	CHEAL	AMABL	CHEAL	AMABL	CHEAL
	lb ai/A		---------------- %	----------------		-------------------------------- %	--------------------------------				
Untreated check			0	0	0	0	0	0	0	0	0
Bensulide +	6.0 +	PREE	6	3	6	90	93	84	92	71	91
halosulfuron	0.03	POST									
Bensulide +	6.0 +	PREE	5	3	10	90	95	85	90	73	90
halosulfuron	0.05	POST									
Halosulfuron +	0.05 +	PREE	9	11	14	71	63	85	93	83	85
halosulfuron	0.03	POST									
Halosulfuron +	0.03 +	POST	-	14	13	-	-	90	90	83	84
rimsulfuron	0.01	POST									
Halosulfuron +	0.03 +	POST	-	16	10	-	-	98	96	94	85
rimsulfuron	0.02	POST									
Halosulfuron	0.05	POST	-	9	11	-	-	76	90	55	79
Clomazone +	0.063 + 0.2 +	PREE	19	14	10	61	62	78	93	63	90
ethafluralin +											
halosulfuron	0.05	POST									
LSD (p=0.05)			11.5	5.8	8.1	31.9	62.3	6.6	6.3	9.4	6

PREE treatments applied on 25 March 2002 and POST treatments applied on 18 April.

Evaluation of preemergence and postemergence herbicides for sweet corn weed control. Kai Umeda. (University of Arizona Cooperative Extension, Maricopa County, 4341 E. Broadway, Phoenix, AZ 85040) A small plot field experiment was conducted at the University of Arizona Maricopa Agricultural Center, Maricopa, AZ. Sweet corn cv. Sugar Ace was planted on 25 March 2002 in a single seedline on 40-inch raised and shaped beds. Plots consisted of two beds measuring 30 ft long and each treatment was replicated four times in a randomized complete block design. All herbicides were applied using a backpack CO_2 sprayer equipped with a hand-held boom consisting of four flat fan 8002 nozzles spaced 20 inches apart. The herbicides were applied in 30 gpa water at 30 psi. The preemergence (PREE) herbicide treatments were applied on 27 March when the air temperature was 64°F, the sky was clear, and there was a very slight breeze at less than 3 mph. The soil was dry and the temperature at a depth of 2-in was 58°F. The field was furrow irrigated and the top of beds were completely wetted immediately after applications to activate the herbicides and to germinate the crop. The postemergence (POST) herbicide treatments were applied on 12 April when the air temperature was 88°F, the sky was clear, and there was a very slight breeze at less than 3 mph. The sweet corn was at the 4-leaf stage of growth, prostrate pigweed, the dominant weed in the site, was at the cotyledon to 4-leaf stage of growth and few barnyardgrass plants that were present were at the 4-leaf stage of growth. All POST herbicide treatments included an adjuvant, Latron CS-7 at 0.25% v/v. Crop injury and weed control visual ratings were done approximately two weeks after each application.

PREE herbicides did not cause sweet corn injury during the crop establishment period. Mesotrione at 0.24 lb ai/A was superior to the lower rate to control prostrate pigweed. Pendimethalin, dimethenamid-p, and *s*-metolachlor were similar and gave acceptable prostrate pigweed control. Pigweed control declined to less than acceptable levels 1 month after all PREE herbicide treatment applications. All POST herbicide treatments of mesotrione gave near complete control of pigweed. A single POST application of mesotrione at 0.188 lb ai/A was comparable to a PREE plus a POST application and both of these treatments were superior to a single PREE application. Dicamba and diflufenzopyr plus dicamba applied POST gave very good pigweed control. Carfentrazone gave slightly less than acceptable control of pigweed.

Table. Evaluation of preemergence and postemergence herbicides for sweet corn weed control.

Treatment	Rate	timing	Corn injury		Weed control	
			16 DAT-1	12 DAT-2	16 DAT-1	12 DAT-2
	lb ai/A		----- % -----		---------- % ----------	
Untreated check			0	0	0	0
Mesotrione	0.188	PREE	0	3	81	73
Mesotrione	0.24	PREE	0	0	90	76
s-metolachlor	0.75	PREE	0	5	89	75
Dimethenamid-P	0.75	PREE	0	3	85	73
Pendimethalin	0.75	PREE	0	2	93	84
Mesotrione	0.188	POST	-	3	-	99
Mesotrione	0.24	POST	-	5	-	99
Diflufenzopyr + dicamba	0.075 + 0.188	POST	-	3	-	97
Dicamba	0.63	POST	-	5	-	97
Carfentrazone	0.008	POST	-	3	-	80
Mesotrione + mesotrione	0.188 + 0.188	PREE + POST	0	0	84	99
Mesotrione + mesotrione	0.24 + 0.24	PREE + POST	0	0	89	99
LSD (p=0.05)			0	5.3	8.2	8.3

Weed control in potatoes with preemergence herbicides: two- and three-way tank mixtures. Pamela J.S. Hutchinson, Felix E. Fletcher, and Brent R. Beutler. (Aberdeen Research and Extension Center, University of Idaho, Aberdeen, ID 83210). The objective of this trial was to compare standard preemergence two- and three-way tank mixtures including EPTC, ethalfluralin, metribuzin, pendimethalin, rimsulfuron, and s-metolachlor. The trial area was infested with 20 redroot pigweed, 30 common lambsquarters, 20 to 30 hairy nightshade, 1 kochia, 1 green foxtail, and 1 volunteer oat/m^2.

The experimental area was fertilized with 100 lb N, 230 lb P_2O_5, 50 lb K_2O, and 2 lb Zn/A before planting. 'Russet Burbank' potatoes were planted 5 inches deep at 12-inch intervals in rows spaced 36 inches apart on May 1, 2001in a Declo loam soil with 1.4% organic matter and pH 8.2. The experimental design was a randomized complete block with three replications. Plot size was 12 by 30 feet.

Potatoes were hilled, and 0.27 lb/A imidacloprid was applied on May 17, 2001. Herbicides treatments were applied after hilling and just prior to potato emergence on May 22, 2001, with a CO_2-pressurized backpack sprayer that delivered 17.5 gpa at 30 psi. Herbicides were incorporated by 0.50-inch sprinkler irrigation immediately after application. No potato or weed plants were exposed at time of application.

Potatoes were sprinkler irrigated as needed throughout the growing season and received additional N and P_2O_5, based on petiole test results, through the irrigation system. Mancozeb (1.5 lb/A) was applied through the irrigation system July 25, 2001. Potato vines were desiccated with 0.375 lb/A diquat September 7, 2001. Tubers were harvested from 25 feet of each of the two center rows in each plot using a single-row mechanical harvester on Sept 18, 2001 and graded according to USDA standards.

Visual weed control ratings were performed throughout the growing season, and a final rating was conducted pre-harvest on August 27, 2001. At pre-harvest, all three-way tank mixtures provided >90% control of redroot pigweed, kochia, green foxtail, and volunteer oat with the exception of EPTC + metribuzin + s-metolachlor, and rimsulfuron + metribuzin + EPTC (88.3% green foxtail control) (Table 1). All two-way tank mixtures including metribuzin or rimsulfuron resulted in >90% control of the two grasses present, and redroot pigweed and kochia, with the exception of metribuzin + ethalfluralin (89.3% volunteer oat control), rimsulfuron + s-metolachlor (87.7% green foxtail control), and rimsulfuron + EPTC (87.7% V.Oat control). EPTC + pendimethalin resulted in < 90% redroot pigweed and kochia control; EPTC + s-metolachlor resulted in <90% kochia control; and EPTC + ethalfluralin resulted in <90% kochia, green foxtail, and volunteer oat control.

All two-way tank mixtures including metribuzin or EPTC (with the exception of EPTC + ethalfluralin), and all three-way tank mixtures provided >90% common lambsquarters control mid-season and pre-harvest (Table 1). EPTC + ethalfluralin resulted in 87.5 and 75.3% common lambsquarters control mid-season, and at pre-harvest, respectively. While rimsulfuron + pendimethalin or s-metolachlor resulted in > 90% common lambsquarters control mid-season, control was less than 90% at pre-harvest. Rimsulfuron + ethalfluralin only was providing 75% common lambsquarters control at pre-harvest. The only rimsulfuron two-way tank mixtures providing >90% common lambsquarters control at pre-harvest were rimsulfuron + EPTC or metribuzin. Rimsulfuron + metribuzin + EPTC was the only treatment providing >90% hairy nightshade control at pre-harvest (Table 1).

Little or no crop injury was observed in this trial throughout the growing season. All herbicide treatments resulted in greater total tuber yields compared to the weedy check (Table 2).

Table 1. Season-long weed control with two- and three-way tank mixed preemergence herbicides in 2001.

		Weed control[1]							
		AMARE	KCHSC	SETVI	V. Oat	CHEAL		SOLSA	
Treatment	Rate	8/27	8/27	8/27	8/27	6/30	8/27	6/30	8/27
	lb/A	%							
Metribuzin									
+ pendimethalin	0.5 + 1.0	98	99.3	99	96.7	98.3	99.3	81.7	65
+ s-metolachlor	0.5 + 1.34	99.3	99.3	99	99	99.7	99.3	83.3	76.7
+ EPTC	0.5 + 3.0	98	99.3	95	91.3	99.7	99.3	83.3	78.3
+ ethalfluralin	0.5 + 0.94	98	99.7	90	89.3	100	98	83.3	70
+ rimsulfuron	0.5 + 0.023	99.3	98	96.3	90	100	99	90	80
Rimsulfuron									
+ pendimethalin	0.023 + 1.0	99.3	96.3	93.3	92.3	95	86	90	82.7
+ s-metolachlor	0.023 + 1.34	94.7	91	87.7	91	93.3	85	90	83.3
+ EPTC	0.023 + 3.0	99	93	91.3	87.7	100	93	93.3	85
+ ethalfluralin	0.023 + 0.94	94	94.7	96.3	96.3	86.7	75	86.7	76.7
EPTC									
+ pendimethalin	3.0 + 1.0	84.7	87.7	96	94.7	96.7	94	83.3	75
+ s-metolachlor	3.0 + 1.34	96.3	86.7	91.7	95	91.7	90	88.3	73.3
+ ethalfluralin	3.0 + 0.94	91.5	79	86.3	87.5	87.5	75.3	82	74.5
+ rimsulfuron	3.0 + 0.023	99	94.7	94.7	94.7	98.3	90	88.3	82.7
EPTC + Metribuzin									
+ pendimethalin	3.0 + 0.5 + 0.75	98	99.3	94.7	94.7	98.3	96.3	90	84.3
+ s-metolachlor	3.0 + 0.5 + 1.0	96.7	99	88.3	93	96.7	96.3	88.3	79.7
+ ethalfluralin	3.0 + 0.5 + 0.94	95	99	94.3	94.3	100	99	83.3	76.7
Rimsulfuron + Metribuzin									
+ pendimethalin	0.023 + 0.5 + 0.75	99	99.7	91.3	94.7	100	99.3	95	87
+ s-metolachlor	0.023 + 0.5 + 1.0	99.7	98	93	90	100	98	95	88.7
+ ethalfluralin	0.023 + 0.5 + 0.94	99.7	99.7	93	92.3	100	99.7	91.7	88.3
+ EPTC	0.023 + 0.5 + 3.0	99.7	99.7	88.3	86.7	96.7	98	96.3	91.7
Pendimethalin + S-metolachlor									
+ metribuzin	0.75 + 1.0 + 0.5	99.3	99.3	94	91.3	100	99.3	91.3	83.3
+ rimsulfuron	0.75 + 1.0 + 0.023	99.3	96	95.3	95.3	95	91	90	83.3
+ EPTC	0.75 + 1.0 + 3.0	91.7	93	96	94.7	96.7	96	86.3	81.7
LSD (0.05)	-	5.74	7.35	8.82	8.92	6.29	6.4	9.08	15.11

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

Table 2. Potato crop response to two- and three-way tank mixed preemergence herbicides in 2001.

Treatment	Rate	U.S. No. 1	Total Tuber
	lb/A	---------------cwt/A---------------	
Weedy check	-	86.83	139.49
Weed-free control	-	188.86	299.11
Metribuzin			
+ pendimethalin	0.5 +1.0	160.50	272.78
+ s-metolachlor	0.5 + 1.0	171.82	266.01
+ EPTC	0.5 + 3.0	173.17	275.01
+ ethalfluralin	0.5 + 0.94	152.85	253.33
+ rimsulfuron	0.5 + 0.23	147.23	254.39
Rimsulfuron			
+ pendimethalin	0.023 + 1.0	168.72	287.50
+ s-metolachlor	0.023 +1.34	159.14	245.29
+ EPTC	0.023 + 3.0	182.37	287.01
+ ethalfluralin	0.023 + 0.94	167.46	263.68
EPTC			
+ pendimethalin	3.0 + 1.0	175.79	270.75
+ s-metolachlor	3.0 + 1.34	213.93	304.24
+ ethalfluralin	3.0 + 0.94	140.70	221.39
+ rimsulfuron	3.0 + 0.23	177.63	275.59
EPTC + Metribuzin			
+ pendimethalin	3.0 + 0.75 + 0.5	130.68	266.68
+ s-metolachlor	3.0 + 0.5 + 1.0	179.66	283.33
+ ethalfluralin	3.0 + 0.5 + 0.94	156.04	253.04
Rimsulfuron+Metribuzin			
+ pendimethalin	0.023+ 0.5 + 0.75	150.43	287.01
+ s-metolachlor	0.023 + 0.5 + 1.0	160.01	269.98
+ ethalfluralin	0.023 + 0.5 + 0.94	142.97	274.24
+ EPTC	0.023 + 0.5 + 3.0	153.14	264.46
Pendimethalin +S-metolachlor			
+ metribuzin	0.75 + 1.0 + 0.5	199.50	300.85
+ rimsulfuron	0.75 + 1.0 + 0.023	180.72	268.23
+ EPTC	0.75 + 1.0 + 3.0	196.60	283.24
LSD (0.05)	-	60.98	48.65

'Russet Burbank' potato tolerance to preemergence sulfentrazone tank mixtures. Pamela J.S. Hutchinson, Felix E. Fletcher, and Brent R. Beutler. (Aberdeen Research and Extension Center, University of Idaho, Aberdeen, ID 83210). The objective of this experiment was to compare tolerance of 'Russet Burbank' potato to preemergence applications of sulfentrazone to tank mixtures of sulfentrazone and standard preemergence herbicides. The experimental area was fertilized with 100 lb N, 310 lb P_2O_5, 230 lb K_2O, lb Zn, 2 lb Mn, and 0.5lb Cu/A before planting 'Russet Burbank' potatoes on May 7, 2001. Potatoes were planted 5 inches deep at 12-inch intervals in rows spaced 36 inches apart in a Declo loam soil with 1.4% organic matter and pH 8.1 in a field trial at the Aberdeen Research and Extension Center. The experimental design was a randomized complete block with four replications. Plot size was 12 by 30 feet.

Potatoes were hilled and 0.27 lb/A imidacloprid was applied on May 23, 2001, just prior to potato emergence. Herbicide treatments were applied on May 30, 2001 with a CO_2-pressurized backpack sprayer that delivered 17.5 gpa at 30 psi. There were no potato or weed plants exposed at the time of application. Herbicides were incorporated by sprinkler irrigation with 0.5 inch of water immediately after application. The trial area, including a weed-free control treatment, was maintained weed-free by hand-weeding throughout the growing season.

Potatoes were sprinkler irrigated as needed throughout the growing season, and received additional N through the irrigation system based on petiole test results. Mancozeb (1.5 lb/A) was applied through the irrigation system July 24, 2001. Potato vines were desiccated with 0.375 lb/A diquat September 19, 2001. Tubers were harvested from 25 feet of each of the two center rows in each plot using a single-row mechanical harvester on October 1, 2001, and graded according to USDA standards.

Similar to an Aberdeen trial conducted in 2000, sulfentrazone + s-metolachlor or pendimethalin resulted in numerically less 'Russet Burbank' crop injury compared to the same rate of sulfentrazone applied alone (Table, year 2000 data not shown). Sulfentrazone + dimethenamid-p resulted in greater initial crop injury in 2000, and similar crop injury in 2001, compared to sulfentrazone applied at the same rate alone, while sulfentrazone + metribuzin resulted in similar initial crop injury in 2000, and greater crop injury in 2001, compared to sulfentrazone applied at the same rate alone. In 2000, total tuber and U.S. No. 1 yields in sulfentrazone tank mixture treated plots were not different than yields from plots treated with the same sulfentrazone rate applied alone (data not shown). In 2001, however, U.S. No. 1 tuber yields were reduced as a result of sulfentrazone + pendimethalin or s-metolachlor compared to the same sulfentrazone rate applied alone (Table).

Table. Potato crop response to sulfentrazone and sulfentrazone tank-mixtures in a weed-free study.

Treatment	Rate	Crop injury		Tuber yield	
		6/19	7/12	U.S. No. 1	Total
	lb/A	--------------%-------------		-------------cwt/A------------	
Weed Free Control		0	0	60.79	213.15
Sulfentrazone	0.063	0	1.7	73.37	210.44
Sulfentrazone	0.094	5	13.3	108.22	240.16
Sulfentrazone	0.125	13.3	11.7	67.57	193.41
Sulfentrazone	0.188	18.3	21.7	105.61	235.90
Sulfentrazone	0.25	26.7	26.7	82.67	207.15
Sulfentrazone + s-metolachlor	0.094+ 1	10	5	72.89	209.18
Sulfentrazone + pendimethalin	0.094+ 1	6.7	6.7	73.57	201.44
Sulfentrazone + EPTC	0.094+ 3	5	18.3	82.86	218.67
Sulfentrazone + dimethenamid-p	0.094+ 0.64	10	11.7	102.70	231.74
Sulfentrazone + metribuzin	0.094+ 0.5	6.7	23.3	81.70	235.90
Sulfentrazone + rimsulfuron	0.094+ 0.023	6.7	18.3	90.90	206.67
LSD(0.05)		6.49	14.73	33.14	47.47

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

The trial area was fertilized with 100 lb N, 230 lb P_2O_5, 50 lb K_2O, and 2 lb Zn/A before planting. 'Russet Burbank' potatoes were planted 5 inches deep at 12-inch intervals in rows spaced 36 inches apart on May 1, 2001. The soil was a Declo loam soil with 1.4% organic matter and pH 8.2. The experimental design was a randomized complete block with three replications. Plot size was 12 by 30 feet.

Potatoes were hilled and 0.27 lb/A imidacloprid was applied on May 17, 2001, just prior to potato emergence. The trial area was treated with a postemergence application of metribuzin to limit weed populations to hairy nightshade. Desiccant treatments were applied on August 14, and Aug 22, 2001 with a tractor-mounted CO_2-pressurized sprayer that delivered 27 gpa at 32 psi. Potatoes were sprinkler irrigated as needed throughout the growing season and received additional N and P_2O_5, based on petiole test results, through the irrigation system. Mancozeb (1.5 lb/A) was applied through the irrigation system July 25, 2001.

Late-season hairy nightshade control by sequential applications carfentrazone, applied alone with methylated seed oil (MSO), or Silwet, or tank mixed with endothall or diquat and MSO, was compared to control resulting from single applications of endothall + MSO, glufosinate ammonium, paraquat, sulfuric acid, or diquat. Single application treatments were applied the same day as the 1st application in the carfentrazone sequential treatments. Sulfuric acid, diquat, or glufosinate ammonium + ammonium sulfate (AMS), ethylated seed oil, or SuperTin and AMS, resulted in >90% hairy nightshade control 1 week after treatment (Table). Carfentrazone + diquat + MSO was providing 87% hairy nightshade control 1 week after the first application, just prior to the second application. Two weeks after the first application/one week after the second carfentrazone application, all carfentrazone treatments were providing >85% control, and all other treatments except paraquat or endothall alone were providing >89% hairy nightshade control. By the third week after the initial application, all treatments except paraquat or endothall were providing >89% hairy nightshade control. A single paraquat or endothall application resulted in 83% or 43% hairy nightshade control, respectively, 3 weeks after treatment. Hairy nightshade control by 30 and 100%v/v CT-311, a sulfuric acid formulation from Cheltec, Inc., was comparable to commercial grade sulfuruic acid.

Hairy nightshade seed germination testing performed in the greenhouse after fall 2001 harvest has revealed no difference between desiccation treatments. Fewer hairy nightshade seeds were present in plots with >90% hairy nightshade control 1 week after application. Seed germination testing will be completed spring 2002.

At 1 week after the first application, just prior to the second application, carfentrazone + endothall (0.5 + 0.05 lb/A), carfentrazone + diquat (0.375 or 0.5 + 0.25), and carfentrazone alone at 0.75 lb/A were the only carfentrazone treatments providing ≥90% potato desiccation (Table 1). All glufosinate ammonium treatments, diquat alone treatments, paraquat, and commercial grade sulfuric acid or CT-311 sulfuric acid treatments resulted in >90% potato desiccation 1 week after the first application. At two weeks after the second application, all carfentrazone treatments were providing >90% potato desiccation, and by three weeks after the second application, the only desiccation treatment with less than 90% potato desiccation was the endothall treatment.

Table. Potato desiccation and late-season hairy nightshade control.

Treatment	Rate	Timing[6]	Potato desiccation				SOLSA control			
			8/22[1]	8/31	9/4	9/12	8/22	8/31	9/4	9/12
	lb/A		%							
Untreated Control			0	15	36.7	80	0	0	0	0
Carfentrazone[2] + carfentrazone[2]	0.025+ 0.025	A B	76.7	76.7	99.3	100	63.3	88.3	97.3	98.3
Carfentrazone[3] + carfentrazone[3]	0.025+ 0.025	A B	80	88.3	99.7	100	75	86.7	97	97.3
Carfentrazone[2] + carfentrazone[2]	0.0375+ 0.0375	A B	86.7	88.3	99.7	100	81.7	93.3	98.7	98.3
Carfentrazone[3] + carfentrazone[3]	0.0375+ 0.0375	A B	82.7	82.7	99.3	99.7	70	86.7	97.3	94
Carfentrazone[2] + carfentrazone[2]	0.05+ 0.05	A B	88.3	86.7	99.3	100	78.3	93.3	98.3	98.7
Carfentrazone[3] + carfentrazone[3]	0.05+ 0.05	A B	83.3	94	97.7	100	63.3	88.3	96	98.7
Carfentrazone[2] + endothall + carfentrazone[2] + endothall	0.0375+ 0.5+ 0.0375+ 0.5	A B	89.3	96.3	99	100	76.7	84.3	91.3	90.7
Carfentrazone[2]	0.05	A	88.3	93	99.7	100	81.7	88.3	92.7	91
Carfentrazone[2] + endothall + carfentrazone[2] + endothall	0.05+ 0.5+ 0.05+ 0.5	A B	91.7	97.7	99.3	100	80	86	88.7	92.7
Carfentrazone[2] + diquat + carfentrazone[2] + diquat	0.025+ 0.25+ 0.025+ 0.25	A B	89.3	96.3	100	100	81.7	93.3	99.3	99
Carfentrazone[2] + diquat + carfentrazone[2] + diquat	0.0375+ 0.25+ 0.0375+ 0.25	A B	91.7	97.7	100	100	87.7	95	99.3	99.7
Carfentrazone[2] + diquat + carfentrazone[2] + diquat	0.05+ 0.25+ 0.05+ 0.25	A B	90	97.7	100	100	86.7	95	99.3	99.7
Carfentrazone[2]	0.075	A	90	99	99	100	80	88.3	89.7	87.7
Carfentrazone[2] + carfentrazone[2]	0.05+ 0.05	A B	63.3	81.7	98	100	66.7	83.3	96.8	98.1
Carfentrazone[2] + carfentrazone[2]	0.075+ 0.075	A B	76.7	86.7	99.7	100	75	90	99	99
Endothall[2]	0.5	A	21.7	53.3	91.3	88.7	15	26.7	43.3	36.7
Glufosinate + AMS Plus	0.375+ 1% v/v	A	97.7	99	99.3	100	91.3	85	91.7	93.7
Glufosinate + Super-Tin+ AMS Plus	0.375+ 0.1875+ 1% v/v	A	96.3	99	99.3	100	91.7	95	94.7	94.7
Glufosinate + hasten	0.375+ 0.25% v/v	A	91.3	96.3	100	100	75	90	98.3	98.7
Diquat[4] + diquat[4]	0.25+ 0.25	A B	95.7	97.7	100	100	91	94	96	91
Diquat[4]	0.5	A	97.3	97.7	98	99.7	92.7	93.3	93.7	95.3
Diquat[4]	0.375	A	99	99	99.7	100	96	93	93	91.3
Paraquat[4]	0.47	A	96.3	99	99.3	99.3	78.3	81.7	83.3	80
Sulfuric acid (CT-311)[5]	30% v/v	A	94.8	98.7	98.7	99.7	83.2	84.3	84.7	80
Sulfuric acid (CT-311)[5]	100% v/v	A	99.8	99	99	99.7	86.7	89.7	89.7	88.3
Sulfuric acid	100% v/v	A	99	99.7	99.7	99.7	93	90	89.7	89.7
LSD(0.05)	-	-	14.7	7.1	4.1	0.6	17.6	9.5	9.0	12.5

[1] 8/22/01 ratings were conducted just prior to Application B

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

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

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

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

[6] Timing 'A' and 'B' applications were applied August 14 and August 22, 2001, respectively.

Weed control and crop response to rimsulfuron and metribuzin: pre- and postemergence. Pamela J.S. Hutchinson, Felix E. Fletcher, and Brent R. Beutler. (Aberdeen Research and Extension Center, University of Idaho, Aberdeen, ID 83210). This experiment was designed to evaluate the efficacy and crop safety of rimsulfuron and metribuzin alone and as tank mix partners applied preemergence (PRE) or postemergence (POST) with 32%N + NIS. These herbicide combinations were compared to a weedy check and a weed-free control.

The experimental area was fertilized with 100 lb N, 230 lb P_2O_5, 50 lb K_2O, and 2 lb Zn/A before planting 'Russet Burbank' potatoes on May 1, 2001. Potatoes were planted 5 inches deep at 12-inch intervals in rows spaced 36 inches apart in a Declo loam soil with 1.4% organic matter and pH 8.2 at the Aberdeen Research and Extension Center, ID. The experimental design was a randomized complete block with three replications. Pot size was 12 by 30 feet.

Potatoes were hilled and 0.27 lb/A imidacloprid was applied on May 17, 2001, just prior to potato emergence. PRE and POST herbicides treatments were applied on May 23, and June 16, 2001, respectively, with a CO_2-pressurized backpack sprayer that delivered 17.5 gpa at 30 psi. PRE treatments were incorporated by 0.5-inch sprinkler irrigation immediately after application. No potato or weed plants were exposed at the time of the PRE application. At the time of the POST application, potatoes were 8 inches tall. Weed sizes/stages at the time of the POST application were as follows: common lambsquarters 1 to 2 inch/3 leaf, hairy nightshade 1 to 2 inch/4 leaf, redroot pigweed 1 to 2 inch/4 leaf, kochia 2 to 3 inch/8 leaf, green foxtail 3 inch 2 to 4 leaf and volunteer oat 2 inch/2 to 3 leaf. Weed populations at POST application time were 40 to 50common lambsquarters, 200 hairy nightshade, 40 redroot pigweed, 1 kochia, 1 green foxtail, and 1 volunteer oat/m^2. Rimsulfuron alone POST treatments included 32%N and NIS, and the rimsulfuron + metribuzin POST treatment included NIS.

Potatoes were sprinkler irrigated as needed throughout the growing season, and received additional N and P_2O_5, based on petiole test results, through the irrigation system. Mancozeb (1.5 lb/A) was applied through the irrigation system July 25, 2001. Potato vines were desiccated with 0.375 lb/A diquat September 7, 2001. Tubers were harvested from 25 feet of each of the two center rows in each plot using a single-row mechanical harvester on Sept 20, 2001, and graded according to USDA standards.

On June 16, 2001, just prior to the POST application, the PRE treatments were providing $\geq$80% control of all weeds present with the exception of metribuzin (74% hairy nightshade control) (data not shown). At 2 weeks after the POST application timing, all treatments were providing >90% redroot pigweed control (Table 1). The rimsulfuron alone PRE and POST treatments were providing <80% common lambsquarters and kochia, and all treatments were providing >90% hairy nightshade control with the exception of metribuzin PRE (68.3%), rimsulfuron + metribuzin PRE (83.3%) (0.023 + 0.5 lb/A), and rimsulfuron alone PRE at 0.023 lb/A (86.7%).

At the pre-harvest weed control rating conducted September 4, 2001, all herbicide treatments resulted in >90% redroot pigweed control (Table 1). Common lambsquarters and kochia control resulting from rimsulfuron alone treatments was <72% regardless of timing. The rimsulfuron + metribuzin PRE, and metribuzin PRE + rimsulfuron POST treatments more effectively controlled common lambsquarters and kochia compared to the PRE rimsulfuron, or POST rimsulfuron alone treatments. Of the rimsulfuron alone treatments, only the 0.31 lb/A rate resulted in >90% hairy nightshade control at pre-harvest. Green foxtail and volunteer oat were controlled at $\geq$90% by all treatments with the exception of rimsulfuron 0.023 lb/A alone PRE. Rimsulfuron alone 0.031 PRE resulted in 88.3% green foxtail and volunteer oat control pre-harvest, and metribuzin PRE resulted in 88.3% green foxtail control pre-harvest.

Slight injury as chlorosis and stunting was observed 4 days after the POST application timing in the PRE rimsulfuron + metribuzin, PRE metribuzin 0.5 lb/A + POST rimsulfuron 0.023 lb/A, and POST rimsulfuron + metribuzin + NIS treatments (Table 2). No injury was observed 10 days later on June 30, 2001. All herbicide treatments had greater total tuber yields compared to the weedy check with the exception of rimsulfuron alone 0.031 lb/A POST (Table 2). Rimsulfuron alone PRE or POST, metribuzin alone PRE, and metribuzin PRE + 0.023 lb/A rimsulfuron POST did not have U.S. No. 1 tuber yields significantly different than the weedy check.

Table 1. Season-long weed control with rimsulfuron and metribuzin applied pre- and postemergence.

Treatment	Rate	Application timing[4]	Weed control[1]											
			AMARE		CHEAL		KCHSC		SOLSA		SETVI		V. OAT	
			6/30	9/4	6/30	9/4	6/30	9/4	6/30	9/4	6/30	9/4	6/30	9/4
	lb/A		%											
Rimsulfuron	0.023	PRE	98	91	73.3	43.3	71.7	71.7	86.7	75	88.3	83.3	88.3	83.3
Rimsulfuron	0.031	PRE	99.7	98	75	50	78.3	66	91.7	84.3	93.3	88.3	93.3	88.3
Metribuzin	0.5	PRE	99.7	96	98	97.7	99.3	96	68.3	61.7	94.3	88.3	94.3	90
Rimsulfuron + metribuzin	0.023+ 0.5	PRE PRE	100	100	100	98.3	100	99.7	93.3	83.3	93.3	93.3	93.3	94.7
Rimsulfuron + metribuzin	0.031+ 0.5	PRE PRE	100	100	96.7	98	99.7	97.7	96	91.3	93	96.3	93	96.3
Metribuzin + rimsulfuron[2,3]	0.5+ 0.023	PRE POST	100	100	100	100	100	100	99.3	97.3	96	96	96	96
Metribuzin + rimsulfuron[2,3]	0.5+ 0.031	PRE POST	100	100	100	100	100	100	99.7	98.3	98	98	98	96.3
Rimsulfuron[2,3]	0.023	POST	99.7	100	56.7	60	53.3	53.3	94.7	86.7	97.7	93.3	97.7	93.3
Rimsulfuron[2,3]	0.031	POST	100	99.3	60	53.3	53.3	63.3	99.3	95	99	91.7	99	91.7
Rimsulfuron + metribuzin[2]	0.023+ 0.5	POST POST	100	99.7	100	100	93.3	96.3	96.7	93.3	100	99	100	99
LSD(0.05)	-	-	1.5	3.5	13.	8.9	8.1	16.7	14.8	10.8	7.0	6.3	7.0	6.4

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

[2] Treatments contained NIS at 0.25% v/v.

[3] Treatments contained liquid urea (32-0-0) at 1qt/A

[4] The POST treatments were applied June 16, 2001

Table 2. Potato crop response to rimsulfuron and metribuzin applied pre- and postemergence.

Treatment	Rate	Application Timing[3]	Crop injury 6/20	Crop injury 6/30	Tuber yield U.S. No. 1	Tuber yield Total
	lb/A		-------------%-------------		------------cwt/A-----------	
Weedy check		-	0	0	52.76	95.54
Weed-free check		-	0	0	156.72	259.52
Rimsulfuron	0.023	PRE	0	0	118.00	187.60
Rimsulfuron	0.031	PRE	0	0	108.71	194.08
Metribuzin	0.5	PRE	0	0	140.17	277.33
Rimsulfuron + metribuzin	0.023+ 0.5	PRE PRE	1.7	0	183.53	302.98
Rimsulfuron + metribuzin	0.031+ 0.5	PRE PRE	6.7	0	204.44	314.70
Metribuzin + Rimsulfuron[1,2]	0.5+ 0.023	PRE POST	4.8	0	123.23	259.81
Metribuzin + Rimsulfuron[1,2]	0.5+ 0.031	PRE POST	0	0	159.04	283.14
Rimsulfuron[1,2]	0.023	POST	0	0	110.54	182.37
Rimsulfuron[1,2]	0.031	POST	0	0	78.70	129.81
Rimsulfuron + Metribuzin[1]	0.023+ 0.5	POST POST	11.7	0	258.55	378.78
LSD(0.05)	-	-	3.6	ns	92.95	80.68

[1] Treatments contained NIS at 0.25% v/v.
[2] Treatments contained liquid urea (32-0-0) at 1qt/A
[3] The POST treatments were applied June 16, 2001

Weed control in potatoes with dimethenamid-p and standard preemergence herbicide tank mixtures. Pamela J.S. Hutchinson, Felix E. Fletcher, and Brent R. Beutler. (Aberdeen Research and Extension Center, University of Idaho, Aberdeen, ID 83210). The objective of this trial was to compare preemergence weed control with dimethenamid-p and standard herbicides alone or in tank mixtures. The Aberdeen Research and Extension trial area was infested with 150 hairy nightshade, 40 common lambsquarter, 40 redroot pigweed, 1 green foxtail, 1 volunteer oat, and 9 kochia/m^2.

The experimental area was fertilized with 100 lb N, 230 lb P_2O_5, 50 lb K_2O, and 2 lb Zn/A before planting 'Russet Burbank' potatoes on May 1, 2001. Potatoes were planted 5 inches deep at 12-inch intervals in rows spaced 36 inches apart in a Declo loam soil with 1.4% organic matter and pH 8.2. The experimental design was a randomized complete block with three replications and 12 by 30 foot plots.

Potatoes were hilled and 0.27 lb/A imidacloprid was applied on May 17, 2001, just prior to potato emergence. Herbicide treatments were applied on May 22, 2001, with a CO_2-pressurized backpack sprayer that delivered 17.5 gpa at 30 psi. Herbicides were incorporated by 0.5-inch sprinkler irrigation immediately after application. No potato or weed plants were exposed at time of application.

Potatoes were sprinkler irrigated as needed throughout the growing season and received additional N and P_2O_5, based on petiole test results, through the irrigation system. Mancozeb (1.5 lb/A) was applied through the irrigation system July 25, 2001. Potato vines were desiccated with 0.375 lb/A diquat September 7, 2001. Tubers were harvested from 25 feet of each of the two center rows in each plot using a single-row mechanical harvester on Sept 18, 2001, and graded according to USDA standards.

Weed control was rated throughout the growing season, and a final rating was performed pre-harvest on August 22, 2001. Dimethenamid-p alone resulted in >90% pre-harvest weed control of all weeds present with the exception of common lambsquarters and hairy nightshade, which were controlled 89.7 and 87.7%, respectively (Table 1). Pendimethalin alone only resulted in >90% pre-harvest kochia control. Metribuzin alone provided >90% control of all weeds present except hairy nightshade and volunteer oat. Rimsulfuron alone resulted in >90% control of redroot pigweed, green foxtail, and volunteer oat. EPTC alone only provided >90% green foxtail control, and s-metolachlor alone resulted only in >90% green foxtail and volunteer oat control. All tank mixtures of these standard preemergence herbicides with dimethenamid-p resulted in >90% season-long control of all weeds present. Dimethenamid-p + metribuzin, and a three-way tank mixture of dimethenamid-p + pendimethalin + metribuzin resulted in >95% season-long control of all weeds present.

Little or no crop injury was observed throughout the growing season (Table 2). Dimethenamid-p was the only herbicide applied alone resulting in greater U.S. No. 1 tuber yields compared to the weedy check (Table 2). Pendimethalin, rimsulfuron, or s-metolachlor applied alone did not result in greater total tuber yields compared to the weedy check.

Table 1. Season-long weed control with preemergence dimethenamid-p and standard herbicides in potatoes.

		Weed control[1]											
		AMARE		CHEAL		KCHSC		SOLSA		SETVI		V. OAT	
Treatment	Rate	6/30	8/22	6/30	8/22	6/30	8/22	6/30	8/22	6/30	8/22	6/30	8/22
	lb/A	%											
Weedy check		0	0	0	0	0	0	0	0	0	0	0	0
Weed-free control		100	100	100	100	100	100	100	100	100	100	100	100
Dimethenamid-p	0.64	100	98.7	85	89.7	93.3	90	86.7	87.7	90	97.7	90	97.7
Pendimethalin	1	80	75	88.3	75	86.7	96.3	0	0	90	86.7	90	83.3
Dimethenamid-p + pendimethalin	0.64+ 1	100	93	100	99.7	100	99.3	96	90	93.3	99.3	93.3	96.3
Metribuzin	0.5	99.3	94.3	93	94.3	97.7	96.7	63.3	10	93.3	90	93.3	88.3
Dimethenamid-p + metribuzin	0.64+ 0.5	100	99.7	100	99.7	100	98	99	96.7	97.7	99.3	97.7	94.7
Rimsulfuron	0.023	99.7	94.3	86.7	77.7	88.3	87.7	88.3	83.3	88.3	93	88.3	96.3
Dimethenamid-p + rimsulfuron	0.64+ 0.023	100	99	96.7	92.7	98.3	91.7	97.7	91.3	96.3	97.7	96.3	96
EPTC	3	93.3	79.3	86.7	85	73.3	36.7	83.3	66.7	90	91.7	90	88.3
Dimethenamid-p + EPTC	0.64+ 3	94.3	98	100	99.3	93.3	94	97.7	94.3	96.3	96	96.3	93
S-metolachlor	1	86.3	70	75	78.3	58.3	50	63.3	53.3	90	93.3	90	93.3
Dimethenamid-p + s-metolachlor	0.64+ 1	100	96.3	95	93	93.3	94	96.3	95.3	93.3	97.7	93.3	96
Dimethenamid-p + pendimethalin + metribuzin	0.64+ 1+ 0.5	100	100	100	100	100	100	97.7	98.3	97.7	99.7	97.7	98.3
LSD(0.05)	-	7.5	10.7	9.9	11.5	12.6	11.3	6.8	13.6	5.7	6.0	5.7	9.6

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

Table 2. Potato crop response to preemergence dimethenamid-p and standard herbicides.

		Crop injury		Tuber yield	
Treatment	Rate	6/20	6/30	U.S. No. 1	Total
	lb/A	%		cwt/A	
Weedy check		0	0	122.65	181.31
Weed-free control		0	0	194.47	286.43
Dimethenamid-p	0.64	0	0	213.93	304.63
Pendimethalin	1	0	0	131.45	200.47
Dimethenamid-p + pendimethalin	0.64+ 1	0	0	218.57	308.31
Metribuzin	0.5	0	0	179.27	266.01
Dimethenamid-p + metribuzin	0.64+ 0.5	1.7	0	211.41	313.05
Rimsulfuron	0.023	0	0	144.52	231.64
Dimethenamid-p + rimsulfuron	0.64+ 0.023	5	0	234.26	322.73
EPTC	3	0	0	172.59	268.04
Dimethenamid-p + EPTC	0.64+ 3	0	0	191.47	306.08
S-metolachlor	1	0	0	116.74	192.34
Dimethenamid-p + s-metolachlor	0.64+ 1	3.3	0	197.86	311.70
Dimethenamid-p + pendimethalin + metribuzin	0.64+ 1+ 0.5	3.3	0	235.61	313.34
LSD(0.05)	-	ns	ns	58.21	63.34

Weed control with preemergence flumioxazin and sulfentrazone herbicides in potatoes. Pamela J.S. Hutchinson, Felix E. Fletcher, and Brent R. Beutler. (Aberdeen Research and Extension Center, University of Idaho, Aberdeen, ID 83210). The objective of this trial was to evaluate preemergence weed control with various rates of sulfentrazone or flumioxazin applied alone or as tank mixtures with standard potato preemergence herbicides in a field trial at the Aberdeen Research and Extension Center. These herbicides were compared to a standard treatment of rimsulfuron +metribuzin in an area infested with 80 hairy nightshade, 10 common lambsquarters, 40 redroot pigweed, 20 green foxtail, 20 volunteer oat, and 1 kochia/m^2.

The experimental area was fertilized with 100 lb N, 230 lb P_2O_5, 50 lb K_2O, and 2 lb Zn/A before planting 'Russet Burbank' potatoes on May 1, 2001. Potatoes were planted 5 inches deep at 12-inch intervals in rows spaced 36 inches apart in a Declo loam soil with 1.4% organic matter and pH 8.2. The experimental design was a randomized complete block with three replications and 12 by 30 foot plots.

Potatoes were hilled and 0.27 lb/A imidacloprid was applied on May 17, 2001, just prior to potato emergence. Herbicides treatments were applied on May 23, 2001, with a CO_2-pressurized backpack sprayer that delivered 17.5 gpa at 30 psi. Herbicides were incorporated by 0.5-inch sprinkler irrigation immediately after application. No potato or weed plants were exposed at time of application.

Potatoes were sprinkler irrigated as needed throughout the growing season and received additional N and P_2O_5, based on petiole test results, through the irrigation system. Mancozeb (1.5 lb/A) was applied through the irrigation system July 25, 2001. Potato vines were desiccated with 0.375 lb/A diquat September 7, 2001. Tubers were harvested from 25 feet of each of the two center rows in each plot using a single-row mechanical harvester on Sept 20, 2001, and graded according to USDA standards.

Visual weed control ratings were performed throughout the growing season, and a final rating was conducted pre-harvest on September 7, 2001. Rimsulfuron + metribuzin provided >90% season-long control of redroot pigweed, common lambsquarters, kochia, and green foxtail, and 86.7% volunteer oat control (Table 1). While hairy nightshade control was 91% mid-season (data not shown), rimsulfuron + metribuzin hairy nightshade control at pre-harvest only was 78.3%. Sulfentrazone alone treatment rates were 0.047, 0.063, 0.094, or 0.125 lb/A. Flumioxaxin alone treatment rates were 0.063, 0.078, 0.094, 0.125, or 0.188 lb/A. The sulfentrazone or flumioxazin tank mixture rate was 0.094 lb/A. Only the highest rate of sulfentrazone (0.125 lb/A) or flumioxazin (0.188 lb/A) applied alone resulted in acceptable grass control of 88.3 and 89.3%, respectively. Sulfentrazone applied alone at 0.063 lb/A or greater, resulted in >90% redroot pigweed control. All sulfentrazone alone treatments resulted in >90% common lambsquarters and kochia control. Sulfentrazone at 0.094, or 0.125 lb/A provided >90% hairy nightshade control. Flumioxazin at 0.094, 0.125, or 0.188 lb/A applied alone resulted in >90% redroot pigweed control, while the two highest flumioxazin rates were necessary for >90% common lambsquarters control. All flumioxazin alone treatments resulted in >90% kochia or hairy nightshade control.

All sulfentrazone tank mixture treatments resulted in >90% broadleaf control (Table 1). Sulfentrazone + s-metolachlor, dimethenamid-p, metribuzin, or EPTC resulted in >90% green foxtail control. Of the sulfentrazone tank mixtures, only the combination with rimsulfuron provided>90% volunteer oat control. All flumioxazin tank mixtures resulted in >90% redroot pigweed, kochia, and hairy nightshade control, and >89% green foxtail control. Of the flumioxazin combinations, only the flumioxazin + dimethenamid-p, metribuzin, or EPTC tank mixtures resulted in >90% common lambsquarters control, and only the flumioxaxin + pendimethalin tank mixture resulted in >90% volunteer oat control. Flufenacet applied alone resulted in 99 to 100% grass control and did not provide acceptable broadleaf control (Table 1). Flufenacet combined with sulfentrazone provided >90% control of all weeds present. Flufenacet combined with flumioxazin resulted in >90% control of all weeds present with the exception of common lambsquarters at 86.7% control.

Crop response (stunting and some leaf malformation) was evident in all herbicide-treated plots prior to row closure (June 20, 2001 rating), and virtually gone 2 weeks later on July 4, 2001 (Table 2). All treatments resulted in greater U.S. No. 1 and total tuber yields compared to the weedy check. The sulfentrazone + flufenacet treatment resulted in the highest tuber yields in the trial.

Table 1. Season-long weed control with preemergence sulfentrazone or flumioxazin applied alone or in tank mixtures with standard herbicides.

Treatment	Rate	Weed control[1]					
		AMARE[2]	CHEAL	KCHSC	SOLSA	SETVI	V. OAT
	lb/A	--------------%					--------------
Sulfentrazone	0.047	84.7	94.7	99	77.7	36.7	75
Sulfentrazone	0.063	93	94.7	99	86	58.3	80
Sulfentrazone	0.094	96	96	99	94	43.3	76.7
Sulfentrazone	0.125	96	99	99	93	71.7	88.3
Sulfentrazone							
+ pendimethalin	0.094+1	97.7	99	99	95.3	88.7	79.3
+ s-metolachlor	0.094+1	94	96.3	99	90.7	93.3	84.3
+ dimethenamid-p	0.094+0.64	96.3	99	99	94.3	94.7	82
+ rimsulfuron	0.094+0.023	99	99	99	96.3	89.7	91.7
+ metribuzin	0.094+0.5	97.7	99	99	90.7	90.3	87
+ EPTC	0.094+3	97.7	99	99	97.7	96	82.7
Flumioxazin	0.063	86.3	75	99	90	36.7	53.3
Flumioxazin	0.078	80	73.3	99	96	70	76.7
Flumioxazin	0.094	91.7	71.3	99	96.3	79.7	83.3
Flumioxazin	0.125	96	91.3	99	97.3	70	86.7
Flumioxazin	0.188	90.7	94.7	99	97.7	92.7	89.3
Flumioxazin							
+ pendimethalin	0.094+1	91.3	88.7	99	97.7	89.3	94.7
+ s-metolachlor	0.094+1	94	89.7	99	96.3	94.7	87.7
+ dimethenamid-p	0.094+0.64	99	96.3	99	99	96.3	87.7
+ rimsulfuron	0.094+0.023	94.3	88	99	91.3	90	88.7
+ metribuzin	0.094+0.5	99	99	99	97.3	96.3	86.7
+ EPTC	0.094+3	92.3	92.3	97.7	96.3	91.3	81
Flufenacet	1.2	23.3	23.3	0	0	99	99
Sulfentrazone + flufenacet	0.094+1.2	97.7	99	99	90.7	96	96
Flumioxazin + flufenacet	0.094+1.2	94.3	86.7	99	97.3	97.3	95.7
Rimsulfuron + metribuzin	0.023+0.5	97.7	96	99	78.3	93	86.7
LSD (0.05)	-	15.77	18.91	0.78	6.88	21.03	19.58

[1] Weed control data from pre-harvest rating date September 7, 2001.

[2] AMARE redroot pigweed; CHEAL common lambsquarters; KCHSC kochia; SOLSA hairy nightshade; SETVI green foxtail; V.Oat volunteer oat.

Table 2. Crop response to preemergence sulfentrazone or flumioxazin applied alone or in tank mixtures with standard herbicides.

Treatment	Rate	Crop injury		Tuber yield	
		6/20	7/4	U.S. No. 1	Total
	lb/A	--------------%------------		-------------cwt/A------------	
Weedy check	-	0	0	41.91	91.67
Weed-free control	-	0	0	182.18	258.07
Sulfentrazone	0.047	1.7	0	223.42	304.34
Sulfentrazone	0.063	6.7	1.7	186.15	265.62
Sulfentrazone	0.094	11.7	0	134.17	238.61
Sulfentrazone	0.125	16.7	0	215.38	318.38
Sulfentrazone					
+ Pendimethalin	0.094+1	8.3	1.7	216.64	330.67
+ S-metolachlor	0.094+1	6.7	1.7	217.89	336.19
+ Dimethenamid-p	0.094+0.64	6.7	1.7	272.2	365.81
+ Rimsulfuron	0.094+0.023	10	1.7	169.98	295.73
+ Metribuzin	0.094+0.5	10	0	205.21	296.02
+ EPTC	0.094+3	3.3	0	221.28	311.6
Flumioxazin	0.063	3.3	0	195.35	275.01
Flumioxazin	0.078	3.3	0	159.53	234.16
Flumioxazin	0.094	3.3	0	162.33	277.43
Flumioxazin	0.125	11.7	0	210.93	281.59
Flumioxazin	0.188	11.7	0	207.35	320.12
Flumioxazin					
+ Pendimethalin	0.094+1	1.7	0	224.87	312.08
+ S-metolachlor	0.094+1	6.7	1.7	196.89	262.62
+ Dimethenamid-p	0.094+0.64	8.3	3.3	172.3	261.36
+ Rimsulfuron	0.094+0.023	3.3	1.7	135.42	244.51
+ Metribuzin	0.094+0.5	5	1.7	196.02	306.37
+ EPTC	0.094+3	6.7	0	153.04	263.01
Flufenacet	1.2	0	0	228.54	293.69
Sulfentrazone + Flufenacet	0.094+1.2	5	0	311.21	378.01
Flumioxazin + Flufenacet	0.094+1.2	3.3	0	241.42	332.02
Rimsulfuron + metribuzin	0.023+0.5	6.7	0	171.53	271.72
LSD (0.05)	-	7.57	3.11	90.32	86.02

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

'Russet Burbank' potatoes were hilled just prior to emergence at all locations and herbicides were applied preemergence. Treatments were sprinkler or mechanically incorporated immediately after application. Applications were made May 17, 2001 in Rexburg and May 22, 2001 in Kimberly and Parma. Hairy nightshade and redroot pigweed were present at Rexburg at low populations of 1 and $3/m^2$, respectively. Kimberly had infestations of 15 redroot pigweed, 30 common lambsquarters, 20 hairy nightshade and 100 grassy weeds (mixed population of wild oat, green foxtail, and barnyardgrass)/ m^2. Populations at Parma were moderate to high, consisting of 40 common lambsquarters, 40 redroot pigweed, 40 hairy nightshade, and 70 yellow nutsedge/ m^2. Yield data were not collected at any location.

Visual weed control ratings were conducted just prior to row closure. Rimsulfuron + metribuzin provided ≥90% control of all weeds at all locations including yellow nutsedge at Parma (Table). Three-way tank mixtures of metribuzin + pendimethalin or s-metolachlor + EPTC or rimsulfuron provided ≥95% control of all weeds at all locations. Dimethenamid-p alone resulted in common lambsquarters suppression in Parma (66.7% control) compared to 94.7% common lambsquarters control at Kimberly. Dimethenamid-p alone provided ≥90% control of all weeds other than common lambsquarters at all locations. Tank mixtures of dimethenamid-p + pendimethalin, s-metolachlor, or metribuzin resulted in improved common lambsquarters control at Parma compared to dimethenamid-p applied alone. Sulfentrazone alone provided ≥95% redroot pigweed, common lambsquarters, and hairy nightshade control at all locations, and suppression of grasses present at Kimberly (75%). Tank mixtures of sulfentrazone and pendimethalin or s-metolachlor resulted in slightly greater grass control (82%). Flumioxazin alone resulted in 70 and 83.3% redroot pigweed at Kimberly and Parma, respectively, compared to 91.3% redroot pigweed control at Rexburg. Flumioxazin alone provided 80 and 86.7% common lambsquarters control at Kimberly and Parma, respectively, and ≥90% hairy nightshade control at all locations. Tank-mixing flumioxazin with pendimethalin improved redroot pigweed control at Kimberly, and common lambsquarters control at Parma compared to flumioxazin applied alone. Tank mixing flumioxazin with s-metolachlor increased redroot pigweed control at Kimberly and Parma, and common lambsquarters control at Kimberly compared to flumioxazin applied alone. Flumioxazin + pendimethalin provided 93.3% grass control at Kimberly.

Dimethenamid-p applied alone resulted in >95% yellow nutsedge control at Parma (Table). Sulfentrazone provided 48% yellow nutsedge control, and flumioxazin provided little or no suppression. Tank mixtures of sulfentrazone + pendimethalin resulted in less control (22%) than sulfentrazone alone. Sulfentrazone or flumioxazin + s-metolachlor provided >95% yellow nutsedge control.

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

		Weed control[1]									
		Rexburg		Kimberly				Parma			
Treatment	Rate	AMARE	SOLSA	AMARE	CHEAL	SOLSA	Grass	AMARE	CHEAL	SOLSA	CYPES
	lb/A	--------	--------	--------	--------	--------	--%--	--------	--------	--------	--------
Rimsulfuron + metribuzin	0.023+ 0.5	93.3	99	100	100	98.3	90	98.3	90	100	95
Pendimethalin + EPTC + metribuzin	0.75+ 3+ 0.5	99.3	95	100	100	100	97.7	100	100	100	99.7
S-metolachlor + EPTC + metribuzin	1.34+ 3+ 0.5	96.3	97.7	100	100	100	96.7	100	100	100	100
Pendimethalin + rimsulfuron + metribuzin	0.75+ 0.023+ 0.5	96.3	96	100	100	100	87.7	100	100	100	96.7
S-metolachlor + rimsulfuron + metribuzin	1.34+ 0.023+ 0.5	98.3	96.3	100	100	100	94.7	100	100	100	100
Sulfentrazone	0.094	91.7	94.7	100	100	100	75	98.3	100	100	48.3
Sulfentrazone + pendimethalin	0.094+ 1	95.3	94.7	100	100	100	81	100	100	100	21.7
Flumioxazin	0.094	91.3	90	70	80	98.3	0	83.3	86.7	100	8.3
Flumioxazin + pendimethalin	0.094+ 1	93	91.7	85	84.7	96.7	48.3	81.7	95	100	10
Dimethenamid-p	0.64	99	97.7	99.7	94.7	95	93	90	66.7	100	100
Dimethenamid-p + pendimethalin	0.64+ 1	99.3	99.3	95	93.3	100	91	90	83.3	100	98.3
Dimethenamid-p + metribuzin	0.64+ 0.5	94.7	96	99.3	100	100	99	100	100	100	100
Sulfentrazone + s-metolachlor	0.094+ 1	91.7	96.3	95	96.7	99.7	82.7	100	100	100	100
Flumioxazin + s-metolachlor	0.094+ 1	89.7	95	96.3	93.3	96.7	78.3	100	83.3	100	100
Dimethenamid-p + s-metolachlor	0.64+ 1	96	97.7	100	98.3	100	93.3	93.3	83.3	100	100
LSD(0.05)	-	9.49	5.32	15.60	17.60	4.05	23.57	9.23	21.85	ns	19.89

[1] AMARE redroot pigweed; SOLSA hairy nightshade; CHEAL common lambsquarters; CYPES yellow nutsedge, grass = wild oat, green foxtail, barnyardgrass mixture

Evaluation of new potential strawberry herbicides. Steven A. Fennimore and Jose A. Valdez. (Dept. of Vegetable Crops and Weed Science, University of California-Davis, Salinas, CA 93905) A study to evaluate new potential strawberry herbicides was initiated on August 22, 2001 near Oxnard, CA. Herbicides evaluated were: DCPA at 9.0 lb ai/A napropamide at 2.0 lb ai/A, pendimethalin at 1.0 lb ai/A and sulfentrazone at 0.125 and 0.25 lb ai/A. Combination treatments included napropamide plus sulfentrazone at 2.0 plus 0.125 lb ai/A and napropamide plus pendimethalin at 2.0 plus 1.0 lb ai/A. Herbicides were applied with a CO_2 backpack sprayer calibrated to deliver 40 gpa. The herbicides were applied to bare soil and then incorporated with 1-inch of sprinkler irrigation. After three days the soil was fumigated with chloropicrin at 200 lb ai/A. Strawberry plants, 'Camarosa', were transplanted October 27, 2001. Each treatment was replicated four times and plots were one 68-inch bed wide by 20 ft. long. Weed density counts were taken on December 12, 2001, February 5, and March 12, 2002. After each weed count the grower weeded all plots. Plant diameters were taken on March 12, 2002. Fruit was harvested weekly from January to June 2002. None of the treatments provided complete control of little mallow, but napropamide plus sulfentrazone was the best treatment (Table). Treatments that included napropamide or pendimethalin provided effective control of annual bluegrass, but sulfentrazone alone was not effective on this weed. The plant diameters in the herbicide treated plots were not different from the untreated control and there were no differences in fruit yields among the treatments.

Table. Weed densities, plant diameters and yield evaluations at Oxnard, CA.

Treatment		Little mallow	Annual bluegrass	Plant diameters	Marketable yield
	Rate lb ai/A	------------- no. 7.4 m^2	-------------	-------cm-------	---Grams /plot ---
Sulfentrazone	0.125	21.0 abc	33.3 a	24.3 abc	15,830
Sulfentrazone	0.25	15.3 bc	31.8 a	23.8 bc	15,330
Pendimethalin	1.0	18.8 abc	5.3 b	24.5 ab	15,972
Napropamide	2.0	17.8 abc	6.5 b	25.3 a	15,417
DCPA	9.0	16.0 bc	17.5 ab	24.5 ab	15,778
Napropamide + Sulfentrazone	2.0 + 0.125	11.8 c	4.5 b	24.6 ab	17,330
Napropamide + Pendimethalin	2.0 + 1.0	26.3 ab	8.0 b	23.3 c	17,404
Untreated control	0	29.5 a	32.3 a	23.4 c	15,727
LSD 0.05		12.6	16.2	1.0	2,158

Evaluation of new herbicides for use in second year strawberries (renovation through second year harvest). Diane Kaufman, Joe DeFrancesco, Judy Kowalski, 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 loam soil with 4.5% 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. Renovation and Winter Timing Trial. 'Totem' strawberries were planted on 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. During the first year of this trial, herbicides were applied May 23, 2000 and January 7, 2001. First year yield data was recorded during June, 2001 and there were no differences among treatments in total marketable yield or fruit size (see report in WSWS Proceedings, 2002). Because strawberry plantings in Oregon are usually harvested for 2 or 3 years, it was necessary to continue the trial to 1. observe how well the various herbicides would control weeds during the second year when there is a shift from annual to perennial weeds and 2. learn if any herbicides evaluated would damage mother or daughter plants during renovation or damage plants or delay spring growth when applied in winter. All plots were renovated (eg. rows mowed, narrowed, fertilized) in early July. Herbicides were applied on July 13, 2001 and followed immediately with one inch of irrigation. Phytotoxicity ratings, conducted on July 17, 2001 (4 DAT) were based on a scale of 0 to 5, with 0 = no signs of damage; 1 = a few red spots on new leaves; 2 = several red spots on new leaves; 3 = several red spots plus marginal burn; 4 = entire leaves brown and 5 = plants dead.

Table 1. Phytotoxicity ratings from herbicides applied at renovation.

Treatment	Rate	Phytotoxicity rating
	lb ai/A	0 to 5
Azafenidin	0.1	1.69
Azafenidin	0.2	2
Dimethenamid	1	0.25
Ethofumesate + flumioxazin	2+ 0.0625	2.5
Dimethenamid + flumioxazin	1+ 0.0625	3.25
Dimethenamid + sulfentrazone	1+ 0.125	2.12
Flumioxazin	0.0625	1.75
Flumioxazin	0.0925	2
Oxyfluorfen	0.25	2.5
Isoxaben + dimethenamid	0.75 + 1	0.25
Sulfentrazone	0.125	0.75
Sulfentrazone	0.25	1.38
Thiazopyr	0.5	0.12
Significance		0.0001
LSD 0.05		0.56

Treatments resulting in the least amount of leaf spotting were thiazopyr, dimethenamid, and the mixture of isoxaben + dimethenamid. The mixture of dimethenamid + flumioxazin resulted in the most phytotoxicity and caused a reddening of the new leaf growth that was very striking in those plots through most of July. Other treatments causing quite a bit of leaf spotting were oxyfluorfen, the high rates of azafenidin and flumioxazin, and the mixtures of ethofumesate + flumioxazin and dimethenamid + sulfentrazone. By August 3, 2001, growth looked normal and there were no visible signs of damage in any plots.

Quality of weed control from the renovation applications was evaluated on August 28, 2001 (45 DAT).

Table 2. Quality of weed control (expressed as percent control compared to weedy check plots or number of dandelion plants per plot), 8/28/01.

Treatment / rate lb ai/a	Broadleaf weeds[1]	Grass weeds[1]	Number of dandelions
Azafenidin 0.1	100	100	0
Azafenidin 0.2	100	100	0.75
Dimethenamid 1.0	98.12	100	2.75
Ethofumesate+flumioxazin	98.75	100	1.75
Dimethenamid+flumioxazin	100	100	1.0
Dimethenamid+sulfentrazone	99.38	100	0.5
Flumioxazin 0.0625	98.75	91.25	0.5
Flumioxazin 0.0925	100	98.12	0
Oxyfluorfen 0.25	100	99.38	0
Isoxaben+dimethenamid	93.12	98.75	3
Sulfentrazone 0.125	100	87.5	0.5
Sulfentrazone 0.25	100	91.25	0
Weeded control			1.25
Weedy control			1.25
Significance	0.0001	NS	0.0296
LSD 0.05	2.15		1.86

[1] Primary weeds: pineappleweed, groundsel, crabgrass, barnyardgrass

Broadleaf and grass weed control was excellent (90% or higher) in most treatments 45 days after application and continued to be excellent throughout the fall. However, broadleaf weed control was not as impressive in the isoxaben + dimethenamid plots as it was in all other treatments. Plots treated with dimethenamid, isoxaben + dimethenamid, and ethofumesate + flumioxazin had the greatest number of dandelions at this time.

The winter herbicide applications were made on December 30, 2001. There were very few weeds present at this time. Because no attempt had been made to cultivate the rows to remove runner plants, there was a network of runners between the rows. Weed pressure continued to be very low across all plots through early spring and weed evaluations were not conducted until April 24 and May 30, 2002 (data not shown). Primary weeds at this time were annual sowthistle, annual bluegrass, and dandelions. With the exception of dimethenamid, which provided only fair control of annual sowthistle (77.5%), all herbicides provided 90% or greater (statistically similar) control of both sowthistle and annual bluegrass. There were no differences in number of dandelion plants on April 24 or May 30, and dandelion populations remained low through harvest. Plots were so clean of weeds in late April that 3 of 4 weedy control plots had no weeds at the time of the evaluation.

This was the fourth year (combined data from our 1999 and 2000 plantings) we have seen very little weed pressure in spring, even in weedy control plots, following a winter herbicide application. Because the last three winters were abnormally dry, we attributed the low weed pressure to dry conditions. However, there was normal rainfall during the winter of 2001-2002. It appears that the lack of weed pressure in spring in the winter-timing trials may be due, at least in part, to the large mound of runners between rows that covered almost the entire ground surface and helped suppress weed growth. Although it is common practice for strawberry growers in Oregon to cut out runners during the fall, we did not want to disturb the soil following the renovation herbicide applications. On May 20, 2002 a narrow band (6 to 10 inches wide) was cultivated down the center of each aisle to facilitate picking.

Fruit was harvested three times between June 11 and June 25, 2002 from a 5- foot length of row per plot. There were no differences among treatments in yield or berry size (data not shown). Average yield and adjusted berry size for the Renovation and Winter Timing Trial were 8.94 lbs and 7.70 grams, respectively.

2. Fall Timing Trial. This planting was also established on raised beds at NWREC on May 22, 2000; however, it was used to evaluate herbicide treatments made in the fall. As in Trial 1, there were no differences among treatments in first-year yields or berry size. All plots were renovated in early July. Weeds were controlled by hand until September 28, 2001 when treatments were applied. The purpose of this trial was to simulate the traditional

fall herbicide application program designed for use of simazine. In this program, growers control weeds and strawberry runner plants with cultivation from renovation until late fall when simazine is applied.

Phytotoxicity ratings (data not shown) were conducted on October 2, 2001 (12 DAT). Strawberry plants treated with dimethenamid or simazine showed no signs of phytotoxicity. Plants treated with sulfentrazone at either rate or the mixture of sulfentrazone + dimethenamid had a few red spots on leaves of runner plants. Plants treated with flumioxazin had several red spots on leaves of both runner and established plants. The mixture of flumioxazin + dimethenamid resulted in several large red blotches on leaves of established plants and severe burn and even death of several runner plants. The only treatments to result in some burn to existing weeds present at the time of application were flumioxazin or the mixture of flumioxazin + dimethenamid.

Quality of weed control was evaluated on March 20, April 24, and May 30, 2002.

Table 3. Percent overall weed control (annuals and perennials) and number of dandelion plants on 3 dates, spring, 2002.

Treatment / rate	Weed control 3/20	Weed control 4/24	Weed control 5/30	Number of dandelions 3/20	Number of dandelions 4/24	Number of dandelions 5/30
lb ai/A						
Flumioxazin+dimethenamid 0.0625 + 1.0	86.5	86.25	95[1]	1.5	0.75	0.25[1]
Dimethenamid 1.0	62.25	50	77	4.75	6.25	1.5
Dimethenamid+sulfentrazone 1.0 + 0.125	63.75	56.75	83	5.5	6.5	1.75
Flumioxazin 0.0625	77	76.25	88	3.5	3	0.75
Sulfentrazone 0.125	78.25	64.25	78.5	3	5.75	2.5
Sulfentrazone 0.25	35	41.25	77	8.75	10.25	4
Simazine 1.0	77	63.75	85	2.5	2.75	1
Significance	NS	NS	NS	NS	NS	NS
Mean	68.54	62.64	83.32	4.21	5.04	1.68

[1] Number of dandelion plants present after established dandelions treated with glyphosate on 4/25/02. Percent overall weed control was improved on 5/30/02 by the reduction in number of dandelions.

Although there were no statistical differences among treatments for any of the parameters shown in Table 3, there were some differences in terms of levels of weed control from a practical perspective. With the exception of the mixture of flumioxazin + dimethenamid, overall weed control was only fair to poor (below 79%) in all treatments by March 20. This was mostly due to pressure from dandelion and annual broadleaf weeds (primarily pineappleweed and annual sowthistle). Weed control ratings below 85% in early spring are not acceptable because the planting would be weedy enough to require some amount of hand-hoeing. Because of the high cost of labor, it is crucial that herbicides provide good enough weed control to minimize the need for hand-hoeing or make it unnecessary. Many of the same herbicides that provided excellent spring weed control when applied in winter, did not provide adequate control when applied three months earlier.

Fruit was harvested three times between June 11 and June 25, 2002 from a 5- foot length of row per plot. There were no differences among treatments in yield or berry size (data not shown). Average yield and adjusted berry size for the Fall Timing Trial were 9.56 lbs and 8.00 grams, respectively.

Based on these results, all herbicides evaluated in the second year of these trials would have potential for use in second year strawberries in Oregon.

Weed pressure in processing tomatoes transitioning to conservation tillage. Jeffrey P. Mitchell (University of California, Davis 95616), Kurt J. Hembree and Neil Va (University of California Cooperative Extension, Fresno County 93702). Weed species biomass was quantified during the third year of a field study in Five Points, CA comparing standard tillage with and without winter cover crops and conservation tillage with and without cover crops in a rotation of processing tomatoes and cotton. Weed management operations in the standard tillage system consisted of an over-the-top application of rimsulfuron at transplanting (without cover crop treatment only), trifluralin incorporated at lay-by, two mechanical cultivations, and one hand weeding. Weed management in the conservation tillage systems relied on an application of rimsulfuron (without cover crop treatment only), two mechanical cultivations using a modified Buffalo High Residue Cultivator, and hand weeding. Total weed dry weights for black nightshade, tumble pigweed, common lambsquarters, common purslane, annual sowthistle, and junglerice were significantly higher in the conservation tillage with cover crop system relative to the standard tillage system without cover crop before the 2002 tomato crop was harvested. These data suggest the need for refined and improved weed management in conservation tillage tomato production systems.

Table. Tomato weed dry weights on August 19, 2002.

			Dry weight/150' on bed centers[1]					
Tillage type	Cover crop	Rimsulfuron	Junglerice	Lambsquarters, common	Nightshade, black	Pigweed, tumble	Purslane, common	Sowthistle, annual
		lb ai/A	(g)					
Standard	Yes	---	211 b	208 bc	822 b	159 b	1083 b	134 b
Standard	No	0.031	0 b	33 c	806 b	8 b	24 c	34 b
Conservation	Yes	---	1300 a	678 a	2763 a	494 a	3613 a	1815 a
Conservation	No	0.031	131 b	341 b	938 b	103 b	498 bc	9 b

[1]Means in each column for each of the weed species followed by the same letter are not significantly different at the 0.05 level of probability as determined by Duncan's multiple range test.

Broadleaf weed control in spring-seeded alfalfa. Richard N. Arnold, Michael K. O'Neill and Dan Smeal. (New Mexico State University Agricultural Science Center, Farmington, NM 87499) Research plots were established on May 15, 2002 at the Agricultural Science Center, Farmington, New Mexico to evaluate the response of spring-seeded alfalfa (var. RSC 451) and annual broadleaf weeds to postemergence application of imazamox and imazethapyr applied alone or in combination. Soil type was a Wall sandy loam with a pH of 7.8 and an organic matter content of less than 1%. The experimental design was a randomized complete block with three replications. Individual plots were 10 by 30 ft in size. Treatments were applied with a compressed air backpack sprayer calibrated to deliver 30 gal/A at 30 psi. Treatments were applied on June 4 when alfalfa was in the second trifoliolate leaf stage and weeds were small. A crop oil concentrate and 32-0-0 was added at 0.5 and 1.0 percent v/v to the spray mixture. Black nightshade, redroot and prostrate pigweed, and common lambsquarters infestations were heavy and Russian thistle infestations were moderate throughout the experimental area. Plots were evaluated on July 9. Alfalfa was harvested on July 29, using a self-propelled Almaco plot harvester.

Imazamox applied at 0.063 lb ai/A had an injury rating of 12. All treatments except the weedy check gave good to excellent control of prostrate and redroot pigweed, black nightshade, and common lambsquarters. Russian thistle control was good to excellent with all treatments except imazamox and imazamox plus imazethapyr applied at 0.032 and 0.024 plus 0.024 lb ai/A and the check. The weedy check had significantly higher yields as compared to other treatments. This is possibly attributed to the high weed content when harvested.

Table. Broadleaf weed control in spring-seeded alfalfa.

Treatments[a]	Rate	Weed control					Alfalfa yield
		AMABL	AMARE	SOLNI	SASKR	CHEAL	
	lb ai/A	%					t/A
Imazamox	0.032	98	98	97	88	96	2.7
Imazamox	0.04	100	100	100	92	99	2.7
Imazamox	0.047	100	100	100	93	98	2.5
Imazamox + imazethapyr	0.024+0.024	100	100	96	86	94	2.8
Imazamox + imazethapyr	0.032+0.032	100	100	100	92	99	2.6
Imazamox[b]	0.063	100	100	100	94	98	2.6
Imazamox + bromoxynil	0.032+0.25	100	100	100	100	100	2.5
Imazamox + bromoxynil	0.04+0.25	100	100	100	100	100	2.5
Imazamox + bromoxynil	0.047+0.25	100	100	100	100	100	2.4
Imazamox + clethodim	0.032+0.094	97	98	96	92	97	2.5
Imazamox + clethodim	0.04+0.094	100	100	100	90	97	2.5
Imazamox + clethodim	0.047+0.094	100	100	100	94	98	2.7
Imazethapyr	0.047	100	100	98	90	95	2.5
Imazethapyr	0.063	100	100	100	94	98	
Imazethapyr + clethodim	0.063+0.094	100	100	99	93	94	2.6
Weedy check		0	0	0	0	0	3.8

[a] Treatments were applied with a COC and AMS at 0.5% and 1.0% v/v.
[b] Treatment had an injury rating of 12.

Imazamox efficacy in seedling alfalfa. Richard P. Affeldt, Charles M. Cole, Jed B. Colquhoun, Carol A. Mallory-Smith, and Bill D. Brewster. (Department of Crop and Soil Science, Oregon State University, Corvallis, OR 97331-3002) 'Baralfalfa 54' alfalfa was seeded at 12 lb/A in 10 in row spacings on April 1, 2002, at the OSU Hyslop Research Farm near Corvallis, OR. The alfalfa was over-seeded with Italian ryegrass. The experimental design was a randomized complete block with four replications; individual plots were 8 ft by 35 ft. The Woodburn silt loam soil had a pH of 5.6 and an organic matter content of 2.6%. Herbicide treatments were applied with a single-wheel, compressed-air plot sprayer that delivered 20 gpa through XR8003 nozzle tips at 20 psi. Clethodim followed by bromoxynil was included as a standard treatment, and imazethapyr was included for comparison. Clethodim was applied at the 1-trifoliolate stage on May 7, 2002, and all other treatments were applied at the 2-trifoliolate stage on May 13. The trial site was infested with shepherdspurse, mayweed chamomile, common groundsel, and sticky chickweed. Visual evaluations were conducted on May 20 and May 31, and weeds and alfalfa were hand-harvested and weighed on July 3. Application information is presented in Table 1.

Table 1. Weed and alfalfa growth stages.

	Application date	
Growth stage	5/7/02	5/13/02
Alfalfa	1 trifoliolate	2 trifoliolate
Shepherdspurse	1 to 3 in diameter	2-4 in diameter
Mayweed chamomile	2 in diameter	3 in diameter
Common groundsel	2 in diameter	4 in diameter
Sticky chickweed	cotyledon to 2 leaf	2 to 4 leaf
Italian ryegrass	2 to 3 tillers	3 to 4 tillers

Imazamox and clethodim were more effective on Italian ryegrass than was imazethapyr (Table 2). All treatments controlled shepherdspurse, but bromoxynil was more effective on mayweed chamomile and common groundsel than was either imazamox or imazethapyr. Imazamox and imazethapyr controlled sticky chickweed, but bromoxynil was ineffective. There were no differences in weed control between crop oil concentrate and non-ionic surfactant.

Table 2. Visual evaluations and fresh weight of weeds.

		Italian ryegrass		Shepherds-purse		Mayweed chamomile		Common groundsel		Sticky chickweed		Weed fresh
Treatment	Rate	5/20	5/31	5/20	5/31	5/20	5/31	5/20	5/31	5/20	5/31	weight
	lb ai/A	%										T/A
Clethodim[1] + bromoxynil	0.25 + 0.25	99	100	94	98	94	99	100	100	28	0	1.3
Imazamox[2]	0.032	70	92	68	98	25	46	50	82	30	98	5.2
Imazamox[2]	0.039	76	96	68	96	32	58	54	81	32	98	2.0
Imazamox[2]	0.047	72	98	75	98	38	77	55	87	40	100	2.2
Imazamox[3]	0.047	75	99	70	100	32	68	55	84	45	100	2.2
Imazamox[2]+ bromoxynil	0.047 + 0.25	72	96	94	100	97	100	95	100	28	100	0.4
Imazethapyr[2]	0.048	58	81	55	97	22	48	45	75	35	97	5.1
Untreated check	0	0	0	0	0	0	0	0	0	0	0	9.0
$LSD_{(0.05)}$		8	5	11	3	13	13	18	10	9	3	1.9

[1]Crop oil concentrate (First Choice) added at 1 qt/A and urea-ammonium nitrate (32% N) added at 1 qt/A.
[2]Crop oil concentrate added at 1% v/v and urea-ammonium nitrate added at 2.5% v/v.
[3]Non-ionic surfactant (R-11) added at 0.25% v/v and urea-ammonium nitrate added at 2.5% v/v.

All treatments stunted the alfalfa (Table 3), but alfalfa yields from treated plots were greater than those of the weedy check. The highest rate of imazamox caused the greatest amount of crop stunting. There were no differences in crop injury or yield between the non-ionic surfactant and the crop oil concentrate with imazamox.

Table 3. Alfalfa injury and yield.

Treatment	Rate	Alfalfa injury		Alfalfa fresh weight
		5/20	5/31	
	lb ai/A	------------------ %	------------------	T/A
Clethodim[1] +	0.25 +	29	36	2.0
bromoxynil	0.25			
Imazamox[2]	0.032	18	24	1.3
Imazamox[2]	0.039	20	39	1.5
Imazamox[2]	0.047	25	51	1.4
Imazamox[3]	0.047	29	52	1.4
Imazamox[2]+	0.047 +	32	42	2.1
bromoxynil	0.25			
Imazethapyr[2]	0.048	11	19	1.6
Untreated check	0	0	0	0.7
$LSD_{(0.05)}$		10	15	0.6

[1]Crop oil concentrate (First Choice) added at 1 qt/A and urea-ammonium nitrate (32% N) added at 1 qt/A.
[2]Crop oil concentrate added at 1% v/v and urea-ammonium nitrate added at 2.5% v/v.
[3]Non-ionic surfactant (R-11) added at 0.25% v/v and urea-ammonium nitrate added at 2.5% v/v.

Barley tolerance to fenoxaprop applied alone and in combination with adjuvants and broadleaf herbicides. Michael J. Wille and Don W. Morishita. (Twin Falls Research and Extension Center, University of Idaho, Twin Falls, ID 83303-1827) A study was conducted in irrigated spring barley ('Camas') at the University of Idaho Research and Extension Center near Kimberly, Idaho to evaluate two-row spring barley tolerance to fenoxaprop & mefenpyr diethyl with and without broadleaf herbicide tank-mix combinations. Barley was planted April 12, 2001, at a seeding rate of 100 lb/A. Experimental design was a randomized complete block with four replications and individual plots were 8 by 25 ft. Herbicides were applied to 2-leaf barley following a nighttime low temperature of 31 F on May 2, 2001. This was followed by nighttime low temperatures of 24 and 28 F the next two days. A CO_2-pressurized bicycle-wheel sprayer calibrated to deliver 20 gpa using 11002 flat fan nozzles was used for the application. Environmental conditions at application were as follows: air temperature 43 F, soil temperature 58 F, relative humidity 96%, wind speed 8 mph, and 30% cloud cover. Crop injury was evaluated visually 7, 14, and 30 days after treatment (DAT) on May 9, May 16, and June 1, respectively. Grain was harvested August 20 with a small-plot combine.

Seven DAT, all fenoxaprop treatments injured barley 24 to 35%, with the exception of fenoxaprop + thifensulfuron + MCPA (10% injury). Tralkoxydim + bromoxynil & MCPA caused 21% crop injury 7 DAT. Injury from all fenoxaprop treatments ranged from 11 to 21% 14 DAT with fenoxaprop alone or combined with bromoxynil & MCPA, and 6% with fenoxaprop + MCPA + thifensulfuron. A higher rate of MCPA without bromoxynil appears to reduce crop injury with applications following and preceding freezing nighttime temperatures. No crop injury was evident in any treatments 30 DAT. Grain yield ranged from 48 to 61 bu/A and did not differ among treatments or from the untreated check.

Table. Spring barley response to fenoxaprop & mefenpyr diethyl combinations with adjuvants and broadleaf herbicides.

Treatment[1]	Application rate	Crop injury 5/9	Crop injury 5/16	Crop injury 6/1	Grain yield
	lb ai/A	------	%	------	bu/A
Check	-	-	-	-	55
Fenoxaprop	0.083	33	18	0	61
Fenoxaprop + Herbimax	0.083 + 0.5 % v/v	33	18	0	62
Fenoxaprop + Herbimax	0.083 + 1 % v/v	30	18	0	72
Fenoxaprop + Herbimax	0.083 + 1.5 % v/v	31	16	0	61
Fenoxaprop + Score	0.083 + 0.5 % v/v	35	18	0	61
Fenoxaprop + bromoxynil & MCPA 5	0.083 + 0.5	34	16	0	61
Fenoxaprop + bromoxynil & MCPA	0.083 + 0.5	31	19	0	63
Fenoxaprop + bromoxynil & MCPA + Herbimax	0.083 + 0.5 + 0.5 % v/v	30	14	0	56
Fenoxaprop + bromoxynil & MCPA + Herbimax	0.083 + 0.5 + 1 % v/v	29	11	0	60
Fenoxaprop + bromoxynil & MCPA + Herbimax	0.083 + 0.5 + 1.5 % v/v	38	15	0	48
Fenoxaprop + bromoxynil & MCPA + Score	0.083 + 0.5 + 0.5 % v/v	24	21	0	58
Fenoxaprop + thifensulfuron + MCPA + nonionic surfactant	0.083 + 0.0187 + 0.347 + 0.25 % v/v	10	6	0	52
Tralkoxydim + Supercharge	0.18 + 0.5 % v/v	8	0	0	60
Tralkoxydim + bromoxynil & MCPA + Supercharge	0.18 + 0.5 + 0.5 % v/v	21	4	0	51
LSD (P=.05)		9	6	0	22

[a] Fenoxaprop was applied as a commercial formulation of fenoxaprop and the safener, mefenpyr diethyl. Herbimax is a commercial crop oil and nonionic surfactant formulation. Score and Supercharge are commercial adjuvants. Bromoxynil & MCPA and bromoxynil & MCPA 5 are commercial formulations of bromoxynil and MCPA (1:1 ratio) containing 4 and 5 lb ai/gal, respectively.

Combine grainloss extent of barley. Estimating average and extreme grainloss fractions. Geoff Soper. (SEAGREEN Research, Pannetts Road, 4 R.D. Christchurch 8021, NZ). All else equal, the scale of any volunteer barley problem is directly related to the extent of barley grainlosses to the field at harvest time. This report examines the likely extent of barley grainlosses as incurred by combine harvester. In average case, these amount to 4% of barley crop yield. Combine induced grainlosses of more than 11 to 12% are unusual ($p<0.05$), but can occur.

Literature mention of combine barley grain losses is restricted to multiple measurements in German trials (Rauber, 1984, 1988) and to a chain of citations which invoke a series of little known but fairly extensive UK surveys (Marshall *et al* 1989; Cussans, 1978; Hughes, 1974; Anon, 1973; and Anon 1971). Because of a number of mistakes that have arisen in this sequence, and because some of the implications of the original surveys were not fully realized, the original onfarm records have been reanalyzed with a view towards rigor and useful context.

To this end, on-farm crop yields were calculated from average combine rate of work (acres/hr) and average combine grain-threshing rates (tons/hr), as were determined for each onfarm case. With yields known, combine grainlosses as fractions of yield could then be calculated. The distributions of these combine grainloss-fractions for the barley harvest of 1969 and for the harvests of 1969 and 1971 taken together, were notably skew (refer Figure), and closely approximated lognormal. With more limited sample numbers, the distribution for 1971 was less well defined.

Calculations of grainloss likelihoods were undertaken for both assumed normal and assumed lognormal distributions, and the results interpreted with these observations in mind. Grainloss likelihoods were also assessed for the actually occurring empirical distributions themselves as an additional check. This involved ordering the observed yearly grainloss fractions (and the yearly log-transformed grainloss fractions), assigning Hazen probabilities (table; Thode, 2002), and calculating the median ($p=0.50$), conservative ($p=0.75$) and significance-threshold ($p=0.95$) values directly from the empirical distributions. The results of these various analyses are presented in Table.

Barley incurred average harvester induced grainloss fractions of 3.9% in 1969, 4.9% in 1971, and 4.0% over both 1969 and 1971, as averaged over 111, 17, and 128 onfarm cases respectively. Over these same years, median grainloss fractions of 2.6%, 4.9% and 2.8% resp. were obtained. The distribution of grainloss fractions sampled over both 1969 and 1971 closely approximated lognormal, and so indicating a conservatively high grainloss value ($p=0.75$) of 5.0%, and a significance threshold value ($p=0.95$) of 11.7% over this period. The significance threshold value, 10.4%, estimated from the empirical distribution was in fact somewhat lower. As a general rule, slightly lower results were obtained over 1969, the most extensively surveyed single year, with good agreement between lognormal and empirical-distribution determined grainloss estimates. Quite different results were obtained for the sparsely sampled 1971 year, when likely grainloss fractions calculated from the empirical distribution closely resembled those obtained for an assumed normal distribution. For this reason they cannot be totally discounted.

In summary then, UK survey data indicates an average barley grainloss of 4%, a median grainloss value of 3%, a conservatively high grainloss ($p=0.75$) of 5%, and a significance threshold grainloss ($p=0.95$) of about 11 to 12%. If these results are taken as typical of combine grainloss extent in other years and other regions, then likely (average), median ($p=0.50$), conservatively high ($p=0.75$), and probable extreme ($p=0.95$) volunteer barley seedbank renewal via combine grainlosses at harvest, might be estimated from crop yield and 1000 kernel weight, and the scale of potential volunteer barley problems better defined.

German trial work observed barley grainlosses in the higher end of this probable range (Rauber, 1988), and exceeded it (Rauber, 1984). In the former case, combine grainlosses for barley crops varied from 2.4% to 10.5% (average 6.3%) over six tillage and nitrogen-fertilizer combinations. In a high lodging harvest year, barley grainlosses were higher still, varying from 7.5% to 19.3% (average 13.6%) over four cultivar and nitrogen-fertilizer combinations. One must bear in mind, when assessing the likely scale of a volunteer barley problem with UK survey result, that higher grainlosses can and do occur.

Finally, an important feature of these combine grainloss studies, is that barley grainloss fractions were 2 fold higher in general, than those observed for wheat (report this volume). Although many farmers and combine-harvester operators share a perception of generally higher grainlosses for barley than for wheat, the literature has a tendency to blur any barley-wheat distinction. No doubt, because of their agronomic and botanic similarities. Doing so here, in the case of their likely grainlosses or volunteer seed-bank extents, is contra-indicated.

Table. Combine barley grainloss fraction statistics.

		1969	1971	1969+71	1969	1971	1969+71
Sample		Grainloss fractions			Log (grainloss fraction) s		
		(%)	(%)	(%)	(%)	(%)	(%)
Statistics							
	mean	3.9	4.9	4.0	2.6	4.0	2.8
	std. dev.	4.4	2.7	4.2	2.4x	2.2x	2.4x
	(n)	(111)	(17)	(128)	(111)	(17)	(128)
Assumed distributions		Normal			Lognormal		
		(%)	(%)	(%)	(%)	(%)	(%)
Confidence limits							
UL [1]	p=0.50	3.9	4.9	4.0	2.6	4.0	2.8
	p=0.75	6.9	6.8	6.9	4.7	7.0	5.0^{+}
	p=0.95	11.2	9.7	11.0	11.1	16.7	11.7
Empirical distributions		Ordered grainloss fractions			Ordered log(grainloss fraction)s		
		(%)	(%)	(%)	(%)	(%)	(%)
Hazen p assignment [2]							
	p=0.50	2.6	4.9	2.8	2.6	4.9	2.8
	p=0.75	4.4	6.6	5.2	4.4	6.6	5.2
	p=0.95	11.0	9.9	10.5'	11.0	9.9	10.4

[1] UL ~ upper limit at designated p value. Student t-test value modified for comparison of an observed "x" with an average calculated from n observations, $t_x = t\ \mathrm{sqrt}(1+1/n)$.

[2] p_i ~ the cumulative probability assigned the i-th ordered grainloss value ... Hazen $p_i = (i - 0.5) / n$, ... (Thode, 2002). Other methods of assigning such probabilities, include ... Alt. $p_i = i / (n+1)$, which is the other most commonly used method, and ... XL $p_i = (i-1) / (n-1)$, a fairly circumscribed method used by MS Excel. These latter two methods are characterized by built-in biases towards exaggeration and understatement respectively of the empirical distribution values associated with significant probabilities.

Reference List:

Anon., 1971. The utilization and performance of combine harvesters. *Farm Mechanization Study No. 18*. ADAS, MAFF, UK. (40 pp).

{ADAS ~ Agricultural Development and Advisory Service, MAFF ~ Min. of Agriculture, Fisheries and Food}.

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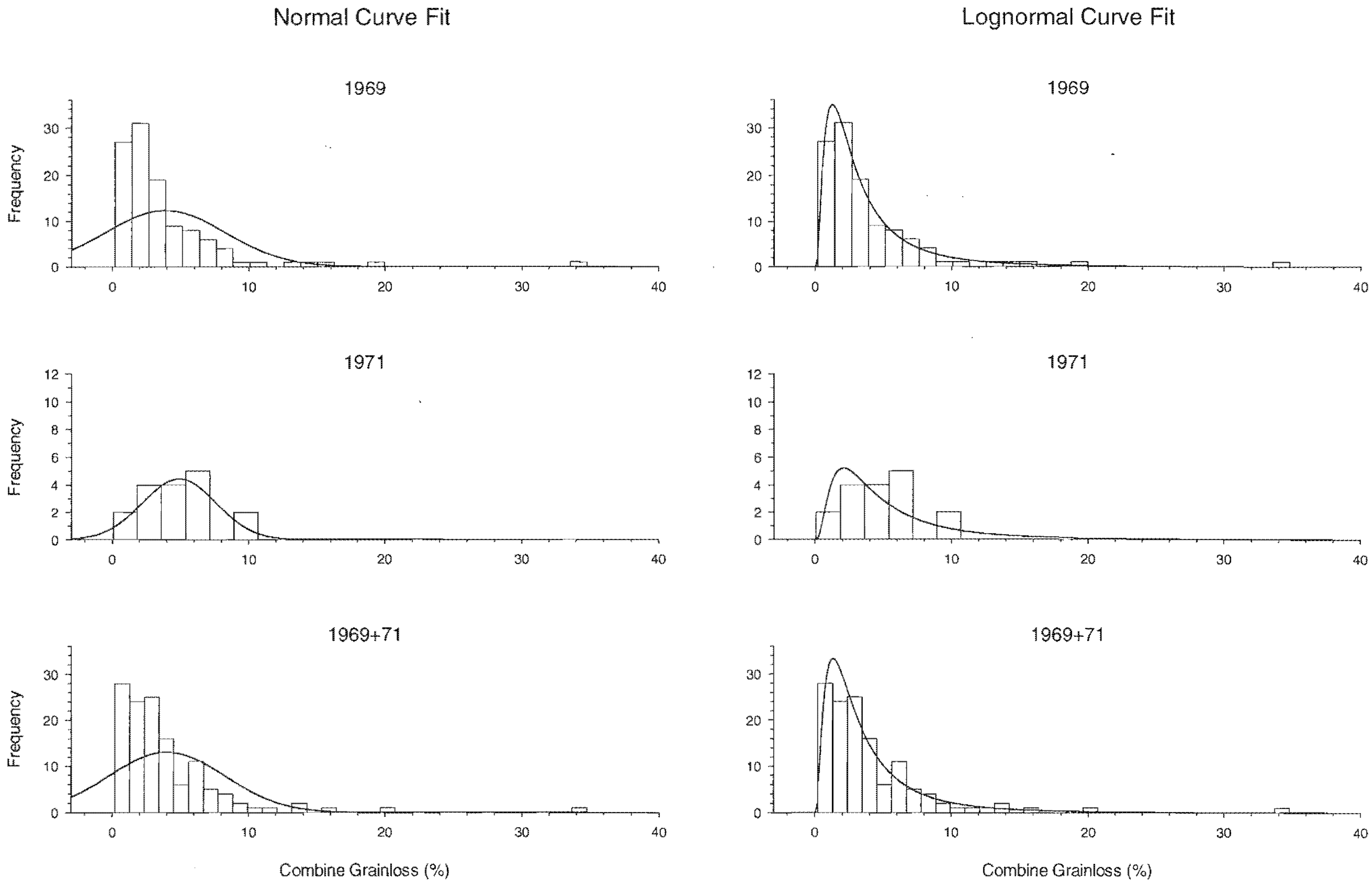

Figure. Distributions of yearly combine barley grainloss fractions. Fit of the normal and lognormal curves defined by grainloss fraction (normal) and log grainloss fraction (lognormal) sample means and standard deviations.

Comparison of fluroxypyr and dicamba for kochia control in spring barley. 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 in Madison County, Idaho, near Ucon to compare the efficacy of fluroxypyr and dicamba formulations in controlling kochia in spring malting barley. 'Busch 1202' spring barley was planted April 1, 2002 in rows 6 inches apart at a seeding rate of 100 lb/A. Experimental design was a randomized complete block with four replications and individual plots were 8 by 25 ft. The soil was a silt loam (54.1% sand, 11.4% silt, and 34.5% clay), pH 6.8, 2.9% organic matter, and CEC of 13-meq/100 g soil. Kochia, wild buckwheat, and common lambsquarters were the major weed species present at densities of 72, 7 and <1 /plants.ft^2, respectively. Herbicides were broadcast-applied to tillering barley on May 29, 2002 with a CO_2-pressurized bicycle-wheel sprayer calibrated to deliver 10 gpa using 11001 flat fan nozzles. Environmental conditions at application were as follows: air temperature 61 F, soil temperature 52 F, relative humidity 80%, wind speed 2 mph, and 95% cloud cover. Crop injury was evaluated visually 9 and 37 days after herbicide treatment (DAT), on June 7 and July 5, respectively. Grain was not harvested.

Herbicide treatments did not injure barley. Common lambsquarters and wild buckwheat were out-competed by the barley and kochia and, therefore, not evaluated for control. Kochia control was similar among herbicide treatments on both evaluation dates, ranging from 56 to 76% on June 7, and from 81 to 94% July 7.

Table. Spring barley injury and weed control response to fluroxypyr and dicamba.

Treatment[1]	Application rate	Crop injury 6/7	Crop injury 7/5	Kochia control 6/7	Kochia control 7/5
	lb ai/A	%			
Check	—	—	—	—	—
Fluroxypyr + Liberate	0.094 + 0.25% v/v	0	1	63	85
Fluroxypyr + Liberate	0.124 + 0.25% v/v	0	0	74	90
Fluroxypyr + Liberate	0.234 + 0.25% v/v	0	0	71	93
Fluroxypyr & 2,4-D + Liberate	0.47 + 0.25% v/v	0	1	71	88
Fluroxypyr & 2,4-D + Liberate	0.623 + 0.25% v/v	1	3	73	89
Fluroxypyr + PCC1133 + PCC1174 + Liberate	0.094 + 0.375 + 0.5 + 0.25% v/v	3	3	71	89
Fluroxypyr + PCC1133 + PCC1174 + Liberate	0.124 + 0.5 + 0.5 + 0.25% v/v	3	1	76	93
Fluroxypyr&MCPA + Liberate	0.5 + 0.25% v/v	0	0	70	86
Fluroxypyr&MCPA + Liberate	0.666 + 0.25% v/v	0	0	69	89
Dicamba	0.0625	0	0	56	84
Dicamba	0.125	0	0	60	81
Bromoxynil&MCPA	0.75	0	0	66	94
LSD (0.05)		*NS*	*NS*	*NS*	*NS*

[1] Fluroxypyr & 2,4-D is a commercial formulation of 0.75 lb ai/ gal fluroxypyr + 3 lb ae/gal 2,4-D. Fluroxypyr&MCPA is a commercial formulation of 0.71 lb ai/ gal fluroxypyr + 3 lb ae/gal MCPA. Bromoxynil&MCPA is a commercial formulation of 2 lb ai/ gal fluroxypyr + 2 lb ae/gal MCPA. PCC1133, and PC1174 are experimental formulantons of dicamba. Liberate is a commercial surfactant.

Comparison of broadleaf herbicide tank mixtures for kochia control. Michael J. Wille and Don W. (Twin Falls Research and Extension Center, University of Idaho, Twin Falls, ID 83303-1827) A study was conducted at the University of Idaho Research and Extension Center near Kimberly, Idaho, to compare effects of a new bromoxynil & MCPA 5EC formulation applied alone or tank-mixed with other broadleaf herbicides on crop injury and weed control in spring barley. 'Moravian 37' spring barley was planted April 6, 2002, at a seeding rate of 100 lb/A. Experimental design was a randomized complete block with four replications and individual plots were 8 by 25 ft. Soil type was a Portneuf silt loam (25% sand, 67% silt, and 8% clay) with a pH of 8, 1.5% organic matter, and CEC of 15-meq/100 g soil. Kochia and common lambsquarters were the major weed species present at plant densities of 5 and 1 plant/ft^2, respectively. Herbicides were applied to fully tillered barley on May 24 with a CO_2-pressurized bicycle-wheel sprayer calibrated to deliver 10 gpa using 11001 flat fan-ozzles. Environmental conditions at application were as follows: air temperature 67 F, soil temperature 60 F, relative humidity 60%, wind speed 5 mph. Crop injury was evaluated visually 18 and 47 days after treatment (DAT) on June 11 and July 10, respectively. Grain was harvested August 15 with a small-plot combine.

Spring barley was not injured by any of the herbicide treatments at either evaluation date. All herbicide treatments controlled kochia 79 to 90% 18 DAT except or bromoxynil&MCPA 5EC + thifensulfuron + 2,4-D (0.5, 0.014 and 0.25 lb ai/A) that controlled kochia only 66%. At 47 DAT, all herbicide combinations that contained fluroxypyr at any rate, as well as combinations of carfentrazone at 0.0125 lb ai/A + bromoxynil&MCPA 5EC at 0.5 lb ai/A controlled kochia 82 to 90%. Tank-mix combinations of carfentrazone at 0.00825 lb ai/A and either 0.5 lb ai bromoxynil&MCPA 5EC, or 0.014 ai/A thifensulfuron + 0.25 lb ai/A, 2,4-D controlled kochia 62 to 69%. Bromoxynil&MCPA 5EC alone at 0.75 lb ai/A, or bromoxynil&MCPA 5EC + thifensulfuron + 2,4-D at 0.5, 0.014 and 0.25 lb ai/A, respectively, only controlled kochia about 52%. All herbicide combinations controlled common lambsquarters 98 to 100%. Barley yields of herbicide-treated plots ranged from 35 to 59 bu/A and did not differ among each other or from the untreated check.

Table. Crop injury, weed control, and grain yield response to a bromoxynil & MCPA formulation combined with other broadleaf herbicides, near Kimberly, ID.

				Weed control[a]			
	Application	Crop injury		KCHSC		CHEAL	Grain
Treatment[b]	rate	6/11	7/10	6/11	7/10	7/10	yield
	lb ai/A			%			bu/A
Check		—	—	—	—	—	30
Bromoxynil & MCPA 5EC	0.75	0	8	79	53	100	43
Bromoxynil & MCPA 5EC thifen&triben NIS	0.5 0.014 0.25	0	0	66	51	100	59
Bromoxynil & MCPA 5EC fluroxypyr	0.5 0.0469	0	3	90	90	100	43
Bromoxynil & MCPA 5EC fluroxypyr	0.5 0.063	1	3	90	87	100	55
Bromoxynil & MCPA 5EC fluroxypyr	0.5 0.094	1	4	87	87	100	46
Bromoxynil & MCPA 5EC carfentrazone	0.5 0.00825	6	4	86	69	100	45
Bromoxynil & MCPA 5EC carfentrazone	0.5 0.0125	6	0	90	82	100	46
Carfentrazone 2,4-D ester thifensulfuron NIS	0.00825 0.25 0.014 0.25	5	4	87	62	100	39
Carfentrazone 2,4-D ester thifensulfuron NIS	0.0125 0.25 0.014 0.25	6	5	90	84	100	47
Carfentrazone fluroxypyr NIS	0.00825 0.1875 0.25	3	5	90	90	99	35
Carfentrazone fluroxypyr NIS	0.0125 0.1875 0.25	5	3	90	90	98	44
LSD (0.05)		4	NS	11	10	NS	NS

[a]Weeds evaluated for control were kochia (KCHSC) and common lambsquarters (CHEAL).

[b]Bromoxynil & MCPA 5EC is a commercial formulation of bromoxynil and MCPA containing 5 lb ai/gal. Thifen&triben is a 2:1 commercial formulation of thifensulfuron & tribenuron. NIS is a nonionic surfactant.

Effects of different rates of carfentrazone in combination with other herbicides on broadleaf weed control and spring barley injury. Branden L. Schiess and Donald C. Thill. (Plant Science Division, University of Idaho, Moscow, ID 83844-2339) A study was conducted near Potlatch, ID in 'Gallatin' spring barley to determine the effects of different carfentrazone rates in combination with 2,4-D, 2,4-D + dicamba, 2,4-D + thifensulfuron, 2,4-D + metsulfuron, and fluroxypyr on field bindweed, common lambsquarters, mayweed chamomile, and pale smartweed control and spring barley injury. Plots were 8 by 25 feet and 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). Common lambsquarters control was evaluated visually on June 17, 2002. Field bindweed, mayweed chamomile, and pale smartweed control was evaluated visually on July 1 and August 11, 2002. Barley injury was evaluated visually on June 19 and August 11, 2002. Barley grain was harvested September 6, 2002 with a small plot combine.

Table 1. Application and soil data.

Application date	June 12, 2002
Barley growth stage	5 leaf
Field bindweed growth stage (inches)	1 to 8
Field bindweed plants/ft^2	1
Common lambsquarters growth stage (inches)	2 to 4
Common lambsquarters plants/ft^2	27
Mayweed chamomile growth stage (inches)	1
Mayweed chamomile plants/ft^2	1
Pale smartweed growth stage (inches)	3
Pale smartweed plants/ft^2	1
Air temperature (F)	80
Soil temperature at 2 in (F)	60
Relative humidity (%)	61
Wind (mph, direction)	0 to 1, W
Cloud cover (%)	5
pH	5.1
OM (%)	2.8
Texture	silt loam

All treatments controlled common lambsquarters 100% on June 17, while no treatment controlled field bindweed at any date (data not shown). All rates of carfentrazone + 2,4-D combined with dicamba, thifensulfuron or metsulfuron controlled mayweed chamomile 70 to 100% on July 1, and 95 to 100% on August 11 (Table 2). All combinations containing 2,4-D controlled pale smartweed 94 to 100% on July 1, and 93 to 100% on August 11. All treatments containing fluroxypyr did not control mayweed chamomile or pale smartweed on any date. On June 19, barley was visually injured (stunting and chlorosis) 13 to 30% by all treatments, by August 11, injury was no longer visible (data not shown). Barley yield ranged from 41 to 58 bu/A.

Table 2. Weed control, spring barley injury, and grain yield with differential rates of carfentrazone in combination with other herbicides near Potlatch, ID in 2002 .

Treatment[1]	Rate	Barley injury	Mayweed chamomile control		Pale smartweed control		Barley yield
		June 19	July 1	Aug 11	July 1	Aug 11	
	lb/A	------------	------------	%	------------	------------	bu/A
Carfentrazone + 2,4-D	0.008 + 0.25	18	5	4	94	93	49
Carfentrazone + 2,4-D	0.012 + 0.25	23	3	4	94	97	42
Carfentrazone + 2,4-D	0.016 + 0.25	30	3	1	100	100	49
Carfentrazone + 2,4-D + dicamba	0.008 + 0.25 + 0.093	20	99	98	100	100	41
Carfentrazone + 2,4-D + dicamba	0.012 + 0.25 + 0.093	28	85	95	100	100	43
Carfentrazone + 2,4-D + dicamba	0.016 + 0.25 + 0.093	23	70	100	100	100	43
Carfentrazone + 2,4-D + thifensulfuron	0.008 + 0.25 + 0.014	13	100	100	100	100	42
Carfentrazone + 2,4-D + thifensulfuron	0.012 + 0.25 + 0.014	18	100	100	100	100	47
Carfentrazone + 2,4-D + thifensulfuron	0.016 + 0.25 + 0.014	23	100	100	100	100	45
Carfentrazone + 2,4-D + metsulfuron	0.008 + 0.25 + 0.00375	18	100	100	100	100	48
Carfentrazone + 2,4-D + metsulfuron	0.012 + 0.25 + 0.00375	23	100	100	100	100	43
Carfentrazone + 2,4-D + metsulfuron	0.016 + 0.25 + 0.00375	30	100	100	100	100	48
Carfentrazone + fluroxypyr	0.008 + 0.1875	18	1	0	3	4	58
Carfentrazone + fluroxypyr	0.012 + 0.1875	15	1	0	1	1	47
Carfentrazone + fluroxypyr	0.016 + 0.1875	23	1	1	3	3	55
Control		–	–	–	–	–	52
LSD (0.05)		6	10	19	5	4	9

[1]A non-ionic surfactant (R-11) was applied at 0.25% v/v with thifensulfuron and metsulfuron treatments.

Crop response and broadleaf control with varying rates of sulfonylureas in combination with bromoxynil/MCPA or 2,4-D ester. Thomas M. Ireland and Donald C. Thill. (Crop and Weed Science Division, University of Idaho, Moscow, ID 83844-2339) A study was established in spring barley near Potlatch, Idaho and in spring wheat near Genesee, Idaho to evaluate broadleaf weed control and crop injury with varying rates of sulfonylureas in combination with bromoxynil/MCPA or 2,4-D ester. The experimental design for both experiments was a randomized complete block with four replications. Plot size was 8 by 25 ft at Potlatch and 8 by 30 ft at Genesee. Herbicide treatments were applied with a CO_2 pressurized backpack sprayer calibrated to deliver 10 gpa at 30 psi and 3 mph (Table 1). Broadleaf weed control and crop injury were evaluated visually 28 DAT at both locations. Grain was harvested with a small plot combine at Potlatch on September 3 and at Genesee on August 30, 2002.

Table 1. Herbicide application and soil data.

Location	Potlatch, ID	Genesee, ID
Application date	June 3, 2002	June 7, 2002
Barley growth stage	1 to 3 tiller	–
Wheat growth stage	–	1 to 3 tiller
Broadleaf weeds growth stage	3 to 4 inches	–
Air temperature (F)	75	38
Relative Humidity (%)	53	70
Soil temperature (F)	70	45
Soil		
pH	5.1	5.8
OM (%)	2.8	3.4
CEC (meq/100 g)	–	23
Texture	silt loam	silt loam

Near Potlatch, no treatment injured spring barley (data not shown). Field pennycress (THLAR) control 28 DAT was 90% with thifensulfuron plus tribenuron at 0.0047 + 0.0023 and 0.0071 + 0.0035 lb ai/A with 2,4-D ester, while control with all other treatments ranged from 96 to 99% (Table 2). Common lambsquarters (CHEAL) control ranged from 90 to 95% with metsulfuron at 0.0019 and 0.0028 lb ai/A plus 2,4-D ester and all rates of thifensulfuron plus tribenuron with 2,4-D ester, while control was 99% with all other treatments. All treatments controlled mayweed chamomile (ANTCO) 91 to 95%, except thifensulfuron plus tribenuron at 0.0071 + 0.0035 lb ai/A with 2,4-D ester (87%). All treatments controlled henbit (LAMAM) 91 to 93%, except for thifensulfuron plus tribenuron at 0.0047 + 0.0023 and 0.0071 + 0.0035 lb ai/A with 2,4-D ester (81%). At Potlatch, spring barley grain yield (5875 to 6360 lb/A) with all herbicide treatments was significantly higher than the untreated control. Near Genesse, no treatment injured spring wheat (data not shown). Broadleaf weed control ratings are not presented due to non-uniform populations. Wheat grain yield (5588 to 6581 lb/A) did not differ among herbicide treatments or from the untreated control.

Table 2. Broadleaf weed control and crop yield with varying rates of sulfonylureas in combination with bromoxynil plus MCPA or 2,4-D ester near Potlatch and Genesee, ID in 2002.

		Potlatch					Genesee
		Weed control				Spring barley	Spring wheat
Treatment[1]	Rate	THLAR	CHEAL	ANTCO	LAMAM	yield	yield
	lb ai /A	%				lb/A	lb/A
Untreated control	--	--	--	--	--	4598	6441
Bromoxynil/MCPA	0.5	99	99	93	91	6237	5844
Bromoxynil/MCPA	0.75	99	99	94	91	6115	5743
Bromoxynil/MCPA + thifensulfuron	0.5 + 0.75	99	99	95	93	6173	5735
Bromoxynil/MCPA + thifensulfuron	0.5 + 0.014	99	99	95	91	5949	6284
Metsulfuron + thifensulfuron + tribenuron + 2,4-D ester	0.0037 + 0.0094 + 0.0047 + 0.375	99	99	93	91	6004	6241
Metsulfuron + thifensulfuron + tribenuron + 2,4-D ester	0.0028 + 0.0071 + 0.0035 + 0.375	99	99	93	91	5971	5723
Metsulfuron + thifensulfuron + tribenuron + 2,4-D ester	0.0019 + 0.0047 + 0.0023 + 0.375	99	99	94	91	5875	6167
Metsulfuron + 2,4-D ester	0.0037 + 0.375	99	99	94	91	6360	5588
Metsulfuron + 2,4-D ester	0.0028 + 0.375	96	95	91	91	5898	6581
Metsulfuron + 2,4-D ester	0.0019 + 0.375	99	95	94	91	5889	6106
Thifensulfuron + tribenuron + 2,4-D ester	0.0094 + 0.0047 + 0.375	97	95	91	92	6073	6000
Thifensulfuron + tribenuron + 2,4-D ester	0.0071 + 0.0035 + 0.375	90	90	87	81	6102	5999
Thifensulfuron + tribenuron + 2,4-D ester	0.0047 + 0.0023 + 0.375	90	90	91	81	5906	6163
LSD (0.05)		1	1	2	3	712	NS
Density (plants/ft^2)		6	10	10	8		

[1] A 90 % non-ionic surfactant (R-11) was added to all treatments at 0.25% v/v. 2,4-D ester rates expressed in lb ae/A. Bromoxynil/MCPA applied as premix formulation (Bronate Advanced).

Weed control and crop safety comparison of 2,4-D formulations in spring barley. Curtis R. Rainbolt and Donald C. Thill. (Plant Science Division, University of Idaho, Moscow, ID 83844-2339) Two field trials were established in spring barley to evaluate weed control and crop safety with 2,4-D acid, 2,4-D dimethylamine salt, and 2,4-D isooctyl ester. Experiment one was conducted near Moscow, ID at the University of Idaho Parker Research Farm in 'Baronesse' spring barley to evaluate the crop safety of 2,4-D acid and 2,4-D isooctyl ester applied at two timings. Crop injury was evaluated visually 7 and 14 DAT and at heading. Grain was harvested with a small plot combine on September 4, 2002. The second experiment was established in 'Morex' spring barley near Potlatch, ID to compare the efficacy of 2,4-D acid, 2,4-D dimethylamine salt, and 2,4-D isooctyl ester. Weed control was evaluated visually 7, 21, and 28 DAT. Crop injury was evaluated visually 21 and 28 DAT and at heading. Grain was harvested with a small plot combine on September 3, 2002. In both trials, the experimental design was a randomized complete block with four replications and herbicide treatments were applied with a CO_2 pressurized backpack sprayer calibrated to deliver 10 gpa at 32 psi and 3 mph (Table 1).

Table 1. Application data.

Location	Moscow, ID		Potlatch, ID
Application date	May 17, 2002	June 3, 2002	June 3, 2002
timing (crop stage)	2-5 leaf	early boot	late tillering
weed stage	--	--	2-4 inches in diameter
Air temperature (F)	66	59	75
Soil temperature at 2 inches (F)	64	52	70
Relative humidity (%)	52	70	55
Wind (mph)	4	2	2
Soil			
pH	4.3		5.1
OM%	5.1		2.8
Texture	loam		silt loam

At Moscow, spring barley was not visibly injured by any treatment (data not shown). Spring barley yield ranged from 1460 to 2000 lb/A and was not different between treatments or from the untreated control (Table 2).

At Potlatch, barley was injured (stunting) 3 and 9% by 2,4-D ester and 2,4-D acid applied at 0.5 lb ae/A 28 DAT (Table 3). At heading, crop injury was 3% with 2,4-D acid at 0.5 lb ae/A and was no longer visible in plots treated with 2,4-D ester (data not shown). Field pennycress (THLAR) control at 28 DAT averaged 95%, except at the lowest rates of all 2,4-D formulations. Common lambsquarters (CHEAL) control was highest with 2,4-D acid at 0.5 lb ae/A (93%), but did not differ from 2,4-D acid at 0.25 lb ae/A (90%). Henbit (LAMAM) control ranged from 51 to 60% and was not different between treatments. All treatments suppressed mayweed chamomile (ANTCO) 40 to 56%. Barley yield ranged from 4980 to 5770 lb/A and did not differ among treatments or from the untreated control.

Table 2. Spring barley yield with 2,4-D formulations near Moscow, ID in 2002.

Treatment[1]	Rate	Application timing	Yield
	lb ae/A		lb/A
2,4-D ester	0.25	2-5 leaf	1460
2,4-D ester	0.50	2-5 leaf	1770
2,4-D acid	0.13	2-5 leaf	1630
2,4-D acid	0.19	2-5 leaf	2000
2,4-D acid	0.25	2-5 leaf	1900
2,4-D acid	0.50	2-5 leaf	1580
Untreated control	–	–	1860
2,4-D ester	0.25	early boot	1840
2,4-D ester	0.50	early boot	1890
2,4-D acid	0.13	early boot	1810
2,4-D acid	0.19	early boot	1930
2,4-D acid	0.25	early boot	1910
2,4-D acid	0.50	early boot	1850
LSD (0.05)			NS

[1]All treatments included a nonionic acidifying surfactant (LI 700) at 0.25% v/v and all 2,4-D acid treatments included the acidifier PCC1174 at 0.5% v/v.

Table 3. Broadleaf weed control and spring barley yield with 2,4-D formulations near Potlatch, ID in 2002.

		Weed control				Barley	
Treatment[1]	Rate	THLAR	CHEAL	LAMAM	ANTCO	Injury	Yield
	lb ae/A	%[2]					lb/A
2,4-D ester	0.25	88	81	51	40	0	5610
2,4-D ester	0.50	94	88	58	53	3	5360
2,4-D amine	0.25	88	84	55	43	0	4980
2,4-D amine	0.50	93	86	56	46	0	5770
2,4-D acid	0.50	96	93	60	56	9	5530
2,4-D acid	0.25	95	90	60	51	0	5260
2,4-D acid	0.19	95	89	59	51	0	5200
2,4-D acid	0.13	91	89	58	46	0	4980
Untreated control	--						5230
LSD (0.05)		4	4	NS	6	3	NS

[1]All treatments included a nonionic acidifying surfactant (LI 700) at 0.25% v/v and all 2,4-D acid treatments included the acidifier PCC1174 at 0.5% v/v.

[2]28 DAT evaluation.

Wild oat herbicide antagonism and spring barley injury from carfentrazone and other broadleaf herbicides. Branden L. Schiess and Donald C. Thill. (Plant Science Division, University of Idaho, Moscow, ID 83844-2339) A study was conducted near Potlatch, ID in 'Gallatin' spring barley to determine the effects of carfentrazone in combination with other herbicides on wild oat control and crop injury. Plots were 8 by 25 feet, 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 33 psi and 3 mph (Table 1). Wild oat control and barley injury were evaluated visually on June 19 and August 11, 2002. Barley grain was harvested September 6, 2002 with a small plot combine, however, data are not shown due to wild oat contamination.

Table 1. Application data.

Application date	June 12, 2002
Barley growth stage	5 leaf
Wild oat growth stage	3 to 4 leaf
Wild oat density (plants/ft^2)	12
Air temperature (F)	75
Soil temperature at 2 in (F)	55
Relative humidity (%)	73
Wind (mph, direction)	1 to 2, W
Cloud cover (%)	5
Soil	
pH	5.1
OM (%)	2.8
Texture	silt loam

On June 19, all treatments containing broadleaf herbicides injured barley 19 to 30% (Table 2). On August 11, all flucarbazone-sodium treatments injured barley 13 to 18% and all propropcarbazone treatments injured barley 43 to 50%. On August 11, wild oat control with fenoxaprop was reduced 31 to 69% when combined with broadleaf herbicides. Wild oat control with clodinafop and propropcarbazone was reduced 20 to 57% by the addition of carfentrazone, MCPA, and thifensulfuron/tribenuron compared to clodinafop and propropcarbazone applied alone. Treatments with flucarbazone-sodium and imazamethabenz controlled wild oat 89 to 100%. All propropcarbazone treatments reduced barley yield 36%, while all other treatments yielded as good or better than the untreated control (data not shown).

Table 2. Wild oat herbicide antagonism and spring barley injury from carfentrazone and other broadleaf herbicides near Potlatch, ID in 2002.

Treatment[1]	Rate	Barley injury June 19	Barley injury August 11	Wild oat control August 11
	lb ai/A	%		
Fenoxaprop	0.083	4	1	95
Fenoxaprop + carfentrazone + MCPA	0.083 + 0.012 + 0.25	25	1	65
Fenoxaprop + carfentrazone + MCPA + thifensulfuron/tribenuron	0.083 + 0.012 + 0.25 + 0.014	19	0	30
Clodinafop	0.05	6	4	98
Clodinafop + carfentrazone + MCPA	0.05 + 0.012 + 0.25	28	8	90
Clodinafop + carfentrazone + MCPA + thifensulfuron/tribenuron	0.05 + 0.012 + 0.25 + 0.014	28	3	43
Flucarbazone-sodium	0.026	6	13	100
Flucarbazone-sodium + carfentrazone + MCPA	0.026 + 0.012 + 0.25	25	14	100
Flucarbazone-sodium + carfentrazone + MCPA + thifensulfuron/tribenuron	0.026 + 0.012 + 0.25 + 0.014	25	18	98
Propropcarbazone	0.04	14	48	100
Propropcarbazone + carfentrazone + MCPA	0.04 + 0.012 + 0.25	30	50	90
Propropcarbazone + carfentrazone + MCPA + thifensulfuron/tribenuron	0.04 + 0.012 + 0.25 + 0.014	30	43	80
Imazamethabenz	0.375	4	0	100
Imazamethabenz + carfentrazone + MCPA	0.375 + 0.012 + 0.25	25	5	93
Imazamethabenz + carfentrazone + MCPA + thifensulfuron/tribenuron	0.375 + 0.012 + 0.25 + 0.014	28	4	89
Control		--	--	--
LSD (0.05)		6	9	17

[1]Fenoxaprop formulation (Puma) contained a safener. A non-ionic surfactant (R-11) was applied at 0.25% v/v to treatments containing thifensulfuron/tribenuron, flucarbazone-sodium, propropcarbazone, and imazamethabenz. All treatments containing clodinafop were applied with a crop oil concentrate (Score) at 0.8% v/v. MCPA rates were lb ae/A.

Flumioxazin on dry bean. Richard K. Zollinger and Jerry L. Ries. (Dept. of Plant Sciences, North Dakota State University, Fargo 58105) An experiment was conducted near Hatton, ND, to evaluate the tolerance of four dry bean varieties to flumioxazin applied PPI. Treatments were applied June 4, 2002, at 2:00 pm and incorporated with a rototiller to a depth of 2 inches. Weather conditions at the time of PPI applications were 79 F air, 68 F subsoil at a depth of 4 inches, 18% relative humidity, 50% clouds, 3 to 5 mph E wind, dry soil surface, and moist subsoil. One row per plot was planted to 'T-39' black bean, 'UI259' red bean, 'Montcalm' dark red kidney bean, and 'UI537' pink bean following treatment incorporation. Treatments were applied to the entire 10 by 40 foot plots with a bicycle-wheel-type plot sprayer delivering 17 gpa at 40 psi through 8002 flat fan nozzles. The experiment was in a randomized complete block design with three replicates. The dry bean types were evaluated for visible injury from 0 for no visible injury to 100 for plant death.

The study was targeted for a weed-free environment. No weeds emerged in the treated area for the duration of the study. Weather conditions in the spring were dry, but up to six inches of rain fell on July 10. After the July rain event, there was no water standing in the plots a full day afterwards due to the sandy soil at this location. Dry bean injury from PPI flumioxazin treatments has been consistently observed in NDSU research. This study evaluated the potential to safen other dry bean types by incorporating flumioxazin. Flumioxazin at 0.064 and 0.127 lb/A caused significant visible injury and stand loss to the four dry bean types. Injury did not decrease over time but the three indeterminate dry bean varieties did produce high yield at harvest. Dark red kidney is a bush-type bean that is determinate. Black, red, and pink are vining-type beans that are indeterminate. The dark red kidney bean being determinate may explain the lower yields in both the treated and untreated plots. Dry conditions and some water damage throughout the study probably delayed the dark red kidney variety enough so that when the single flowering event was complete, the plants were not large or developed enough to produce a large yield. The dark red kidney bean may also be more susceptible to water damage. The other three varieties are indeterminate (multiple flowering) and were able to continue to produce seed through the remainder of the growing season, resulting in greater yields. The three indeterminate bean types also may be more tolerant to excess water. High yields of the three indeterminate bean types may indicate minimal impact of the high rainfall event.

Table. Flumioxazin on dry bean.

Flumioxazin	June 18				July 2				July 2				Yield			
rate	Black	Red	DRK[1]	Pink	Black	Red	DRK[1]	Pink	Black	Red	DRK[1]	Pink	Black	Red	DRK[1]	Pink
lb/A	------% injury------				------% injury------				-----% stand loss-----				-------cwt/A-------			
0.064	23	12	3	14	35	20	20	23	38	18	20	37	21.7	27.1	11.3	24.9
0.127	33	7	4	22	57	57	18	35	58	38	17	55	16.9	24.3	12.7	20.8
0	0	0	0	0	0	0	0	0	0	0	0	0	26.0	27.2	10.4	24.8
LSD (0.05)	15	5	4	11	17	16	6	8	19	24	9	16	4.5	5.4	3.6	4.8

[1]DRK = Dark Red Kidney.

Nightshade control in dry edible bean. Richard K. Zollinger and Jerry L. Ries. (Dept. of Plant Sciences, North Dakota State University, Fargo, ND 58105) An experiment was conducted near Hatton, ND, to evaluate treatments applied PPI to control eastern black nightshade in dry edible bean. May 16, 2002, PPI applications were made and incorporated with a rototiller operating to a depth of 2 inches at 1:00 pm with 48 F air, 48 F soil at a depth of 4 inches, 32% relative humidity, 0% clouds, 7 mph N wind, dry soil surface, and moist subsoil. Ensign '372' navy bean was planted on May 29. Treatments were applied to the entire 10 by 40 foot plots with a bicycle-wheel-type plot sprayer delivering 17 gpa at 40 psi through 11002 flat fan nozzles. The experiment had a randomized complete block design with three replicates per treatment.

On May 30 (14 DAT), no weeds or dry bean plants had emergence. On June 4 dry bean plants were just emerging, but no eastern black nightshade had emerged. Injury on June 13 (28 DAT) was stunting and poor emergence. An interesting observation was made on June 13, there was better germination of dry bean and weeds in the rototilled area of the plots than the rest of the field where just cultivation was used to prepare the field for planting. Weeds were spotty in the study area causing some variability in ratings. Environmental conditions were extremely dry until rain occurred on June 9. Slight stunting and no crop canopy was observed on June 27 (42 DAT) and July 9 (56 DAT). Yields were not taken due to four to six inches of rainfall on July 10, causing death and stunting to much of the study. All rates and combination of flumioxazin and dimethenamid-P applied alone provided near complete control of eastern black nightshade. Tank-mixes with flumioxazin at 0.064 lb/A or higher caused significant injury.

Table. Nightshade control in dry edible bean.

		June 13			June 27			July 7	
Treatment[1]	Rate	Navy bean	SOLPT	CHEAL	Navy bean	SOLPT	CHEAL	SOLPT	CHEAL
	lb/A	% injury	- % control -		% injury	- % control -		- % control -	
Pendimethalin	1.49	1	48	45	0	23	23	13	10
Pendimethalin	1.5	0	93	78	1	25	38	15	23
Dimethenamid-P	0.98	4	99	98	2	94	50	94	59
Flumioxazin	0.048	0	99	89	5	98	58	98	55
Flumioxazin	0.064	0	89	47	2	99	42	98	33
Flumioxazin	0.096	2	99	58	3	98	58	98	57
Flumioxazin	0.127	1	99	85	6	99	81	99	80
Pend+flmx	1.49+0.048	0	99	99	3	99	82	99	57
Pend+flmx	1.49+0.096	0	99	95	23	99	90	99	68
Dime+flmx	0.98+0.048	6	99	96	6	99	87	99	83
Dime+flmx	0.98+0.064	10	99	90	17	99	72	99	70
Dime+flmx	0.98+0.096	12	99	94	16	99	86	99	68
LSD (0.05)		4	13	19	11	10	25	7	39

[1]Pendimethalin in treatment two = Prowl H_2O; pend = pendimethalin; flmx = flumioxazin; dime = dimethenamid-P.

Bentazon&sethoxydim tank-mixes in dry edible bean. Richard K. Zollinger and Jerry L. Ries. (Dept. of Plant Sciences, North Dakota State University, Fargo 58105) An experiment was conducted near Hatton, ND, to evaluate dry edible bean response from herbicides applied PPI and POST. On June 4, 2002, PPI treatments were applied and incorporated with a rototiller operating to a 2 inch depth at 2:00 pm with 79 F air, 68 F soil at a depth of 4 inches, 18% relative humidity, 50% clouds, 3 to 5 mph E wind, dry soil surface, and moist subsoil. The planting of 'Maverick' pinto bean followed the incorporation of treatments. POST treatments were applied July 15 at 9:30 am with 77 F air, 80 F soil surface, 71% relative humidity, 0% clouds, 5 to 8 mph SW wind, wet soil surface, wet subsoil, excellent crop vigor, and no dew present to V4 to V6 dry edible bean. Weed species present were: 6 to 18 inch ($1/yd^2$) blossoming wild mustard. Treatments were applied to the entire 10 by 40 foot plots with a bicylce-wheel-type plot sprayer delivering 17 gpa at 40 psi through 8002 flat fan nozzles for PPI treatments and 8.5 gpa at 40 psi through 8001 flat fan nozzles for POST treatments. The experiment had a randomized complete block design with three replicates per treatment.

The experiment was established in a near weed free environment. The few wild mustard plants that emerged were completely controlled by all herbicide treatments. On July 10, four to six inches of rain fell. Only a few plots in the far end of the third replication had water damage. The PPI treatments were rated prior to application of POST treatments on July 15, injury was stunting and stand loss. Pendimethalin&imazethapyr at 0.63&0.047 lb/A caused increased injury, but recovered in later evaluations. Injury ratings taken on July 29 (14 DAT) and August 5 (21 DAT) were based on foliar injury from POST treatments. POST treatment injury was slight puckering/krinkling of newest trifoliate. No burn/speckling was observed. Injury from POST herbicides, as observed on August 5 (21 DAT) was to older leaves. The top, newer leaf had no visual injury. Injury that did not decrease over time had some new leaf puckering and crinkling. All treatments were safe to Pinto type dry bean.

Table. Bentzon&sethoxydim tank-mixes in dry edible bean.

		July 15		July 29	August 5	Pinto
Treatment[1]	Rate	Pinto	Pinto	Pinto	Pinto	Yield
	lb/A	% injury	% stand loss	% injury	% injury	cwt/A
PPI/POST						
Pend/immx+bent&seth+PO+28-0-0	1.44/0.016+1&0.2	4	3	0	0	17.2
Pend/imep+bent&seth+PO+28-0-0	1.44/0.011+1&0.2	4	4	0	0	17.2
Pend&imep+pend/bent&seth+PO	0.42&0.03+0.93/1&0.2	6	3	1	1	13.3
Pend&imep+pend/bent&seth+PO	0.63&0.047+0.66/1&0.2	25	4	0	0	14.1
Dime/immx+bent&seth+PO+28-0-0	0.75/0.016+1&0.2	6	0	0	0	17.7
POST						
Bent&seth+PO	1&0.2	-	0	1	2	21.7
Immx+NIS	0.0312	-	0	1	1	17.1
Imep+NIS	0.012	-	0	0	0	20.1
Immx+bent&seth+PO+28-0-0	0.016+1&0.2	-	0	0	0	19.9
Imep+bent&seth+PO+28-0-0	0.011+1&0.2	-	0	0	0	20.3
Immx+s-metolachlor+NIS	0.016+1.59	-	0	3	3	18.0
Fomesafen+dime+NIS	0.125+0.56	-	0	4	2	18.2
Untreated		0	0	0	0	19.2
LSD (0.05)		5	4	1	3	4.8

[1]Pend = pendimethalin; immx = imazamox; bent&seth = bentazon&sethoxydim; imep = imazethapyr; pend&imep = pendimethalin&imazethapyr; dime = dimethenamid-P; PO = Herbimax at 1% v/v; 28-0-0 = urea ammonium nitrate at 1qt/A; NIS = nonionic surfactant at 0.25% v/v.

Sugar beet tolerance to dimethenamid-P. Michael J. Wille and Don W. Morishita. (Twin Falls Research and Extension Center, University of Idaho, Twin Falls, ID 83303-1827) A study was initiated at the University of Idaho Research and Extension Center near Kimberly, Idaho to measure the tolerance of sugar beet to dimethenamid-P applied in combination with currently registered sugar beet herbicides. Sugar beet ('PM21') was planted April 16, 2001 in 22-inch rows at a rate of 57,024 seed/A. The experiment was a randomized complete block design with four replications and individual plots were four rows by 30 ft. Soil type was a Portneuf silt loam (20% sand, 71% silt, and 9% clay) with a pH of 8.1, 1.5% organic matter, and CEC of 17-meq/100 g soil. Herbicides were applied in an 11-inch band with a CO_2-pressurized bicycle-wheel sprayer using 8001 even fan nozzles calibrated to deliver 20 gpa at 28 psi. Additional environmental and application information is given in Table 1. Plots were maintained weed free by handweeding. Crop injury was evaluated visually May 16 and June 15, which was 5 and 30 days, respectively after the last herbicides were applied. The two center rows of each plot were harvested mechanically October 1.

Table 1. Environmental conditions at herbicide application.

Application date	May 4	May 11	May 18
Application timing	Cotyledon	7 d later	7 d later
Air temperature (F)	71	85	54
Soil temperature (F)	58	76	54
Relative humidity (%)	42	30	40
Wind speed (mph)	2	2	4
Cloud cover (%)	0	0	40

Sugar beet injury was similar among herbicide treatments, ranging from 1 to 5% at 5 days after the last treatment was applied (DALT), and 3 to 6% at 30 DALT. Sugar beet root yields ranged from 30 to 31 ton/A among the herbicide treatments compared to 31 ton/A in the weed free check. Herbicide treatments did not differ among each other or from the untreated check.

Table 2. Sugar beet response to dimethenamid.

	Application		Crop injury		Root
Treatment [a]	rate	date	5/16	6/15	yield
	lb ai/A		--------%--------		ton/A
Check	-	-	-	-	31
Efs&dmp&pmp + triflusulfuron	0.33 + 0.0156	5/4	4	4	31
Efs&dmp&pmp + triflusulfuron + clopyralid clopyralid	0.33 + 0.0156 + 0.094	5/11, 5/18			
Efs&dmp&pmp + triflusulfuron	0.33 + 0.0156	5/4, 5/11, 5/18	3	5	31
Efs&dmp&pmp + triflusulfuron	0.33 + 0.0156	5/4	4	4	30
Efs&dmp&pmp + triflusulfuron + dimethenamid-P	0.33 + 0.0156 + 0.64	5/11			
Efs&dmp&pmp + triflusulfuron	0.33 + 0.0156	5/18			
Efs&dmp&pmp + triflusulfuron	0.33 + 0.0156	5/4	5	4	31
Efs&dmp&pmp + triflusulfuron + clopyralid + dimethenamid-P	0.33 + 0.0156 + 0.094 0.64	5/11			
Efs&dmp&pmp + triflusulfuron + clopyralid	0.33 + 0.0156 + 0.094	5/18			
Efs&dmp&pmp + triflusulfuron	0.33 + 0.0156	5/4	1	3	32
Efs&dmp&pmp + triflusulfuron + clopyralid + dimethenamid-P	0.33 + 0.0156 + 0.094 0.96	5/11			
Efs&dmp&pmp + triflusulfuron + clopyralid	0.33 + 0.0156 + 0.094	5/18			
Efs&dmp&pmp + triflusulfuron	0.33 + 0.0156	5/4	5	3	30
Efs&dmp&pmp + triflusulfuron + clopyralid + dimethenamid-P	0.33 + 0.0156 + 0.094 1.28	5/11			
Efs&dmp&pmp + triflusulfuron + clopyralid	0.33 + 0.0156 + 0.094	5/18			
Efs&dmp&pmp + triflusulfuron	0.33 + 0.0156	5/4	3	6	31
Efs&dmp&pmp + triflusulfuron + clopyralid + dimethenamid-P	0.33 + 0.0156 + 0.094 1.6	5/11			
Efs&dmp&pmp + triflusulfuron + clopyralid	0.33 + 0.0156 + 0.094	5/18			
LSD (0.05)			5	4	3

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

Table 2. (cont.)

Treatment[b]	Application rate	Application timing	Crop injury	Weed control[a] KCHSC	AMARE	CHEAL	SOLSA	Root yield
			%					ton/A
Efs&dmp&pmp +	0.25 +	May 4	9	96	92	91	97	22
triflusulfuron +	0.0164 +							
ethofumesate	0.0625							
Efs&dmp&pmp +	0.33 +	May 14						
triflusulfuron +	0.0156 +							
ethofumesate	0.0625							
Efs&dmp&pmp +	0.45 +	May 22						
triflusulfuron +	0.0164 +							
ethofumesate	0.0625							
Efs&dmp&pmp +	0.25 +	May 4	13	99	92	86	99	22
triflusulfuron	0.0164							
Efs&dmp&pmp +	0.33 +	May 14						
triflusulfuron +	0.0156 +							
ethofumesate	0.125							
Efs&dmp&pmp +	0.45 +	May 22						
triflusulfuron +	0.0164 +							
ethofumesate	0.125							
Efs&dmp&pmp +	0.0833 +	May 4 &	0	95	95	96	99	27
triflusulfuron +	0.0052 +	May 11 &						
MSO	1.5% v/v	May 17&						
		May 22						
Efs&dmp&pmp +	0.0833 +	May 4 &	5	94	96	90	99	27
triflusulfuron +	0.0052 +	May 11 &						
ethofumesate +	0.0625 +	May 17&						
MSO	1.5% v/v	May 22						
Efs&dmp&pmp +	0.0833 +	May 4 &	6	88	96	88	100	26
triflusulfuron +	0.0052 +	May 11						
MSO	1.5% v/v							
Efs&dmp&pmp +	0.0833 +	May 17&						
triflusulfuron +	0.0052 +	May 22						
ethofumesate +	0.125 +							
MSO	1.5% v/v							
Efs&dmp&pmp +	0.0833 +	May 4	3	75	82	83	100	24
clopyralid +	0.031 +							
ethofumesate +	0.0625 +							
MSO	1.5% v/v							
Efs&dmp&pmp +	0.0833 +	May 11						
clopyralid +	0.031 +							
ethofumesate +	0.094 +							
MSO	1.5% v/v							
Efs&dmp&pmp +	0.0833 +	May 17						
clopyralid +	0.031 +							
ethofumesate +	0.125 +							
MSO	1.5% v/v							
Efs&dmp&pmp +	0.0833 +	May 22						
clopyralid +	0.031 +							
ethofumesate +	0.25 +							
MSO	1.5% v/v							
LSD (0.05)			6	ns	ns	ns	ns	7

[a] Weeds evaluated for control were kochia (KCHSC), redroot pigweed (AMARE), common lambsquarters (CHEAL), and hairy nightshade (SOLSA).
[b] Efs&dmp&pmp is a commercial formulation of a 1:1:1 mixture of ethofumesate, desmedipham, and phenmedipham. MSO is methylated seed oil.

Application timing of postemergence sugar beet herbicides. Don W. Morishita and Michael J. Wille (Twin Falls Research and Extension Center, University of Idaho, Twin Falls, ID 83303-1827) Properly timed postemergence herbicide applications for weed control in sugar beet is critical, especially for growers who choose not to apply preplant or preemergence herbicides. A study was conducted at the University of Idaho Research and Extension Center near Kimberly, Idaho to compare different application timings of postemergence sugar beet herbicides. The experimental design was a randomized complete block with four replications. Individual plots were four rows by 30 ft. Soil type was a Portneuf silt loam (26.4% sand, 65% silt, and 5.6% clay) with a pH of 8.1, 1.6% organic matter, and CEC of 14-meq/100 g soil. 'HM 2984RZ' sugar beet was planted April 25, 2002, in 22-inch rows at a rate of 57,024 seed/A. Freezing conditions on May 7 and 8 required replanting the experiment on May 14 with 'HM 2980RZ'. Common lambsquarters, kochia, redroot pigweed, and hairy nightshade were the major weed species present. Herbicides were applied in an 11-inch band over each row with a CO_2-pressurized bicycle-wheel sprayer using 8001 even-fan nozzles calibrated to deliver 20 gpa. Additional environmental and application information is given in Table 1. Crop injury and weed control was evaluated visually July 16, which was 14 days after the last herbicide treatment was applied (DALT). The two center rows of each plot were harvested mechanically October 8.

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

Application date	May 23	May 31	June 4	June 11	June 19	July 2
Application timing	PRE	cotyledon	5 d later	7 d later	8 d later	13 d later
Air temperature (F)	65	78	74	74	71	92
Soil temperature (F)	58	79	80	71	78	82
Relative humidity (%)	52	60	59	50	38	31
Wind speed (mph)	5	3	2	5	0	3
Cloud cover (%)	100	50	25	15	0	0
Weed species/ft^2						
lambsquarters, common	0	1	1	2	1	2
pigweed, redroot	0	4	5	4	5	3
nightshade, hairy	0	3	5	4	3	4
kochia	0	0	<1	1	<10	<1
foxtail, green	0	<1	<1	1	1	1

Higher rates of efs&dmp&pmp applied three times at 0.51 lb ai/A followed by 0.59, and 0.675 lb ai/A applied in combination with triflusulfuron + clopyralid injured sugar beet 14% (Table 2). A single application of ethofumesate + triflusulfuron + clopyralid at 1.12 + 0.0312 + 0.25 lb ai/A injured sugar beet 11%. These two treatments were among the highest injury levels. Common lambsquarters and redroot pigweed were controlled 92 and 91%, respectively with efs&dmp&pmp + triflusulfuron applied at the cotyledon stage, followed by two applications of efs&dmp&pmp + triflusulfuron + clopyralid, and efs&dmp&pmp applied alone at 0.675 lb ai/A. No herbicide treatment satisfactorily controlled kochia. Hairy nightshade control ranged from 38 to 84%. The best hairy nightshade control was obtained with the two treatments beginning on May 23, which was at least one week earlier than all other herbicide treatments. All herbicide treatments yielded higher than the untreated check. However, due to replanting and poor early weed control none of the treatments had outstanding yields. Heavy weed pressure reduced the untreated check yield to 4 ton/A compared to 19 ton/A for the highest yielding treatment.

Table 2. Crop Injury, weed control, and sugar beet root yield response to application timings of postemergence sugar beet herbicides

Treatment [b]	Application		Crop	Weed control [a]				Root
	Rate	Date	injury	CHEAL	AMARE	KCHSC	SOLSA	yield
	lb ai/A		-----------------------------	----------	%	----------	-----------------------------	ton/A
Check	-	-	-	-	-	-	-	4
Efs&dmp&pmp + triflusulfuron /	0.25 + 0.0156	5/23	0	94	84	69	83	14
Efs&dmp&pmp +	0.337	5/31						
triflusulfuron + clopyralid	0.0234 + 0.094							
Efs&dmp&pmp +	0.42	6/4						
triflusulfuron + clopyralid	0.0312 + 0.094							
Efs&dmp&pmp + triflusulfuron	0.25 + 0.0156	5/23	4	92	91	61	84	11
Efs&dmp&pmp	0.337	5/31						
triflusulfuron + clopyralid	0.0234 + 0.094							
Efs&dmp&pmp	0.42	6/04						
triflusulfuron + clopyralid	0.0312 + 0.094							
Efs&dmp&pmp	0.675	6/11						
Efs&dmp&pmp + triflusulfuron	0.25 + 0.0156	5/31	0	64	58	48	53	12
Efs&dmp&pmp	0.337	6/04						
triflusulfuron + clopyralid	0.0234 + 0.094							
Efs&dmp&pmp	0.42	6/11						
triflusulfuron + clopyralid	0.0312 + 0.094							
Efs&dmp&pmp + triflusulfuron	0.25 + 0.0156	6/04	8	65	59	65	48	9
Efs&dmp&pmp	0.337	6/11						
triflusulfuron + clopyralid	0.0234 + 0.094							
Efs&dmp&pmp	0.42	6/19						
triflusulfuron + clopyralid	0.0312 + 0.094							
Efs&dmp&pmp + triflusulfuron	0.337 + 0.0156	6/0	1	68	64	48	40	11
Efs&dmp&pmp	0.42	6/11						
triflusulfuron + clopyralid	0.0234 + 0.094							
clopyralid	0.094							
Efs&dmp&pmp	0.51	6/19						
triflusulfuron + clopyralid	0.0312 + 0.094							
Efs&dmp&pmp + triflusulfuron	0.42 + 0.0156	6/04	4	71	67	47	51	13
Efs&dmp&pmp	0.51	6/11						
triflusulfuron + clopyralid	0.0234 + 0.094							
Efs&dmp&pmp	0.59	6/19						
triflusulfuron + clopyralid	0.0312 + 0.094							
Efs&dmp&pmp + triflusulfuron	0.337 + 0.0156	6/11	4	74	63	58	41	14
Efs&dmp&pmp	0.42	6/19						
triflusulfuron + clopyralid	0.0234 + 0.094							
Efs&dmp&pmp	0.51	7/02						
triflusulfuron + clopyralid	0.0312 + 0.094							
Efs&dmp&pmp + triflusulfuron	0.42 + 0.0156	6/11	8	86	74	66	64	19
Efs&dmp&pmp	0.51	6/19						
triflusulfuron + clopyralid	0.0234 + 0.094							
Efs&dmp&pmp	0.59	7/02						
triflusulfuron + clopyralid	0.0312 + 0.094							
Efs&dmp&pmp + triflusulfuron	0.51 + 0.0156	6/11	14	75	75	60	61	14
Efs&dmp&pmp	0.59	6/19						
triflusulfuron + clopyralid	0.0234 + 0.094							
Efs&dmp&pmp	0.675	7/02						
triflusulfuron + clopyralid	0.0312 + 0.094							
Efs&dmp&pmp + triflusulfuron	0.76 + 0.0156	6/11	6	79	62	69	58	12
Efs&dmp&pmp	1.05	6/19						
triflusulfuron + clopyralid	0.0234 + 0.094							
Efs&dmp&pmp	1.12	6/11	11	63	50	56	38	9
triflusulfuron + clopyralid	0.0312 + 0.25							
LSD (P=0.05)			7	11	9	NS	22	4

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

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

Comparison of formulations of ethofumesate, desmedipham, and phenmedipham 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, Idaho to compare the effectiveness of commercial and candidate formulations of desmedipham, desmedipham & phenmedipham, and ethofumesate & desmedipham & phenmedipham for weed control in sugar beet. 'AE B038107 00 EC31 A2' is a candidate formulation of desmedipham; 'AE B038584 01 EC31 A2' is a candidate formulation of desmedipham & phenmedipham (dmp&pmp); and 'AE B049913 01 EC18 A2'is a candidate formulation of ethofumesate & desmedipham & phenmedipham (efs&dmp&pmp). The experiment was a randomized complete block design with four replications; and individual plots were four rows by 30 ft. Soil type was a Portneuf silt loam (20% sand, 71% silt, and 9% clay) with a pH of 8.1, 1.5% organic matter, and CEC of 17-meq/100 g soil. 'HM 2984RZ" Sugar beet was planted April 26, 2002, in rows 22-inches apart at a rate of 57,024 seed/A. Due to a late killing frost May 7 and 8, the experiment was replanted over surviving sugar beet plants on May 14 with cultivar 'HM 2980RZ'. Kochia, common lambsquarters, redroot pigweed, hairy nightshade, and green foxtail were the major weed species present. Herbicides were applied in an 11-inch band with a CO_2-pressurized bicycle-wheel sprayer using 8001 even-fan nozzles calibrated to deliver 20 gpa. Additional environmental and application information is given in Table 1. Crop injury was evaluated visually 6 days after the last herbicide treatment (DALT) on June 17 and both crop injury and weed control were similarly evaluated 29 DALT on July 10. The two center rows of each plot were harvested October 7.

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

Application date	May 31	June 4	June 11
Application timing	Cotyledon	5 d later	7 d later
Air temperature (F)	68	70	71
Soil temperature (F)	68	72	71
Relative humidity (%)	80	55	50
Wind speed (mph)	0	0	5
Cloud cover (%)	60	0	15
Weed species/ft^2			
lambsquarters, common	1	1	1
pigweed, redroot	4	5	4
nightshade, hairy	5	5	0
kochia	0	0	0
foxtail, green	0	1	1

Sugar beet injury due to herbicide treatments ranged from 1 to 13% 6 DALT, and from 2 to 11% 29 DALT but did not differ from each other on either evaluation date (Table 2). All herbicide treatments controlled common lambsquarters 35 to 68%; redroot pigweed, 26 to 58%; kochia, 40 to 68%; and hairy nightshade, 70 to 100% and did not differ among each other with respect to these weed species. The lack of significant differences is due in part to variability in weed control among replications for the herbicide treatments. Green foxtail was controlled 62 to 71% among all herbicide treatments except either formulation of desmedipham alone, or AE B038584 01 EC31 A2 (dmp&pmp formulation), which controlled green foxtail only 6 to 10%. The untreated check plots yielded an average of 6 ton/A sugar beets and 1494 lbs/A extractable sugar. All of the herbicide treatments, except 'AE B049913 01 EC18 A2', yielded 8 to 15 ton/A sugar beet and from 2,214 to 3,195 lb/A extractable sugar and did not differ from each other or from the untreated check. 'AE B049913 01 EC18 A2' yielded 15 ton/A sugar beet and 3823 lb/A extractable sugar, which was similar to other herbicide treatments but was greater than the untreated check. There was an unusually large amount of variation between plots of the same treatment in this experiment that was likely the result of the late freeze and its subsequent effects. This large variation made treatment differences difficult to detect; therefore, treatment effects may exist that are not apparent in this data.

Table 2. Crop injury, weed control, and sugar beet root yield response to sugar beet herbicide formulations.

	Application		Crop injury		Weed control[a]					Root	Extractable
Treatment[b]	Rate	Timing	6/17	7/10	CHEAL	AMARE	KCHSC	SOLSA	SETVI	yield	sugar
	lb ai/A		-----	-----	-----	-----	%	-----	-----	ton/A	lb/A
Check	-	-	-	-	-	-	-	-	-	6	1490
AE B049913 01 EC18	0.25	5/31	8	3	48	58	68	99	68	15	3820
AE B049913 01 EC18	0.33	6/5 &									
Efs&dmp&pmp	0.25	5/31	13	2	47	43	42	100	63	9	2290
Efs&dmp&pmp	0.33	6/5 &									
AE B049913 01 EC18	0.08	5/31 &	11	11	61	39	63	95	60	11	2810
triflusulfuron	0.004	6/5 &									
clopyralid	0.03	6/11									
MSO	1.5										
Efs&dmp&pmp	0.08	5/31 &	8	4	68	48	58	97	71	12	3200
triflusulfuron	0.004	6/5 &									
clopyralid	0.03	6/11									
MSO	1.5										
AE B038584 01 EC31	0.25	5/31	6	1	40	35	44	99	10	8	2210
AE B038584 01 EC31	0.33	6/5 &									
Dmp&pmp	0.25	5/31	1	3	53	35	40	86	70	9	2240
Dmp&pmp	0.325	6/5 &									
AE B038584 01 EC31	0.08	5/31 &	8	5	47	30	40	94	63	9	2300
triflusulfuron	0.004	6/5 &									
clopyralid	0.03	6/11									
MSO	1.5										
Dmp&pmp	0.079	5/31 &	15	5	47	26	52	91	62	10	2740
triflusulfuron	0.004	6/5 &									
clopyralid	0.03	6/11									
MSO	1.5										
AE B038107 00 EC31	0.25	5/31	1	3	67	49	60	92	6	10	2600
AE B038107 00 EC31	0.33	6/5 & /11									
Desmedipham	0.25	5/31	5	5	38	58	49	70	10	10	2510
Desmedipham	0.33	6/5 & /11									
LSD (0.05)			ns	ns	ns	ns	ns	ns	15	ns	ns

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

[b]AE B049913 01 EC18 A2 is an experimental formulation of ethofumesate, desmedipham, and phenmedipham, AE B038584 01 EC31 A2 is an experimental formulation of desmedipham and phenmedipham, and AE B038107 00 EC31 A2 is and experimental formulation of desmedipham. MSO is methylated seed oil.

Broadleaf and grass weed control in sugar beet with dimethenamid-P. Michael J. Wille and Don W. Morishita. (Twin Falls Research and Extension Center, University of Idaho, Twin Falls, ID 83303-1827). Dimethenamid-P is a relatively new herbicide and is under consideration for use in sugar beet. A study was established at the University of Idaho Research and Extension Center near Kimberly, Idaho to determine the effectiveness of dimethenamid-P when applied with ethofumesate & desmedipham & phenmedipham (efs&dmp&pmp) + triflusulfuron + clopyralid for grass and broadleaf weed control. Sugar beet ('PM21') was planted April 16, 2001, in 22-inch rows at a seeding rate of 57,024 seed/A. Experimental design was a randomized complete block with four replications. Individual plots were four rows by 30 ft. Soil type was a Portneuf silt loam (20% sand, 71% silt, and 9% clay) with an 8.1 pH, 1.5% organic matter, and 17-meq/100 g soil CEC. Kochia, common lambsquarters, hairy nightshade, and redroot pigweed were the major weed species present. Herbicides were applied in 11-inch bands with a CO_2-pressurized bicycle-wheel sprayer using 8001even fan nozzles calibrated to deliver 20 gpa at 28 psi. Additional environmental and application information is presented in Table 1. Crop injury and weed control were evaluated visually June 15; 28 days after the last herbicide treatment. The two center rows of each plot were harvested mechanically October 1.

Table 1. Application information and weed species densities.

Application date	May 4	May 11	May 18
Application timing	Cotyledon	2 leaf	4 leaf
Air temperature (F)	71	80	54
Soil temperature (F)	62	75	54
Relative humidity (%)	50	47	40
Wind speed (mph)	4	3	4
Cloud cover (%)	10	0	40
Weed species/ft^2			
kochia	1	1	0
common lambsquarters	12	2	2
redroot pigweed	3	1	1
hairy nightshade	1	1	1

Sugar beet was not injured by any herbicide combination tested (Table 2). Control of common lambsquarters, kochia, and redroot pigweed ranged from 94 to 100%, 75 to 100%, and 99 to 100%, respectively. Hairy nightshade was completely controlled by all herbicide combinations. Weed control did not differ among herbicide treatments for any weed species. Sugar beet root yields among herbicide treatments ranged from 17 to 25 tons/A compared to 2 ton/A in the check. Yields of herbicide-treated plots were greater than untreated plots but did not differ among each other. In this experiment, the addition of dimethenamid-P did not offer any advantage in weed control or sugar beet yield.

Table 2. Crop injury, weed control, and sugar beet root yield response to dimethenamid-P tank-mixed with registered sugar beet herbicides near Kimberly, Idaho.

	Application		Crop	Weed control[a]				Root
Treatment[b]	rate	date	injury	AMARE	CHEAL	KCHSC	SOLSA	yield
	lb/A		%					ton/A
Check	-	-	-	-	-	-	-	2
Efs&dmp&pmp +	0.33 +	May 4	3	100	94	75	100	17
triflusulfuron /	0.0156							
Efs&dmp&pmp +	0.33 +	May 11						
triflusulfuron +	0.0156 +							
clopyralid	0.094							
Efs&dmp&pmp +	0.33 +	May 4	3	100	100	84	100	21
triflusulfuron /	0.0156							
Efs&dmp&pmp +	0.33 +	May 11						
triflusulfuron +	0.0156 +							
clopyralid /	0.094							
Efs&dmp&pmp +	0.33 +	May 18						
triflusulfuron +	0.0156 +							
clopyralid	0.094							
Efs&dmp&pmp +	0.33 +	May 4	1	99	97	94	100	24
triflusulfuron +	0.0156 +							
dimethenamid-P /	0.64							
Efs&dmp&pmp +	0.33 +	May 11						
triflusulfuron +	0.0156 +							
clopyralid	0.094							
Efs&dmp&pmp +	0.33 +	May 4	1	100	99	81	100	22
triflusulfuron /	0.0156							
Efs&dmp&pmp +	0.33 +	May 11						
triflusulfuron +	0.0156 +							
clopyralid +	0.094 +							
dimethenamid-P	0.64							
Efs&dmp&pmp +	0.33 +	May 4	0	100	99	95	100	25
triflusulfuron /	0.0156							
Efs&dmp&pmp +	0.33 +	May 11						
triflusulfuron +	0.0156 +							
clopyralid /	0.094							
Efs&dmp&pmp +	0.33 +	May 18						
triflusulfuron +	0.0156 +							
clopyralid +	0.094 +							
dimethenamid-P	0.64							
Efs&dmp&pmp +	0.33 +	May 4	3	100	100	83	100	24
triflusulfuron /	0.0156							
Efs&dmp&pmp +	0.33 +	May 11						
triflusulfuron +	0.0156 +							
clopyralid +	0.094 +							
dimethenamid-P /	0.32							
Efs&dmp&pmp +	0.33 +	May 18						
triflusulfuron +	0.0156 +							
clopyralid +	0.094 +							
dimethenamid-P	0.32							
Efs&dmp&pmp +	0.33 +	May 4	1	99	94	98	100	21
triflusulfuron +	0.0156 +							
dimethenamid-P /	0.32							
Efs&dmp&pmp +	0.33 +	May 11						
triflusulfuron +	0.0156 +							
clopyralid +	0.094 +							
dimethenamid-P	0.32							
LSD (0.05)			NS	NS	NS	NS	NS	5

[a] AMARE is redroot pigweed, CHEAL is common lambsquarters, KCHSC is kochia, and SOLSA is hairy nightshade.
[b] Efs&dmp&pmp is a commercial formulation of a 1:1:1 mixture of ethofumesate, desmedipham, and phenmedipham..

Evaluation of dimethenamid-P with conventional herbicide rates for weed control in sugar beets. 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, Idaho, to evaluate dimethenamid-P applied at different rates and timings tank-mixed with conventional sugar beet herbicides for weed control. The experiment was a randomized complete block design with four replications; and individual plots were four rows by 30 ft. Soil type was a Portneuf silt loam (29% sand, 64% silt, and 6% clay), with a pH of 8.1, 1.6% organic matter, and CEC of 14-meq/100 g soil. 'HM 2984RZ' sugar beet was planted April 25, 2002, in rows 22-inches apart at 57,024 seed/A. Due to a late freeze May 7 and 8; the experiment was replanted over surviving sugar beet plants on May 14 with cultivar 'HM 2980RZ'. Common lambsquarters, redroot pigweed, hairy nightshade, kochia, and green foxtail were the major weed species present. Herbicides were applied in an 11-inch band with a CO_2-pressurized bicycle-wheel sprayer with 8001 even-fan nozzles calibrated to deliver 20 gpa. Weed population and environmental information is given in Table 1. Crop injury and weed control were evaluated visually 14 days after the last herbicide treatment (DALT) on July 3. The two center rows of each plot were harvested mechanically October 7.

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

Application date	May 31	June 4	June 11	June 19
Application timing	Cotyledon	4 d later	7 d later	8 d later
Air temperature (F)	78	74	74	71
Soil temperature (F)	79	80	73	76
Relative humidity (%)	60	59	50	32
Wind speed (mph)	2	4	1	0
Cloud cover (%)	50	25	15	1
Weed species (plants/ft^2)				
foxtail, green	0	1	1	0
lambsquarters, common	1	1	1	1
nightshade, hairy	2	5	0	3
pigweed, redroot	0	5	4	4
kochia	1	1	1	1

Sugar beet injury ranged from 3 to 15% but did not differ among herbicide treatments (Table). Common lambsquarters control ranged from 76 to 95%, redroot pigweed from 87 to 100%, hairy nightshade from 96 to 100%, and green foxtail from 71 to 97% but herbicide treatments did not differ among each other with respect to these species. All herbicide treatments controlled kochia 85 to 98% except the treatments that included 0.656 lb ai/A dimethenamid-P + 1.56 lb ai/A pyrazon at the second application date, or that included 0.656 and0.328 lb ai/A dimethenamid-P at the second and third application dates, respectively. Average sugar beet root and extractable sugar yields among herbicide treatments ranged from 16 to 22 tons/A, and from 4213 to 5692 lb sugar/A, respectively, compared to 11 tons of sugar beet, and 2745 lb sugar/A in the untreated check. Sugar beet root yields and extractable sugar yields of all herbicide treatments were greater than the untreated check, but were similar to each other. There was an unusually large amount of variation between plots of the same treatment in this experiment that was likely the result of the late freeze and its subsequent effects. This large variation made treatment differences difficult to detect; therefore treatment effects may exist that are not apparent in these data.

Table 2. Crop injury, weed control, and sugar beet yield resopnse to dimethenamid-P combined with other herbicides.

Treatment [b]	Application Rate	Application Date	Crop injury	Weed control[a] CHEAL	AMARE	KCHSC	SOLSA	SETVI	Root yield	Extractable sugar
	lb ai/A		%						ton/A	lb/a
Check	-	-	-	-	-	-	-	-	11	2745
Efs&dmp&pmp + triflusulfuron / Efs&dmp&pmp + triflusulfuron + clopyralid	0.25 + 0.0156 / 0.33 + 0.0156 + 0.094	5/31 6/4 & 6/11& 6/19	4	95	99	85	100	71	17	4304
Efs&dmp&pmp + triflusulfuron / Efs&dmp&pmp + triflusulfuron + clopyralid + dimethenamid-P / Efs&dmp&pmp + triflusulfuron + clopyralid	0.25 + 0.0156 / 0.33 + 0.0156 + 0.094 + 0.656 / 0.33 + 0.0156 + 0.094	5/31 6/4 6/11& 6/19	3	79	98	96	100	96	19	4949
Efs&dmp&pmp + triflusulfuron / Efs&dmp&pmp + triflusulfuron + clopyralid + dimethenamid-P	0.25 + 0.0156 / 0.33 + 0.0156 + 0.094 + 0.84	5/31 6/4	5	76	90	87	96	95	21	5476
Efs&dmp&pmp + triflusulfuron / Efs&dmp&pmp + triflusulfuron + clopyralid + dimethenamid-P + pyrazon / Efs&dmp&pmp + triflusulfuron + clopyralid	0.25 + 0.0156 / 0.33 + 0.0156 + 0.094 + 0.656 + 1.56 / 0.33 + 0.0156 + 0.094	5/31 6/4 6/11& 6/19	3	81	91	48	99	93	18	4585
Efs&dmp&pmp + triflusulfuron / Efs&dmp&pmp + triflusulfuron + clopyralid Efs&dmp&pmp + triflusulfuron + clopyralid + dimethenamid-P / Efs&dmp&pmp + triflusulfuron + clopyralid	0.25 + 0.0156 / 0.33 + 0.0156 + 0.094 0.33 + 0.0156 + 0.094 + 0.656 / 0.33 + 0.0156 + 0.094	5/31 6/4 & 6/19 6/11	8	81	88	88	100	86	22	5692
Efs&dmp&pmp + triflusulfuron / Efs&dmp&pmp + triflusulfuron + clopyralid + dimethenamid-P / Efs&dmp&pmp + triflusulfuron + clopyralid + dimethenamid-P / Efs&dmp&pmp + triflusulfuron + clopyralid	0.25 + 0.0156 / 0.33 + 0.0156 + 0.094 + 0.656 / 0.33 + 0.0156 + 0.094 + 0.328 / 0.33 + 0.0156 + 0.094	5/31 6/4 6/11 6/19	15	91	100	45	100	97	19	5006

Table 2 (cont.).

Treatment [b]	Application rate	Application date	Crop injury	Weed control[a] CHEAL	AMARE	KCHSC	SOLSA	SETVI	Root yield	Extractable sugar
	lb ai/A		%						ton/A	lb/a
Efs&dmp&pmp +	0.25 +	5/31	15	93	96	98	100	88	20	5245
Triflusulfuron /	0.0156									
Efs&dmp&pmp +	0.33 +	6/4								
triflusulfuron +	0.0156 +									
clopyralid +	0.094 +									
dimethenamid-P /	0.656									
Efs&dmp&pmp +	0.33 +	6/11								
triflusulfuron +	0.0156 +									
clopyralid +	0.094 +									
dimethenamid-P /	0.328									
Efs&dmp&pmp +	0.33 +	6/19								
triflusulfuron +	0.0156 +									
clopyralid +	0.094 +									
pyraclostrobin	0.187									
Efs&dmp&pmp +	0.25 +	5/31	6	95	98	95	98	87	21	5494
triflusulfuron /	0.0156									
Efs&dmp&pmp +	0.33 +	6/4								
triflusulfuron +	0.0156 +									
clopyralid +	0.094 +									
dimethenamid-P /	0.656									
Efs&dmp&pmp +	0.33 +	6/11								
triflusulfuron +	0.0156 +									
clopyralid +	0.094 +									
dimethenamid-P /	0.328		4	84	93	85	96	75	20	5260
Efs&dmp&pmp +	0.33 +	6/19								
triflusulfuron +	0.0156 +									
clopyralid +	0.094 +									
pyraclostrobin	0.187									
Efs&dmp&pmp +	0.25 +	5/31								
triflusulfuron /	0.0156									
Efs&dmp&pmp +	0.33 +	6/4 &								
triflusulfuron +	0.0156 +	6/11								
clopyralid /	0.094		6	83	87	95	100	88	16	4213
Efs&dmp&pmp +	0.33 +									
triflusulfuron +	0.0156 +									
clopyralid +	0.094 +	6/19								
dimethenamid-P	0.656									
Efs&dmp&pmp +	0.25 +	5/31								
triflusulfuron /	0.0156									
Efs&dmp&pmp +	0.33 +	6/4 &								
triflusulfuron +	0.0156 +	6/11								
clopy ralid /	0.094									
Efs&dmp&pmp +	0.33 +									
triflusulfuron +	0.0156 +									
clopyralid +	0.094 +									
dimethenamid-P	0.84									
LSD (0.05)			ns	ns	ns	17	ns	16	5	1300

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

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

Ethofumesate added to sugar beet herbicide micro-rates for kochia 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, Idaho to assess the effect of additional ethofumesate tank mixed at different rates and application timings with micro-rates of 1:1:1 ethofumesate & desmedipham & phenmedipham (efs&dmp&pmp) applied with and without triflusulfuron and/or clopyralid for kochia control. Sugar beet ('PM21') was planted April 16, 2001, in 22-inches rows at a seeding rate of 57,024 seed/A. The experiment was a randomized complete block design with four replications and individual plots were four rows by 30 ft. Soil type was a Portneuf silt loam (20% sand, 71% silt, and 9% clay) with a pH of 8.1, 1.5% organic matter, and CEC of 17-meq/100 g soil. Common lambsquarters, hairy nightshade, kochia, and redroot pigweed were the major weed species present. Herbicides were broadcast-applied with a CO_2-pressurized bicycle-wheel sprayer using 11001 flat fan nozzles calibrated to deliver 10 gpa at 28 psi except ethofumesate alone which was applied preemergence in an 11-inch band at 20 gpa using 8001even fan nozzles at 36 psi. Additional environmental and application information is given in Table 1. Crop injury and weed control were evaluated visually June 15, which was 24 days after the last herbicide treatment. The two center rows of each plot were harvested mechanically October 1.

Table 1. Application information and weed species densities.

Application date	April 18	May 4	May 11	May 14	May 17	May 22
Application timing	PRE	Cotyledon	5-7 d later	2 leaf	4 leaf	6 leaf
Air temperature (F)	54	71	80	58	60	65
Soil temperature (F)	44	62	75	52	58	72
Relative humidity (%)	50	50	47	60	58	34
Wind speed (mph)	4	4	3	4	5	5
Cloud cover (%)	5	10	0	5	0	0
Weed species/ft^2						
kochia	0	0	4	4	4	1
common lambsquarters	0	15	15	15	23	12
redroot pigweed	0	0	9	9	7	4
hairy nightshade	0	8	8	8	3	3

Sugar beet injury from ranged from 0 to 13% among all herbicide treatments. Kochia control ranged from 75 to 100%. Control of common lambsquarters, redroot pigweed, and hairy nightshade ranged from 84 to 99%, 82-100%, and 99 to 100%, respectively. Weed control did not differ among herbicide treatments for any weed species. Sugar beet root yields in the herbicide treatments ranged from 22 to 31 tons/A compared to 2 ton/A in the check. Efs&dmp&pmp at 0.25 lb ai/A followed by (fb) efs&dmp&pmp + clopyralid at 0.33 + 0.094 fb the same herbicides at 0.45 + 0.094 lb ai/A was among the highest yielding standard rate treatments. The highest yielding micro-rate treatments included efs&dmp&pmp + triflusulfuron + clopyralid + MSO at 0.0833 + 0.0052 + 0.031 + 1.5% v/v applied four times, as well as the same herbicide combination and rates with the addition of ethofumesate at 0.125 lb ai/A applied with the last two applications. Kochia control tended to be slightly improved with the addition of ethofumesate postemergence in treatments without triflusulfuron.

Table 2. Crop injury, weed control, and sugar beet root yield response to applications of ethofumesate, clopyralid, desmedipham, phenmedipham, and triflusulfuron combinations near Kimberly, Idaho

	Application		Crop	Weed control [a]				Root
Treatment [b]	rate	date	injury	KCHSC	AMARE	CHEAL	SOLSA	yield
	lb ai/A		%					ton/A
Check			—	—	—	—	—	2
Ethofumesate	1.12	April 18	5	89	100	88	100	26
Efs&dmp&pmp	0.25	May 14						
Efs&dmp&pmp	0.33	May 22						
Efs&dmp&pmp	0.25	May 4	9	95	98	95	100	30
Efs&dmp&pmp + clopyralid	0.33 + 0.094	May 14						
Efs&dmp&pmp + clopyralid	0.45 + 0.094	May 22						
Efs&dmp&pmp + triflusulfuron + clopyralid + MSO	0.0833 + 0.0052 + 0.031 + 1.5% v/v	May 4 & May 11& May 17 & May 22	4	88	95	93	100	30
Efs&dmp&pmp + triflusulfuron + clopyralid + ethofumesate + MSO	0.0833 + 0.0052 + 0.031 + 0.0625 + 1.5% v/v	May 4 & May 11& May 17 & May 22	1	94	96	92	100	29
Efs&dmp&pmp + triflusulfuron + clopyralid + MSO	0.0833 + 0.0052 + 0.031 + 1.5% v/v	May 4 & May 11	1	96	99	99	100	31
Efs&dmp&pmp triflusulfuron + clopyralid + ethofumesate + MSO	0.0833 + 0.0052 + 0.031 + 0.125 + 1.5% v/v	May 17 & May 22						
Efs&dmp&pmp	0.25	May 4	3	100	96	97	99	27
Efs&dmp&pmp	0.33	May 14						
Efs&dmp&pmp	0.45	May 22						
Efs&dmp&pmp + ethofumesate	0.25 + 0.0625	May 4	6	91	93	94	100	21
Efs&dmp&pmp + ethofumesate	0.33 + 0.0625	May 14						
Efs&dmp&pmp + ethofumesate	0.45 + 0.0625	May 22						
Efs&dmp&pmp	0.25	May 4	6	95	98	96	99	28
Efs&dmp&pmp + ethofumesate	0.33 + 0.125	May 14						
Efs&dmp&pmp + ethofumesate	0.45 + 0.125	May 22						
Efs&dmp&pmp + triflusulfuron	0.25 + 0.0156	May 4	9	95	98	95	100	24
Efs&dmp&pmp + triflusulfuron	0.33 + 0.0156	May 14						
Efs&dmp&pmp + triflusulfuron	0.45 + 0.0164	May 22						

Broadleaf weed control in sugar beet with micro and conventional rates. Don W. Morishita and Michael J. Wille (Twin Falls Research and Extension Center, University of Idaho, Twin Falls, ID 83303-1827). A field experiment was conducted at the University of Idaho Research and Extension Center near Kimberly, Idaho to compare several conventional and micro herbicide rates in sugar beet. Experimental design was a randomized complete block with four replications. Individual plots were four rows by 30 ft. Soil type was a Portneuf silt loam (29.4% sand, 65% silt, and 5.6% clay) with a pH of 8.1, 1.6% organic matter, and CEC of 14-meq/100 g soil. HM 2984RZ sugar beet was planted April 25, 2002, in 22-inch rows at a rate of 57,024 seed/A. Due to a late freeze on May 7 and 8, the experiment was replanted May 14 with HM 2980RZ. Common lambsquarters, redroot pigweed, hairy nightshade, and green foxtail were the major weed species present. Herbicides were band-applied with a CO_2-pressurized bicycle-wheel sprayer calibrated to deliver 20 gpa using 8002 even fan nozzles. Additional environmental and application information is given in Table 1. Crop injury and weed control were evaluated visually 11 days after the last herbicide treatment (DALT) on July 8. The two center rows of each plot were harvested mechanically October 8.

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

Application date	April 26	May 31	June 4	June 11	June 19	June 26
Application timing	PRE	cotyledon	4 d later	7 d later	8 d later	7 d later
Air temperature (F)	58	78	74	74	71	84
Soil temperature (F)	48	80	71	73	78	79
Relative humidity (%)	58	65	40	50	38	52
Wind speed (mph)	5	2	4	1	0	7
Cloud cover (%)	65	40	30	15	1	50
Weed species/ft^2						
lambsquarters,						2
common	0	1	1	4	1	
pigweed, redroot	0	2	5	4	5	4
nightshade, hairy	0	2	5	0	3	5
foxtail, green	0	0	0	0	1	1

None of the herbicide treatments significantly injured the sugar beet crop (Table 2). However, using the sequential conventional rates of efs&dmp&pmp at + 0.25, 0.33, and 0.42 lb ai/A + triflusulfuron + clopyralid at 0.0156 + 0.105 lb ai/A caused an average injury of 11%. Although some kochia was present in this site, kochia control data are not included due to variability in population. Common lambsquarters control ranged from 60 to 88% with more consistent control with the conventional rates compared to the micro rates. The same general pattern was observed with redroot pigweed and green foxtail control. The conventional tank mix rate of efs&dmp&pmp + clopyralid and without triflusulfuron did not control green foxtail (26%). Hairy nightshade control ranged from 93 to 100% among all herbicide treatments. In general, the conventional rate treatments yielded higher than the micro rate treatments. Ethofumesate applied preemergence followed by efs&dmp&pmp + ethofumesate + triflusulfuron at the cotyledon stage and efs&dmp&pmp + triflusulfuron + clopyralid applied two more times was among the highest yielding treatments.

Table 2. Sugar beet injury, weed control, and sugar beet root yield response to conventional and micro herbicide rates.

Treatment [b]	Rate	Application date	Crop injury	Weed control[a] CHEAL	AMARE	SOLSA	SETVI	Root yield
	lb ai/A		------------------------%------------------------					ton/A
Untreated check	-	-	-	-	-	-	-	3
Efs&dmp&pmp +	0.08 +	5/31 &	3	65	76	93	72	15
triflusulfuron +	0.0052 +	6/4						
clopyralid + MSO	0.0312 + 1.5% v/v							
efs&dmp&pmp +	0.122 +	6/11 &						
triflusulfuron +	0.0052 +	6/19&						
clopyralid + MSO	0.0312 + 1.5% v/v	6/26						
Efs&dmp&pmp +	0.08 +	5/31 &	4	66	79	100	76	16
triflusulfuron +	0.0052 +	6/4						
clopyralid +	0.0312 +							
ethofumesate + MSO	0.0625 + 1.5% v/v							
efs&dmp&pmp +	0.122 +	6/11						
triflusulfuron +	0.0052 +							
clopyralid +	0.0312 +							
ethofumesate + MSO	0.094 + 1.5% v/v							
efs&dmp&pmp +	0.122 +	6/19&						
triflusulfuron +	0.0052 +	6/26						
clopyralid + MSO	0.0312 + 1.5% v/v							
Efs&dmp&pmp +	0.08 +	5/31 &	0	85	56	95	74	12
clopyralid +	0.0312 +	6/4						
ethofumesate + MSO	0.0625 + 1.5% v/v							
efs&dmp&pmp +	0.122 +	6/11						
clopyralid +	0.0312 +							
ethofumesate + MSO	0.094 + 1.5% v/v							
efs&dmp&pmp +	0.122 +	6/19						
clopyralid + MSO	0.0312 + 1.5% v/v							
efs&dmp&pmp +	0.122 +	6/26						
triflusulfuron +	0.0052 +							
clopyralid + MSO	0.0312 + 1.5% v/v							
Efs&dmp&pmp +	0.08 +	5/31 &	9	60	66	97	93	17
triflusulfuron +	0.0052 +	6/4						
clopyralid + MSO	0.0312 + 1.5% v/v							
efs&dmp&pmp +	0.122 +	6/11						
triflusulfuron +	0.0052 +							
clopyralid +	0.0312 +							
dimethenamid + MSO	0.656 + 1.5% v/v							
efs&dmp&pmp +	0.122 +	6/19&						
triflusulfuron +	0.0052 +	6/26						
clopyralid + MSO	0.0312 + 1.5% v/v							
Efs&dmp&pmp +	0.08 +	5/31 &	4	75	68	98	93	18
triflusulfuron +	0.0052 +	6/4						
clopyralid +	0.0312 +							
ethofumesate + MSO	0.0625 + 1.5% v/v							
efs&dmp&pmp +	0.122 +	6/11 &						
triflusulfuron +	0.0052 +	6/19						
clopyralid +	0.0312 +							
dimethenamid + MSO	0.328 + 1.5% v/v							
efs&dmp&pmp +	0.122 +							
triflusulfuron +	0.0052 +							
clopyralid + MSO	0.0312 + 1.5% v/v							

Table 2. (cont.)

Treatment [b]	Rate	Application date	Crop injury	Weed control[a] CHEAL	AMARE	SOLSA	SETVI	Root yield
	lb ai/A		-----------	-----------	%	-----------	-----------	ton/A
Efs&dmp&pmp +	0.25 +	5/31	11	81	91	99	70	20
triflusulfuron	0.0156 +							
efs&dmp&pmp +	0.336 +	6/4						
triflusulfuron +	0.0156 +							
clopyralid	0.105							
efs&dmp&pmp +	0.42 +	6/11						
triflusulfuron +	0.0156 +							
clopyralid	0.105							
Efs&dmp&pmp	0.25 +	5/31	6	84	75	97	26	17
efs&dmp&pmp +	0.337 +	6/4						
clopyralid	0.105							
efs&dmp&pmp +	0.42 +	6/11						
clopyralid	0.105							
Efs&dmp&pmp +	0.25 +	5/31	8	88	88	100	94	21
triflusulfuron	0.0156 +							
efs&dmp&pmp +	0.336 +	6/4						
triflusulfuron +	0.0156 +							
clopyralid	0.105							
efs&dmp&pmp +	0.42 +	6/11						
triflusulfuron +	0.0156 +							
clopyralid +	0.105 +							
dimethenamid	0.656							
Ethofumesate	1.12	4/26	6	81	84	98	84	19
efs&dmp&pmp +	0.25 +	5/31						
clopyralid	0.105							
efs&dmp&pmp +	0.337 +	6/4						
clopyralid	0.105							
efs&dmp&pmp +	0.42 +	6/11						
clopyralid	0.105							
Ethofumesate	1.12	4/26	9	80	94	99	81	23
efs&dmp&pmp +	0.337 +	6/4						
triflusulfuron +	0.0156 +							
clopyralid	0.105							
efs&dmp&pmp +	0.42 +	6/11						
triflusulfuron +	0.0156 +							
clopyralid	0.105							
Efs&dmp&pmp +	0.25 +	5/31	4	83	85	100	95	22
triflusulfuron +	0.0156 +							
ethofumesate	0.187							
efs&dmp&pmp +	0.337 +	6/4						
triflusulfuron +	0.0156 +							
ethofumesate	0.187							
efs&dmp&pmp +	0.42 +	6/11						
triflusulfuron +	0.0156 +							
dimethenamid	0.656							
LSD (P=.05)			NS	13	15	3	12	4

[a]Weeds evaluated for control were common lambsquarters (CHEAL), redroot pigweed (AMARE), hairy nightshade (SOLSA), and green foxtail (SETVI).
[b]Efs&dmp&pmp is a commercial formulation of a 1:1:1 mixture of ethofumesate, desmedipham, and phenmedipham. MSO is methylated seed oil applied at 1.5% v/v.

Ethofumesate tank-mixed with registered sugar beet herbicide micro-rates affects on crop tolerance, weed control, and carryover to spring barley. Don W. Morishita and Michael J. Wille. (Twin Falls Research and Extension Center, University of Idaho, Twin Falls, ID 83303-1827) This study was initiated in 2001 at the University of Idaho Research and Extension Center near Kimberly, Idaho. The purpose of this experiment was to evaluate preemergence (PRE) and postemergence (POST) ethofumesate applications alone and tank mixed with micro-rates of ethofumesate & desmedipham & phenmedipham (efs&dmp&pmp) + clopyralid for sugar beet injury, weed control, and carryover potential to spring barley. Sugar beet ('PM21') was planted April 16, 2001, on 22-inch rows at a rate of 57,024 seed/A. The experiment was a randomized complete block design with four replications and individual plots were four rows by 30 ft. Soil type was a Portneuf silt loam (20% sand, 71% silt, and 9% clay) with an 8.1 pH, 1.5% organic matter, and CEC of 17-meq/100 g soil. Herbicide treatments consisted of ethofumesate applied POST at different broadcast or band-applied rates, with or without a preemergence PRE ethofumesate application. All POST treatments included efs&dmp&pmp + clopyralid at 0.0833 and 0.094 lb ai/A. Herbicides were applied with a CO_2-pressurized bicycle-wheel sprayer calibrated to deliver 10 gpa using 11001 flat fan nozzles for broadcast applications, and 20 gpa using 8001 even fan nozzles for 11-inch band applications. Additional environmental and application information is given in Table 1. Sugar beet injury and weed control were evaluated visually June 15, 2001,which was 24 days after the last herbicide application. The two center rows of each plot were harvested mechanically October 1. Moravian 37 spring barley was planted into the same area April 6, 2002, at a 100 lb/A seeding rate. The barley was oversprayed with fenoxaprop at 0.083 lb ai/A and tribenuron + bromoxynil & MCPA at 0.0078 + 0.5 lb ai/A on May 17, 2002, for wild oat and broadleaf weed control. Barley crop injury was evaluated June 11 and July 10, 2002. Spring barley was harvested August 18 with a small-plot combine.

Table 1. Environmental conditions at application and weed species densities in 2001 sugar beet crop.

Application date	5/4	5/11	5/17	5/22
Application timing	Early POST	2 leaf	7 d later	5 d later
Air temperature (F)	67	76	56	64
Soil temperature (F)	55	72	60	58
Relative humidity (%)	55	45	48	68
Wind speed (mph)	2	4	4	1
Cloud cover (%)	0	0	0	0
Weed species/ft^2				
lambsquarters, common	1	1	4	4
pigweed, redroot	0	2	2	1
nightshade, hairy	1	1	1	1
kochia	1	1	1	1

Herbicide treatments injured sugar beet ≤10% (Table 2). Even though the highest injury level was significantly greater than the lowest injury level, no differences in yield were observed. Common lambsquarters control ranged from 75 to 100% among all herbicide treatments. Ethofumesate applied POST four times at 0.125, 0.187, 0.25, and 0.25 lb ai/A either in a band or broadcast controlled common lambsquarters best. A PRE ethofumesate application followed by three POST applications tended to control common lambsquarters better with the 20 gpa band application compared to the 10 gpa broadcast application. Kochia, redroot pigweed, and hairy nightshade control did not differ among herbicide treatments. Sugar beet yields among herbicide treatments ranged from 23 to 29 tons/A compared to 3 tons/A in the untreated check. Beet yields from all herbicide treatments were greater than the untreated check but did not differ among each other.

In the spring barley follow-crop, carryover injury was not different among herbicide treatments (Table 3). Barley grain yield was not different among any of the treatments. This indicates that even with maximum ethofumesate rates applied to sugar beets, carryover effects on barley are minimal.

Table 2. Crop injury, weed control and sugar beet yield response to applications of ethofumesate PRE and ethofumesate POST tank-mixed ethofumesate & desmedipham & phenmedipham + clopyralid + MSO.

Treatment [a]	Application rate	Application date	Crop injury	Weed control [b] CHEAL	AMARE	KCHSC	SOLSA	Yield
			--- % ---					ton/A
Check	-	-	-	-	-	-	-	3
Ethofumesate (band at 20 gpa)	1.12	5/4	3	75	84	84	100	23
Ethofumesate (broadcast at 10 gpa)	0.094	5/11						
Ethofumesate (broadcast at 10 gpa)	0.125	5/17						
Ethofumesate (broadcast at 10 gpa)	0.156	5/22						
Ethofumesate (band at 20 gpa)	1.12	5/4	10	84	92	98	100	26
Ethofumesate (band at 20 gpa)	0.094	5/11						
Ethofumesate (band at 20 gpa)	0.125	5/17						
Ethofumesate (band at 20 gpa)	0.156	5/22						
Ethofumesate (band at 20 gpa)	1.12	5/4	0	83	93	96	100	26
Ethofumesate (broadcast at 10 gpa)	0.125	5/11						
Ethofumesate (broadcast at 10 gpa)	0.156	5/17						
Ethofumesate (broadcast at 10 gpa)	0.187	5/22						
Ethofumesate (band at 20 gpa)	1.12	5/4	5	93	97	88	100	25
Ethofumesate (band at 20 gpa)	0.125	5/11						
Ethofumesate (band at 20 gpa)	0.156	5/17						
Ethofumesate (band at 20 gpa)	0.187	5/22						
Ethofumesate (broadcast at 10 gpa)	0.125	5/4	4	100	97	86	100	29
Ethofumesate (broadcast at 10 gpa)	0.178	5/11						
Ethofumesate (broadcast at 10 gpa)	0.25	5/17						
Ethofumesate (broadcast at 10 gpa)	0.25	5/22						
Ethofumesate (band at 20 gpa)	0.125	5/4	8	98	97	78	100	26
Ethofumesate (band at 20 gpa)	0.187	5/11						
Ethofumesate (band at 20 gpa)	0.25	5/17						
Ethofumesate (band at 20 gpa)	0.25	5/22						
Ethofumesate (band at 20 gpa)	1.12	5/4	3	86	97	70	100	23
Ethofumesate (broadcast at 10 gpa)	0.125	5/11						
Ethofumesate (broadcast at 10 gpa)	0.25	5/17						
Ethofumesate (broadcast at 10 gpa)	0.25	5/22						
LSD (P=.05)			7	11	ns	ns	ns	7

[a] All postemergence ethofumesate treatments were tank-mixed with a 1:1:1 commercial formulation of ethofumesate & desmedipham & phenmedipham at 0.0833 lb/A + clopyralid at 0.0312 lb/A + methylated seed oil at 1.5% v/v.

[b] Weed species evaluated were common lambsquarters (CHEAL), redroot pigweed (AMARE), hairy nightshade (SOLSA), and kochia.

Table 3. Barley injury, grain yield, and test weight in response to applications of ethofumesate PRE and POST applied with ethofumesate & desmedipham & phenmedipham + clopyralid + MSO.

Treatment [a]	Application		Crop injury		Barley	
	rate	date	6/11	7/10	yield	test wt.
			---------%---------		bu/A	
Check	-	-	--	--	40	51
Ethofumesate (band at 20 gpa)	1.12	5/4	5	0	51	49
Ethofumesate (broadcast at 10 gpa)	0.094	5/11				
Ethofumesate (broadcast at 10 gpa)	0.125	5/17				
Ethofumesate (broadcast at 10 gpa)	0.156	5/22				
Ethofumesate (band at 20 gpa)	1.12	5/4	9	1	33	49
Ethofumesate (band at 20 gpa)	0.094	5/11				
Ethofumesate (band at 20 gpa)	0.125	5/17				
Ethofumesate (band at 20 gpa)	0.156	5/22				
Ethofumesate (band at 20 gpa)	1.12	5/4	4	0	37	50
Ethofumesate (broadcast at 10 gpa)	0.125	5/11				
Ethofumesate (broadcast at 10 gpa)	0.156	5/17				
Ethofumesate (broadcast at 10 gpa)	0.187	5/22				
Ethofumesate (band at 20 gpa)	1.12	5/4	4	2	45	49
Ethofumesate (band at 20 gpa)	0.125	5/11				
Ethofumesate (band at 20 gpa)	0.156	5/17				
Ethofumesate (band at 20 gpa)	0.187	5/22				
Ethofumesate (broadcast at 10 gpa)	0.125	5/4			46	48
Ethofumesate (broadcast at 10 gpa)	0.178	5/11				
Ethofumesate (broadcast at 10 gpa)	0.25	5/17				
Ethofumesate (broadcast at 10 gpa)	0.25	5/22				
Ethofumesate (band at 20 gpa)	0.125	5/4			39	49
Ethofumesate (band at 20 gpa)	0.187	5/11				
Ethofumesate (band at 20 gpa)	0.25	5/17				
Ethofumesate (band at 20 gpa)	0.25	5/22				
Ethofumesate (band at 20 gpa)	1.12	5/4	4	0	46	49
Ethofumesate (broadcast at 10 gpa)	0.125	5/11				
Ethofumesate (broadcast at 10 gpa)	0.25	5/17				
Ethofumesate (broadcast at 10 gpa)	0.25	5/22				
LSD (P=.05)			ns	ns	ns	ns

[a] All postemergence ethofumesate treatments were applied with a 1:1:1 commercial formulation of ethofumesate & desmedipham & phenmedipham at 0.0833 lb/A + clopyralid at 0.0312 lb/A + methylated seed oil at 1.5% v/v.

Evaluation of carfentrazone, fluroxypyr, and quinclorac as candidate herbicides 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 established at the University of Idaho Research and Extension Center near Kimberly, Idaho to evaluate the potential of carfentrazone, fluroxypyr, and quinclorac for weed control in micro-rate tank-mixtures with ethofumesate & desmedipham & phenmedipham (efs&dmp&pmp) + triflusulfuron + clopyralid + MSO. Sugar beet ('PM21') was planted April 16, 2002, in 22-inch rows, at a rate of 57,024 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 (20% sand, 71% silt, and 9% clay) with a pH of 8.1, 1.5% organic matter, and CEC of 17-meq/100 g soil. Common lambsquarters and redroot pigweed were the major weed species present. Herbicides were applied in an 11-inch band with a CO_2-pressurized bicycle-wheel sprayer calibrated to deliver 20 gpa at 28 psi using 8001 even-fan nozzles. Additional application information is shown in Table 1. Crop injury and weed control were evaluated visually 7 and 24 days after the last herbicide treatment (DALT) on May 20 and June 15. The two center rows of each plot were harvested mechanically October 1.

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

Application date	May 4	May 11	May 17	May 22
Application timing	Cotyledon	7 d later	7 d later	7 d later
Air temperature (F)	65	75	77	70
Soil temperature (F)	62	70	72	62
Relative humidity (%)	36	45	56	67
Wind speed (mph)	3	5	3	2
Cloud cover (%)	0	0	0	10
Weed species/ft^2				
common lambsquarters	3	3	2	2
redroot pigweed	3	5	3	3

Sugar beet injury 7 DALT ranged from 45 to 73% in plots treated with carfentrazone, fluroxypyr, or quinclorac, but only from 8 to 10% in plots treated with efs&dmp&pmp + triflusulfuron + clopyralid. By 24 DALT, no injury was evident in plots treated with efs&dmp&pmp + triflusulfuron + clopyralid only, but averaged 41% in treatments with carfentrazone or quinclorac, and 83% in treatments with fluroxypyr. Herbicides controlled common lambsquarters 91 to 98% and redroot pigweed 66 to 91% 7 DALT. At 24 DALT, herbicides controlled common lambsquarters and redroot pigweed 69 to 100% and 64 to 100% , respectively. The inclusion of carfentrazone, fluroxypyr, or quinclorac at any of the tested rates did not increase the efficacy of the 'micro-rate' tank-mix of efs&dmp&pmp + triflusulfuron + clopyralid for either weed species at either evaluation date. The inclusion of carfentrazone, fluroxypyr, or quinclorac in a 'micro-rate' tank mix of efs&dmp&pmp + triflusulfuron + clopyralid caused severe crop injury and did not improve weed control compared to efs&dmp&pmp + triflusulfuron + clopyralid alone. Therefore, the inclusion of these herbicides is unwarranted at these rates and application timings.

Table 2. Crop injury, weed control, and sugar beet root yield response to carfentrazone, fluroxypyr, and quinclorac tank-mixed with ethofumesate, desmedipham, phenmedipham, triflusulfuron, and clopyralid.

Treatment[b]	Rate	Application date	Crop injury 5/29	Crop injury 6/15	Weed control[a] CHEAL 5/29	CHEAL 6/15	AMARE 5/29	AMARE 6/15	Root yield
	lb ai/A		%						ton/A
Check	-	-	-	-	-	-	-	-	0
Efs&dmp&pmp +	0.0833 +	May 4, 11, 17, and 22	60	38	79	78	86	83	9
clopyralid +	0.0312 +								
MSO	1.5% v/v								
carfentrazone +	0.002 +	May 17 & 22							
Efs&dmp&pmp +	0.0833 +	May 4, 11, 17 & 22	59	41	74	74	86	86	9
clopyralid +	0.0312 +								
MSO	1.5% v/v								
carfentrazone +	0.004 +	May 17 & 22							
Efs&dmp&pmp +	0.0833 +	May 4, 11, 17 & 22	73	43	71	71	74	74	7
clopyralid +	0.0312 +								
MSO	1.5% v/v								
carfentrazone +	0.008 +	May 22							
Efs&dmp&pmp +	0.0833 +	May 4, 11, 17 & 22	61	75	80	80	71	71	4
clopyralid +	0.0312 +								
MSO	1.5% v/v								
fluroxypyr +	0.0625 +	May 22							
Efs&dmp&pmp +	0.0833 +	May 4, 11, 17 & 22	68	90	68	66	64	64	0
clopyralid +	0.0312 +								
MSO	1.5% v/v								
fluroxypyr	0.125	May 17 & 22							
Efs&dmp&pmp +	0.0833 +	May 4, 11, 17 & 22	45	41	91	91	73	73	9
quinclorac	0.094	May 22							
Efs&dmp&pmp +	0.0833 +	May 4, 11, 17 & 22	10	0	86	86	94	94	25
triflusulfuron +	0.0052 +								
clopyralid +	0.0312 +								
MSO	1.5% v/v								
Efs&dmp&pmp +	0.0833 +	May 4, 11, 17 & 22	9	0	83	83	100	100	25
triflusulfuron +	0.0052 +								
clopyralid +	0.0312 +								
Hasten	1.5% v/v								
Efs&dmp&pmp +	0.0833 +	May 4, 11, 17 & 22	8	0	86	88	94	98	26
triflusulfuron +	0.0052 +								
clopyralid +	0.0312 +								
In-Place +	6 fl oz/A +								
Hasten	1.5% v/v								
LSD (P=.05)			14	21	13	13	15	14	7

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

[b] Efs&dmp&pmp is a commercial formulation of a 1:1:1 mixture of ethofumesate, desmedipham, and phenmedipham. Carfentrazone, fluroxypyr, and quinclorac were applied in combination with the sugar beet herbicides on the corresponding application dates. MSO is methylated seed oil. Hasten is a vegetable seed oil/nonionic surfactant blend, In-Place is a spray deposition aid.

Volunteer potato 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) A study was conducted at the University of Idaho Research and Extension Center near Kimberly, Idaho to determine the most effective method of controlling volunteer potato in sugar beet. The experiment was a 2 by 6 factorial split plot arrangement in a randomized complete block design with four replications. Main plots were the herbicide treatments and subplots were the presence or absence of volunteer potato. Individual subplots were 4 rows by 30 ft. Soil type was a Portneuf silt loam (29% sand, 64% silt, and 6% clay) with a pH of 8.1, 1.6% organic matter, and CEC of 14-meq/100 g soil. Whole potato seed pieces weighing 1 to 3 oz were planted at 18-inch intervals within each row prior to sugar beet planting. 'HM 2984RZ' sugar beet was planted April 25, 2002, in 22-inch rows at a rate of 57,024 seed/A. Due to a late freeze May 7 and 8, the experiment was replanted May 14 with 'HM 2980RZ'. Herbicides were applied in an 11-inch band with a CO_2-pressurized bicycle-wheel sprayer using 8001 even fan nozzles calibrated to deliver 20 gpa. Additional application information is shown in Table 1. Plots, including the untreated check, were kept weed-free, except for volunteer potato, by handweeding, as needed. Crop injury and volunteer potato control was evaluated visually 21days after last herbicide treatment (DALT) on July 23. Tuber biomass from four volunteer potato plants in each plot was measured prior to sugar beet harvest. The two center rows of each plot were harvested mechanically October 8.

Table 1. Environmental conditions at application.

Application date	May 31	June 5	June 11	June 19	June 26	July 9
Application timing	cotyledon	5 d later	6 d later	7 d later	7 d later	14 d later
Air temperature (F)	68	70	71	71	82	73
Soil temperature (F)	68	72	71	76	69	70
Relative humidity (%)	80	55	50	34	58	38
Wind speed (mph)	0	0	5	0	6	0
Cloud cover (%)	60	0	15	1	15	5

Data analysis showed significant herbicide treatment by volunteer potato presence interactions for crop injury, volunteer potato control and biomass, and sugar beet root and sucrose yield (Table 2). With the exception of the glyphosate treatment, crop injury tended to be higher in the treatments without volunteer potato. Addition of fluroxypyr for volunteer potato control injured the sugar beets with and without volunteer potato 51 and 76%, respectively. Sugar beet injury in the glyphosate treatment was not a factor in plots without volunteer potato because glyphosate was hand-applied to the volunteer potato only and thus not applied in the respective subplots without volunteer potato. Injury observed in this treatment was 10% and was caused by the sugar beet herbicides. The first three herbicide treatments in this study are registered for use in sugar beets, while the last two are not. Of the three registered-herbicide treatments, ethofumesate controlled volunteer potato 54% and was better than applying clopyralid at 0.156 lb ai/A (33% control), or just using the standard herbicide application of efs&dmp&pmp + triflusulfuron + clopyralid (23%). It also had the second lowest potato tuber biomass at 4,110 lb/A compared to glyphosate, which controlled volunteer potato 100%. The untreated check produced 24,590 pounds of potato tubers per acre. All of the herbicide treatments had lower potato tuber biomass than the check. Sugar beet yield in the untreated check with and without volunteer potato was 7 and 20 ton/A. This indicates that volunteer potato densities of 1 tuber per 2.75 ft^2 or 15,840 tubers per acre can reduce sugar beet yields by 65%. Sugar beet yields using the standard herbicide regime (treatment 2) were reduced 27% by volunteer potato. Using ethofumesate for volunteer potato control eliminated volunteer potato competition and had the highest sugar beet root and sucrose yield of the subplots that had volunteer potato present.

Table 2. Crop injury, volunteer potato control, and sugar beet yield response to herbicide treatments.

Treatment	Application Rate	Application Timing	Crop injury with SOLTU	Crop injury without SOLTU	SOLTU control	SOLTU biomass	Sugar beet root yield with SOLTU	Sugar beet root yield without SOLTU	Sugar beet sucrose yield with SOLTU	Sugar beet sucrose yield without SOLTU
	lb ai/A		---------------%---------------			lb/A	------ton/A------		-------lb/A------	
Untreated check	-	-	-	-	-	24,590	7	20	2,260	2,580
Efs&dmp&pmp +	0.25 +	5/31	3	11	23	6,080	16	22	3,980	5,890
triflusulfuron /	0.0156 /									
efs&dmp&pmp +	0.33 +	6/5 & 6/11								
triflusulfuron +	0.0156 +									
clopyralid	0.094									
Efs&dmp&pmp +	0.25 +	5/31	6	10	33	12,580	16	22	4,030	5,600
triflusulfuron /	0.0156 /									
efs&dmp&pmp +	0.33 +	6/5 & 6/19								
triflusulfuron /	0.0156 /									
clopyralid +	0.156 +	6/26								
COC	1 qt/A									
Efs&dmp&pmp +	0.25 +	5/31	6	16	54	4,110	21	20	5,510	4,950
triflusulfuron /	0.0156 /									
efs&dmp&pmp +	0.33 +	6/5 & 6/19								
triflusulfuron +	0.0156 +									
clopyralid /	0.094 /									
ethofumesate	0.75	6/26								
Efs&dmp&pmp +	0.25 +	5/31	51	76	40	7,060	1	3	-	2,030
triflusulfuron /	0.0156 /									
efs&dmp&pmp +	0.33 +	6/5 & 6/11								
triflusulfuron +	0.0156 +									
clopyralid /	0.094 /									
fluroxypyr	0.1875	6/16								
Efs&dmp&pmp +	0.25 +	5/31	58	10	100	0	9	22	2,450	5,600
triflusulfuron /	0.0156 /									
efs&dmp&pmp +	0.33 +	6/5 & 6/11								
triflusulfuron +	0.0156 +									
clopyralid /	0.094 /									
glyphosate	50% conc.	7/9								
LSD (P=0.05)			11		8	2,580	5		1,210	

[a] SOLTU is volunteer potato

[b] Efs&dmp&pmp is a commercial 1:1:1 formulation of ethofumesate, desmedipham, and phenmedipham. COC is crop oil concentrate. Glyphosate was applied with a cotton glove dipped into a 50% glyphosate concentration.

Effect of trinexapac-ethyl on Kentucky bluegrass lodging. Janice M. Reed and Donald C. Thill. (Plant Science Division, University of Idaho, Moscow, ID 83844-2339) A study was conducted at the Jacklin Seed research site near Nezperce, ID to evaluate the effect of three rates of trinexapac-ethyl (growth regulator) on 'Kenblue' Kentucky bluegrass lodging and seed yield. 'Kenblue' is a tall, early-maturing variety that lodges commonly. Plots were 8 by 30 ft arranged in a randomized complete block design with four replications. Treatments were applied with a CO_2 pressurized backpack sprayer calibrated to deliver 10 gpa at 30 psi and 3 mph. Application data are presented in Table 1. Bluegrass height was measured and percent lodging was estimated visually on June 13, 2002. Biomass was collected from a 2.7 ft^2 area of each plot on July 17, 2002. Plots were swathed on July 17 and harvested on July 30, 2002.

All rates of trinexapac-ethyl reduced Kentucky bluegrass height an average of 41 % compared to the untreated check and 31 % compared to prohexadione calcium (Table 2). Bluegrass lodging was 54 % in the untreated check and 33 % in the prohexadione calcium treatments, while bluegrass did not lodge with trinexapac-ethyl. All treatments reduced plant biomass 30 to 42% compared to the untreated control. Bluegrass seed yield did not differ among trinexapac-ethyl treatments and the untreated check; however, the prohexadione calcium treatment had a higher yield than the 0.267 lb ai rate of trinexapac-ethyl.

Table 1. Application data.

Date	May 9, 2002
Air temperature (F)	52
Relative humidity (%)	55
Wind (mph)	3
Cloud cover (%)	75
Soil temperature at 2 in (F)	44

Table 2. Kentucky bluegrass height, lodging, biomass, and seed yield with trinexapac-ethyl treatments.

Treatment	Rate	Height	Lodging	Biomass	Seed yield
	lb ai/A	inches	%	oz/ft^2	lb/A
Untreated check	----	34	54	1.4	201
Trinexapac-ethyl	0.178	22	0	0.97	287
Trinexapac-ethyl	0.267	20	0	0.90	140
Trinexapac-ethyl	0.356	19	0	0.82	222
Prohexadione calcium	0.25	29	33	0.98	351
LSD (0.05)		5	31	0.34	200

Kentucky bluegrass injury and weed control with carfentrazone in combination with other broadleaf herbicides. Janice M. Reed and Donald C. Thill. (Plant Science Division, University of Idaho, Moscow, ID 83844-2339) A study was conducted near Nezperce, ID to evaluate the effect of the emulsifiable concentrate (EC) formulation of carfentrazone compared to the dry flowable (DF) formulation and in combination with other broadleaf herbicides on Kentucky bluegrass injury and weed control. The experiment was conducted in a first year seed harvest field (seeded spring 2000) of variety 'J2695' Kentucky bluegrass. Plots were 8 by 16 ft arranged in a randomized complete block design with four replications and included an untreated check. Treatments were applied with a CO_2 pressurized backpack sprayer calibrated to deliver 10 gpa at 30 psi and 3 mph (Table 1). Weed control and Kentucky bluegrass injury were evaluated visually 3, 7, 14, and 28 DAT. Weeds present were sheperds-purse (CAPBU), flixweed (DESSO), corn gromwell (LITAR), and field pennycress (THLAR). Bluegrass seed was not harvested.

Table 1. Application data.

Date	April 9, 2002
Kentucky bluegrass growth stage	2 to 3 inches
Weed growth stages:	
sheperds-purse	1 to 2 inches
flixweed	2 to 4 inches
corn gromwell	2 to 4 inches
field pennycress	1 to 2 inches
Air temperature (F)	49
Relative humidity (%)	68
Wind (mph)	3
Cloud cover (%)	50
Soil temperature at 2 in (F)	41

No treatment visibly injured Kentucky bluegrass at any evaluation date (data not shown). At 3 DAT, CAPBU (50%), DESSO (70%), and THLAR (24%) control were all best with the high rate of carfentrazone plus dicamba (Table 2). LITAR control was best (70%) with the high rate of carfentrazone plus clopyralid/MCPA. At 28 DAT, CAPBU control was 100% with carfentrazone 40 DF treatments, carfentrazone plus tribenuron treatments, and the high rate of carfentrazone plus clopyralid/MCPA. All treatments controlled DESSO and THLAR 100%. LITAR control was 94 to 100% with carfentrazone in combination with all broadleaf herbicides; however, control was lowest with the low rates of the 40 DF (80%) and the 2 EC (70%) formulations of carfentrazone alone.

Table 2. Weed control with carfentrazone 2 EC in combination with other broadleaf herbicides.

Treatment[1]	Rate[2]	3 DAT				28 DAT			
		CAPBU	DESSO	LITAR	THLAR	CAPBU	DESSO	LITAR	THLAR
	lb ai/A	%							
Carfentrazone 40DF	0.016	19	14	12	10	100	100	80	100
Carfentrazone 40DF	0.025	25	25	24	12	100	100	93	100
Carfentrazone 2 EC	0.016	25	22	26	12	69	100	70	100
Carfentrazone 2EC	0.025	40	28	26	10	98	100	92	100
Carfentrazone 2EC + 2,4-D	0.016 + 0.25	28	11	11	10	86	100	98	100
Carfentrazone 2EC + 2,4-D	0.025 + 0.25	25	14	25	11	98	100	96	100
Carfentrazone 2EC + MCPA	0.016 + 0.375	30	19	26	12	86	100	98	100
Carfentrazone 2EC + MCPA	0.025 + 0.375	40	22	30	10	95	100	100	100
Carfentrazone 2EC + dicamba	0.016 + 0.25	35	25	25	16	80	100	100	100
Carfentrazone 2EC + dicamba	0.025 + 0.25	50	70	25	24	73	100	95	100
Carfentrazone 2EC + tribenuron	0.016 + 0.016	40	42	25	12	100	100	94	100
Carfentrazone 2EC + tribenuron	0.025 + 0.016	24	22	42	12	100	100	98	100
Carfentrazone 2EC + clopyralid/MCPA	0.016 + 0.3	21	26	45	12	94	100	100	100
Carfentrazone 2EC + clopyralid/MCPA	0.025 + 0.3	28	38	70	12	100	100	100	100
LSD (0.05)		6	6	5	5	10	NS	6	NS

[1] All treatments applied with a 90% non-ionic surfactant at 0.25% v/v. Clopyralid/MCPA was applied as the commercial premix formulation.
[2] 2,4-D, MCPA, dicamba, and clopyralid/MCPA rates are in lb ae/A.

Annual weed control in field corn with postemergence mesotrione. J. Earl Creech, John O. Evans, and R. William Mace (Plants, Soils, and Biometeorology Dept., Utah State University, Logan, UT 84322-4820). To evaluate the performance of mesotrione for postemergence annual weed control in field corn, Asgrow variety RX489RR was planted May 8, 2001 at a growers farm in Cornish, UT in 0.76 m rows at a rate of 80,000 seeds/ha. The soil was a Kidman fine sandy loam with 1.6 % O.M. and 7.6 pH. Treatments were applied to 3.0 by 9.1 m plots arranged in a randomized complete block design with four replications. Individual treatments were applied with a CO_2 backpack sprayer with flat fan 80015 nozzles calibrated to deliver 230 L/ha at 275 kPa. Treatments were applied June 11 to corn 20 to 25 cm tall. At the time of application, redroot pigweed (AMARE), common lambsquarters (CHEAL), and green foxtail (SETVI) were 4 to 7, 1 to 4, and 1 to 8 cm tall, respectively. Visual evaluations of crop injury and weed control were completed June 25 and July 11 and plots were harvested September 5.

Without additives, mesotrione failed to provide acceptable control of any weed evaluated except common lambsquarters at the high rate. With additives, redroot pigweed and green foxtail control improved significantly but mesotrione still did not perform as well as some of the industry standards. The high rate of glyphosate proved to be the best treatment. Crop injury was not observed with any treatment. Corn silage yields were not significantly different among treatments.

Table. Redroot pigweed, common lambsquarters, and green foxtail control and corn injury and silage yield.

		Control[4]			ZEAMA	
Herbicide	Rate	AMARE	CHEAL	SETVI	Injury[5]	Yield
	g/ha	-------	%	-------	%	kg/ha
Mesotrione	70	30	61	3	0	36,954
Mesotrione	140	48	95	16	0	36,057
Mesotrione[12]	140	76	98	46	0	36,416
Glyphosate[3]	560	54	99	97	0	40,363
Glyphosate[3]	1120	96	100	99	0	48,256
Nicosulfuron +	13	94	94	77	0	39,107
rimsulfuron +	13					
atrazine[1,2]	851					
Rimsulfuron +	12	88	89	64	0	39,107
thifensulfuron-methyl[1,2]	6					
Nicosulfuron[1,2]	53	93	18	95	0	33,367
Primisulfuron-methyl[1,2]	40	48	56	35	0	40,004
Control		0	0	0	0	32,469
LSD (0.05)		7.8	7.1	6.3	NS	NS

[1] Crop oil concentrate added at 1% v/v
[2] Ammonium nitrate added at 4.7 L/ha
[3] Isopropyl amine salt
[4] Includes only July 11 evaluations
[5] Includes only June 25 evaluations

Annual weed control in field corn with preemergence mesotrione. J. Earl Creech, John O. Evans, and R. William Mace (Plants, Soils, and Biometeorology Dept., Utah State University, Logan, UT 84322-4820). This study was conducted at a growers farm in Cornish, UT to evaluate the performance of mesotrione for preemergence annual weed control in field corn. Asgrow variety RX489RR was planted May 8, 2001 in 0.76 m rows at a rate of 80,000 seeds/ha. The soil was a Kidman fine sandy loam with 1.6 % O.M. and 7.6 pH. Treatments were applied to 3.0 by 9.1 m plots arranged in a randomized complete block design with four replications. Individual treatments were applied with a CO_2 backpack sprayer with flat fan 80015 nozzles calibrated to deliver 230 L/ha at 275 kPa. Treatments were applied May 9 without subsequent mechanical incorporation into the soil. Visual evaluations of crop injury and weed control were completed May 30 and June 20 and plots were harvested September 5.

Mesotrione provided excellent control of redroot pigweed (AMARE) and common lambsquarters (CHEAL)at all rates but failed to control green foxtail (SETVI). A tank mix of mesotrione with metolachlor increased green foxtail control to 95 % while maintaining strong broadleaf weed control. Crop injury was not observed with any treatment. Significant differences were noted among yields and because of a heavy green foxtail infestation, those treatments with better grass control generally had higher yields.

Table. Redroot pigweed, common lambsquarters, and green foxtail control and corn injury and silage yield.

		Control[1]			ZEAMA	
Herbicide	Rate	AMARE	CHEAL	SETVI	Injury[2]	Yield
	g/ha	-----------------	%	-----------------	%	kg/ha
Mesotrione	70	93	96	0	0	23,769
Mesotrione	140	94	97	14	0	24,397
Mesotrione	210	94	96	23	0	29,559
Mesotrione +	70	95	95	95	0	43,861
metolachlor	534					
Mesotrione +	70	97	96	51	0	35,609
atrazine	560					
Dimethenamid	468	97	95	96	0	46,193
Flufenacet +	247	77	97	95	0	42,515
metribuzin +	62					
atrazine	636					
Metolachlor	601	92	85	92	0	39,197
Acetochlor	2242	97	97	98	0	47,897
Control		0	0	0	0	20,809
LSD (0.05)		2.8	5.7	4.1	NS	12,806

[1] Includes only June 20 evaluations
[2] Includes only May 30 evaluations

Broadleaf weed control in field corn with preemergence followed by sequential postemergence herbicides. Richard N. Arnold, Michael K. O'Neill and Dan Smeal. (New Mexico State University Agricultural Science Center, Farmington, NM 87499) Research plots were established on May 13, 2002 at the Agricultural Science Center, Farmington, New Mexico to evaluate the response of field corn (var. Pioneer 34M95) and annual broadleaf weeds to preemergence followed by sequential postemergence herbicides. Soil type was a Wall sandy loam with a pH of 7.8 and an organic matter content of less than 1%. The experimental design was a randomized complete block with three replications. Individual plots were 4, 34 in rows 30 ft long. Field corn was planted with flexi-planters equipped with disk openers on May 13. Preemergence treatments were applied on May 15 and immediately incorporated with 0.75 in of sprinkler-applied water. Postemergence treatments were applied on June 5 when corn was in the 4[th] leaf stage and weeds were small. Treatments with diflufenzopyr plus dicamba had a nonionic surfactant and 32-0-0 added at 0.25 and 0.5 percent v/v to the spray mixture. Black nightshade, prostrate and redroot pigweed, and common lambsquarters infestations were heavy and Russian thistle infestations were light throughout the experimental area. Treatments were evaluated on August 8.

Dimethenamid-p applied preemergence at 0.66 lb ai/A followed by a sequential postemergence treatment of atrazine plus dicamba applied at 0.8 lb ai/A caused the highest injury rating of 7. All treatments except the weedy check gave good to excellent control of common lambsquarters, black nightshade, redroot and prostrate pigweed. Russian thistle control was poor with s-metolachlor applied preemergence at 0.95 lb ai/A followed by a sequential postemergence treatment of mesotrione plus atrazine applied at 0.094 plus 0.25 lb ai/A.

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

Treatments[a]	Rate	Crop injury	Weed control				
			CHEAL	SOLNI	AMARE	AMABL	SASKR
	lb ai/A	—%—	—%—				
S-metolachlor + atrazine (pm)/mesotrione	2.0/0.094	0	96	100	99	97	99
S-metolachlor/mesotrione + atrazine	0.95/0.094+0.25	0	99	98	100	100	72
Dimethenamid-p/dicamba + atrazine (pm)	0.66/0.8	7	99	100	99	100	95
Dimethenamid-p/diflufenzopyr + dicamba (pm) + atrazine	0.66/0.175+0.5	5	99	100	98	99	99
Dimethenamid-p + atrazine/ diflufenzopyr + dicamba (pm)	0.66+0.8/0.175	3	100	100	99	99	98
Dimethenamid-p + pendimethalin/atrazine + dicamba (pm)	0.66+1.0/0.8	6	100	100	100	100	100
Dimethenamid-p + pendimethalin/diflufenzopyr + dicamba (pm) + atrazine	0.66+1.0/0.175+0.5	6	100	100	99	100	99
Weedy check		0	0	0	0	0	0

[a] pm equal packaged mix and first treatment was applied preemergence followed by a sequential postemergence treatment.

Broadleaf weed control in field corn with postemergence herbicides. Richard N. Arnold, Michael K. O'Neill and Dan Smeal. (New Mexico State University Agricultural Science Center, Farmington, NM 87499) Research plots were established on May 13, 2002 at the Agricultural Science Center, Farmington, New Mexico to evaluate the response of field corn (var. Pioneer 34M95) 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 13. Postemergence treatments were applied on June 5 when corn was in the 4th leaf stage and weeds were small. All treatments had methylated seed oil and 32-0-0 applied at 0.5 and 1.0 percent v/v added to the spray mixture. 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 8.

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

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

Treatments[a]	Rate	Weed control				
		AMARE	AMABL	CHEAL	SOLNI	SASKR
	lb ai/A			%		
Nicosulfuron + rimsulfuron (pm)	0.035	100	100	100	57	46
Nicosulfuron + rimsulfuron (pm) + dicamba	0.035+0.25	100	100	100	98	98
Nicosulfuron + rimsulfuron (pm) + dicamba + atrazine (pm)	0.035+0.4	100	100	100	99	99
Nicosulfuron + rimsulfuron (pm) + diflufenzopyr + dicamba (pm)	0.035+0.09	100	100	100	73	98
Nicosulfuron + rimsulfuron (pm) + mesotrione	0.035+0.06	100	100	100	98	72
DPX 79406	0.023	100	100	100	52	43
DPX 79406 + dicamba + atrazine (pm)	0.023+0.4	100	100	100	96	98
DPX 79406 + diflufenzopyr + dicamba (pm)	0.023+0.09	100	100	100	98	98
Foramsulfuron	0.033	100	100	100	89	36
Foramsulfuron + dicamba	0.033+0.25	100	100	100	98	98
Foramsulfuron + diflufenzopyr + dicamba (pm)	0.033+0.09	100	100	100	98	98
Foramsulfuron + dicamba + atrazine (pm)	0.033+0.4	100	100	100	100	98
Foramsulfuron + mesotrione	0.033+0.06	100	100	100	98	73
Weedy check		0	0	0	0	0

[a] pm equal packaged mix.

Broadleaf weed control in field corn with preemergence herbicides. Richard N. Arnold, Michael K. O'Neill and Dan Smeal. (New Mexico State University Agricultural Science Center, Farmington, NM 87499) Research plots were established on May 13, 2002 at the Agricultural Science Center, Farmington, New Mexico to evaluate the response of field corn (Pioneer 34M95) and annual broadleaf weeds to preemergence herbicides. Soil type was a Wall sandy loam with a pH of 7.8 and an organic matter content of less than 1%. The experimental design was a randomized complete block with three replications. Individual plots were 4, 34 in rows 30 ft long. Treatments were applied with a compressed air backpack sprayer calibrated to deliver 30 gal/A at 30 psi. Field corn was planted with flexi-planters equipped with disk openers on May 13. Treatments were applied on May 15 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 12 and weed control evaluations were made on July 12.

Flufenacet plus atrazine plus isoxaflutole and dimethenamid-p plus atrazine plus isoxaflutole applied at 0.2 plus 0.66 plus 0.024 and 0.56 plus 0.66 plus 0.024 lb ai/A caused the highest injury ratings of 7. Broadleaf weed control was good to excellent with all treatments except the check.

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

Treatments[a]	Rate	Crop injury	Weed control				
			AMABL	AMARE	SOLNI	SASKR	CHEAL
	lb ai/A	—%—			%		
Flufenacet + metribuzin (pm) + atrazine	0.17+0.66	0	100	97	98	98	100
Flufenacet + flufenacet + isoxaflutole (pm)	0.2+0.16	0	100	97	95	100	100
Flufenacet + atrazine	0.45+0.66	0	100	100	99	100	100
Flufenacet + isoxaflutole	0.45+0.024	6	100	100	100	95	100
Flufenacet + mesotrione	0.45+0.147	4	100	100	97	99	100
Flufenacet + flufenacet + isoxaflutole (pm)	0.158+0.127	0	100	100	100	99	100
Flufenacet + atrazine + isoxaflutole	0.2+0.66+0.024	7	100	100	100	100	100
Dimethenamid-p + isoxaflutole	0.56+0.0.147	6	100	99	100	94	100
Dimethenamid-p + mesotrione	0.56+0.024	4	100	100	99	90	97
Dimethenamid-p + atrazine	0.56+0.66	0	100	99	100	99	98
Dimethenamid-p + atrazine + isoxaflutole	0.56+0.66+0.024	7	100	100	100	100	99
Dimethenamid-p + atrazine + mesotrione	0.56+0.66+0.147	3	100	100	100	99	100
S-metolachlor + isoxaflutole	0.95+0.024	0	100	100	100	92	99
S-metolachlor + mesotrione	0.95+0.147	0	100	98	99	95	98
S-metolachlor + atrazine (pm)	2.25	0	100	98	98	98	100
Weedy check		0	0	0	0	0	0

[a] pm equal packaged mix.

Annual weed control in silage corn. John O. Evans, and R.William Mace. (Department of Plants, Soils, and Biometeorology, Utah State University, Logan, Utah 84322-4820) DeKalb DK626RR silage corn was planted June 6, 2002 at the Utah State University Greenville Farm in North Logan, UT to compare several postemergence herbicide treatments for lambsquarter control(CHEAL). Individual treatments were applied to 10 by 30 foot plots with a CO_2 backpack sprayer using T-jet 015 nozzles providing a 10 foot spray width calibrated to deliver 25 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 three replications. Postemergence treatments were applied June 25, when the corn was in the 5-6 leaf stage and lambsquarter was 4-6 inches tall. Visual evaluations for weed control and crop injury were completed July 26 and plots were harvested October 18.

There was no evidence of corn injury from postemergence treatments. Fenoxaprop+diflufenzopyr/dicamba gave excellent lambsquarter control at both application rates. DPX 79406 and nicosulfuron/rimsulfuron/atrazine were only slightly less effective. Whereas, nicosulfuron/rimsulfuron treatments resulted in 81.7% lambsquarter control. Yields were not significantly different among treatments.

Table. Lambsquarter control in corn with selected postemergence herbicides.

		Corn			Weed Control
		Injury		Yield	CHEAL
Treatment	Rate	7/7	7/26	10/18	7/26
	lb ai/A	------%------		T/A	------%-----
Fenoxaprop+ diflufenzopyr/dicamba[a]	0.07+ 0.23	0	0	24.8	98.3
Fenoxaprop+ diflufenzopyr/dicamba[a]	0.09+ 0.23	0	0	26.4	96.7
Nicosulfuron/rimsulfuron[a]	0.05	0	0	25.7	81.7
DPX 79406[a]	0.03	0	0	27.2	88.3
Nicosulfuron/rimsulfuron/atrazine[a]	0.74	0	0	25.5	88
Untreated	0	0	0	25.6	0.0
LSD(0.05)				8.2	4

[a] NIS at 0.25% + N at 1.25% added

New pendimethalin formulations and combinations for broadleaf weed control in silage corn. John O. Evans, J. Earl Creech, and R. William Mace (Department of Plants, Soils and Biometeorology, Utah State University, Logan, Utah 84322-4820) Two identical studies were conducted at the Utah State University Research Farm in Logan, Utah (Table 1.) and at Harold Falslev's farm in Benson, Utah (Table 2.) to evaluate pendimethalin, diflufenzopyr+dicamba, flufenocet, and dimethenamid for weed control in silage corn. Corn hybrid DK662RR was planted at Logan and Grand Valley SX1342 at Benson May 1,2002. Preemergent applications were applied shortly after planting and postemergence application treatments at the five to six leaf stage for corn and 5 to 6 inches in height for all weeds. Treatments were applied in a randomized block design with three replications to 10 by 30 foot plots using a CO_2 backpack sprayer. The sprayer had flatfan T-jet 015 nozzles providing a 10 ft spray width calibrated to deliver 25 gpa at 39 psi. The soils were Kidman fine sandy loam with pH of 8.8 and O.M. of 2%, and Millville silt loam with pH of 7.9 and a O.M. of 3%, at Benson and at Logan, respectively.

No injury to corn was observed at either location. Lambsquarter (CHEAL) was best controlled at Logan with treatments that included postemergence applications following initial preemergence treatments. There was a greater diversity and higher population of weeds at Benson where bristly foxtail (SETVE) was the most prevalent weed and by season's end all treatments displayed at least 80 percent control of this species. Evaluations in July indicated only pendimethalin +dimethenamid and the two rates of diflufenzopyr+dicamba gave acceptable bristily foxtail control. Velvetleaf (ABUTH) was best controlled by treatments that included both premergence followed by postemergence herbicides treatments. Redroot pigweed (AMARE) was observed early in the season but was crowded out by velvetleaf and bristly foxtail by mid July. Flufenacet did not control velvetleaf effectively but did suppress bristly foxtail enough that by harvest its population was significantly reduced. Yield was not statistically different for any treatment.

Table1. Broadleaf weed control in silage corn, **Logan, UT**.

Treatment	Rate	Timing	Crop Injury 6/28	Crop Injury 7/26	Yield 10/3	Weed Control CHEAL 6/28	Weed Control CHEAL 7/26
			----------%----------		T/A	----------%----------	
Pendimethalin +dimethenamid	1.0+0.66	PRE	0	0	11.95	36.7	1.8
Pendimethalin+H_2O+dimethenamid	1.0+0.66	PRE	0	0	12.48	33.3	55.3
Pendimethalin +dimethenamid difulfenzopyr/dicamba	1.0+0.66 0.188	PRE + POST	0	0	13.44	50.0	95.0
Pendimethalin+H_2O+dimethenamid difulfenzopyr/dicamba	1.0+0.66 0.188	PRE + POST	0	0	13.39	31.7	100.0
Pendimethalin +dimethenamid difulfenzopyr/dicamba	1.0+0.66 0.28	PRE + POST	0	0	13.39	43.9	100.0
Flufenacet	0.56	PRE	0	0	12.48	23.3	50.0
Flufenacet	0.75	PRE			10.99	21.5	73.3
Untreated			0	0	11.36	0.0	16.7
LSD (0.05)					2.28	12.9	20.2

[a] NIS added at 0.25% v/v.
[b] N added at 1.25% v/v.

Table2. Broadleaf weed control in silage corn, **Benson, UT**

Treatment	Rate	Timing	Crop Injury 6/25	Crop Injury 7/26	Crop Yield 9/20	Weed control SETVE 7/26	Weed control ABUTH 9/20	Weed control SETVE 9/20
			-----%----		T/A	----------%----------		
Pendimethalin +dimethenamid	1.0+0.66	PRE	0	0	15.4	66.7	16.7	100.0
Pendimethalin+H_2O+dimethenamid	1.0+0.66	PRE	0	0	16.6	86.9	3.3	80.0
Pendimethalin +dimethenamid difulfenzopyr+dicamba	1.0+0.66 0.188	PRE + POST	0	0	20.0	90.0	81.4	90.0
Pendimethalin+H_2O+dimethenamid difulfenzopyr+dicamba	1.0+0.66 0.188	PRE + POST	0	0	16.2	66.9	83.3	85.0
Pendimethalin +dimethenamid difulfenzopyr+dicamba	1.0+0.66 0.28	PRE + POST	0	0	23.5	90.0	93.3	85.0
Flufenacet	0.56	PRE	0	0	15.0	70.0	3.3	96.7
Flufenacet	0.75	PRE			14.7	40.0	30.0	86.7
Untreated			0	0	15.6	0.0	0.0	0.0
LSD (0.05)					2.28	39	17	12

[a] NIS added at 0.25% v/v.
[b] N added at 1.25% v/v.

Efficacy of dimethenamid-P and pendimethalin formulations in sweet corn. Richard P. Affeldt, Charles M. Cole, Carol A. Mallory-Smith, Bill D. Brewster, and Jed B. Colquhoun. (Department of Crop and Soil Science, Oregon State University, Corvallis, OR 97331-3002) 'Jubilee Supersweet' sweet corn was seeded in 30-in-wide rows on May 2, 2002, at the OSU Hyslop Research Farm near Corvallis, OR. Treatments were applied preemergence to weeds and crop on May 7, 2002, with a single-wheel, compressed-air plot sprayer fitted with XR8003 flat fan nozzle tips that delivered 20 gpa at 20 psi. Application data and soil characteristics are presented in Table 1. The experimental design was a randomized complete block with four replications; individual plots were 10 ft by 35 ft. Visual evaluations were conducted on May 31 and July 8, 2002. Corn ears were harvested by hand-picking the center two rows for a distance of 12 feet in the middle of each plot on August 28, 2002.

Table 1. Application conditions and soil type.

Soil type	Woodburn silt loam
pH	5.5
O.M. (%)	2.4
Condition	Dry, granular
Air temperature (F)	44
Soil temperature (F) (2 inch depth)	46
Relative humidity (%)	81
Wind	Calm

The water soluble formulation of pendimethalin (pendimethalin-H_2O) was as effective as the standard pendimethalin in controlling shepherdspurse (Table 2), and was no more injurious on the corn. All treatments increased corn ear yield, but yields were greatest where dimethenamid-P was applied alone.

Table 2. Visual evaluations of weed control, corn injury, and corn ear yield.

		Shepherdspurse control		Corn injury		Corn ear yield
Treatment	Rate	5/31	7/8	5/31	7/8	8/28
	lb ai/A	%				T/A
Dimethenamid-P	0.64	100	99	16	19	10.8
Pendimethalin	1.0	100	86	0	2	7.8
Pendimethalin-H_2O	1.0	100	89	2	6	8.5
Dimethenamid-P + pendimethalin	0.64 + 1.0	100	100	19	30	9.1
Dimethenamid-P + pendimethalin-H_2O	0.64 + 1.0	100	99	18	22	8.3
Untreated check	0	0	0	0	0	2.8
$LSD_{(0.05)}$			4	7	11	2.1

Flax response to application timing of postemergence herbicides. Blaine G. Schatz and Gregory J. Endres. (Carrington Research Extension Center, North Dakota State University, Carrington, ND 58421) The trial was conducted to evaluate flax response to three application timings of selected POST herbicides. The experimental design was a randomized complete block design with a split-plot arrangement (main plots=herbicide application timing and subplots=herbicide treatments) and three replicates. The trial was conducted on a conventional-tilled, loam soil with 7.6 pH and 3.0% organic matter at Carrington, ND in 2002. 'Cathay' flax was seeded on May 3 at the rate of 42 lb/A. Herbicide treatments were applied to the center 6.7 ft of 10- by 25-ft plots with a CO_2 pressurized hand-held plot sprayer delivering 17 gal/A at 30 psi through 8002 flat fan nozzles for the PRE treatment and 35 psi through 80015 flat fan nozzles for POST treatments. PRE sulfentrazone was applied on May 10 with 60 F, 24% RH, 70% clear sky and dry soil surface. No significant rain was received during May following sulfentrazone application. Early POST (POST A) treatments were applied on June 7 with 57 F, 69% RH, 0% clear sky, and 5 mph wind to 2-inch tall flax. Mid POST (POST B) treatments were applied on June 19 with 67 F, 84% RH, 10% clear sky, and 5 mph wind to 5- to 7-inch tall flax and emerging to 6-inch tall weeds. Late POST (POST C) treatments were applied on June 27 with 78 F, 59% RH, 50% clear sky, and 5 mph wind to 10- to 14-inch tall (initial flowering stage) flax and 4- to 10-inch tall weeds. Density of weed species was low, ranging from 0 to 3 plants/ft^2. The trial was harvested on September 3 with a plot combine.

Grass and broadleaf weed control ranged from 80 to 99% with bromoxynil&MCPA or clopyralid&MCPA and clethodim tank mixtures, or the three-way tank mixture (Table 1). Weed control generally was not affected by timing of herbicide application. Averaged across herbicide treatments, flax growth reduction was higher with the first two herbicide application times compared to the late application (Table 2). However, first flower dates were delayed and seed yield was reduced as application timing was delayed. Physiological maturity was not affected by application timing (data not shown). Seed yield with POSTA application timing was 17% greater than POSTC yield. Herbicide treatments that included clopyralid&MCPA generally had significant flax growth reduction ranging from 3 to 47% (Table 3). Flax injury did not occur with sulfentrazone (data not shown). This was probably due to the extended delay of rainfall following application of sulfentrazone. While seed yield was improved with herbicides, application timing of the seven herbicide treatments did not impact seed yield or test weight (Table 4).

Table 1. Weed control in flax as impacted by three application timings of herbicides.

Herbicide		Weed control[a]					
		Grass			Broadleaf		
		Herbicide aplication timing[b]					
Treatment[c]	Rate	POSTA	POSTB	POSTC	POSTA	POSTB	POSTC
	lb/A	%					
Sulfentrazone/Bromoxynil&MCPA+ clethodim+COC	0.19/0.23&0.23+ 0.08+2pt	95	95	92	99	98	98
Bromoxynil&MCPA	0.23&0.23	0	0	0	93	86	87
Clopyralid&MCPA	0.07&0.39	0	0	0	87	91	85
Bromoxynil&MCPA+clopyralid&MCPA	0.23&0.23+0.07&0.39	0	0	0	97	95	95
Bromoxynil&MCPA+clethodim+COC	0.23&0.23+0.08+2pt	96	95	89	95	87	90
Clopyralid&MCPA+clethodim+COC	0.07&0.39+0.08+2pt	98	92	90	80	90	90
Bromoxynil&MCPA+clopyralid&MCPA + clethodim+COC	0.23&0.23+0.07&0.39+ 0.08+2pt	99	92	91	97	93	85
Untreated check	x	0	0	0	0	0	0
Interaction of Timing x Herbicide: LSD (0.05)		NS			6		

[a]Grass=yellow and green foxtail; Broadleaf=Common lambsquarters, redroot and prostrate pigweed, common purslane, and wild buckwheat. Visual evaluation one month after herbicide application.

[b]POSTA=June 7; POSTB=June 19; POSTC=June 27.

[c]Bromoxynil&MCPA=Bronate Advanced; COC=Destiny, a methylated seed oil from Agriliance, St. Paul, MN.

Table 2. Flax response to herbicide treatments across three application timings.

	Flax			
Herbicide application timings[a]	Injury[b]	First flower[c]	Seed yield	Test weight
	%	days	bu/A	lb/bu
POSTA	18	56	21.0	54.4
POSTB	19	58	19.2	54.3
POSTC	6	63	17.4	54.3
LSD (0.05)	8	1	1.6	NS

[a]POSTA=June 7; POSTB=June 19; POSTC=June 27.

[b]Injury=% growth reduction by visual evaluation 7 days after herbicide application.

[c]Days from seeding date.

Table 3. Flax injury and days to first flower as impacted by three application timings of herbicides.

Herbicide		Flax					
		Injury[a]			Days to first flower[b]		
		Herbicide application timing[c]					
Treatment[d]	Rate	POSTA	POSTB	POSTC	POSTA	POSTB	POSTC
	lb/A						
Sulfentrazone/Bromoxynil&MCPA+ clethodim+COC	0.19/0.23&0.23+ 0.08+2pt	10	3	0	55	56	59
Bromoxynil&MCPA	0.23&0.23	3	10	3	55	58	65
Clopyralid&MCPA	0.07&0.39	8	13	3	56	58	65
Bromoxynil&MCPA+clopyralid&MCPA	0.23&0.23+0.07&0.39	42	33	15	57	59	66
Bromoxynil&MCPA+clethodim+COC	0.23&0.23+0.08+2pt	8	12	2	56	57	60
Clopyralid&MCPA+clethodim+COC	0.07&0.39+0.08+2pt	25	38	12	56	59	66
Bromoxynil&MCPA+clopyralid+MCPA+ clethodim+COC	0.23&0.23+0.07&0.39+ 0.08+2pt	47	43	12	57	60	66
Untreated check	x	0	0	0	55	55	55
Interaction of Timing x Herbicide: LSD (0.05)		9			2		

[a]Injury=% growth reduction by visual evaluation 7 days after herbicide application.

[b]Days from seeding date.

[c]POSTA=June 7; POSTB=June 19; POSTC=June 27.

[d]Bromoxynil&MCPA=Bronate Advanced; COC=Destiny, a methylated seed oil from Agriliance, St. Paul, MN.

Table 4. Flax seed yield and test weight as impacted by three herbicide application timings of herbicides.

Herbicide		Seed yield			Test weight		
		bu/acre			lb/bu		
		Herbicide application timing[a]					
Treatment[b]	Rate	POSTA	POSTB	POSTC	POSTA	POSTB	POSTC
	lb/A						
Sulfentrazone/Bromoxynil&MCPA+ clethodim+COC	0.19/0.23&0.23+ 0.08+2pt	22.3	21.0	20.4	54.8	54.5	54.6
Bromoxynil&MCPA	0.23&0.23	18.9	19.6	17.3	53.8	54.1	54.1
Clopyralid&MCPA	0.07&0.39	21.3	18.9	19.6	54.6	54.2	54.1
Bromoxynil&MCPA+clopyralid&MCPA	0.23&0.23+0.07&0.39	20.6	21.7	17.2	54.2	53.8	54.1
Bromoxynil&MCPA+clethodim+COC	0.23&0.23+0.08+2pt	24.6	20.8	19.3	54.1	54.4	54.3
Clopyralid&MCPA+clethodim+COC	0.07&0.39+0.08+2pt	23.4	20.6	16.2	54.7	54.7	54.1
Bromoxynil&MCPA+clopyralid+MCPA+ clethodim+COC	0.23&0.23+0.07&0.39+ 0.08+2pt	24.0	18.8	17.5	54.7	54.5	54.6
Untreated check	x	12.9	12.4	12.0	54.6	53.9	54.6
Interaction of Timing x Herbicide: LSD (0.05)		NS					

[a]POSTA=June 7; POSTB=June 19; POSTC=June 27.

[b]Bromoxynil&MCPA=Bronate Advanced; COC=Destiny, a methylated seed oil from Agriliance, St. Paul, MN.

Tolerance of peppermint to flumioxazin and sulfentrazone. Charles M. Cole, Richard P. Affeldt, Carol A. Mallory-Smith, Bill D. Brewster, and Jed B. Colquhoun. (Department of Crop and Soil Science, Oregon State University, Corvallis, OR 97331-3002) Four trials were conducted in dormant peppermint. Two trials were conducted in western Oregon and two in central Oregon. Soil types and herbicide application information are presented in Table 1.

Table 1. Herbicide application date and soil types.

	Soil			Application date	
Farm	Type	pH	O.M.	Fall	Winter
			%		
Chambers, Linn Co.	Chehalis silty clay loam	5.0	5.2	December 4, 2001	February 1, 2002
Jager, Lane Co.	Chehalis silty clay loam	5.6	3.8	December 14, 2001	February 1, 2002
Avila, Crook Co.	Deschutes sandy loam	5.0	2.4	December 20, 2001	March 21, 2002
Landrus, Crook Co.	Ochoco loamy sand	5.2	4.4	December 20, 2001	March 21, 2002

Herbicides were applied with a single-wheel, compressed air plot sprayer that delivered 20 gpa through XR8003 flat fan nozzle tips at 20 psi. The experimental design was a randomized complete block with four replications; plots were 8 ft by 20 ft. Visual evaluations were completed in late spring and early summer. Plots at Chambers Farm and Jager Farm were harvested on August 6 and July 3, 2002, respectively. Oil was distilled from samples collected at the Chambers Farm.

All treatments caused some peppermint stunting at most of the sites (Table 2). Sulfentrazone and the standard oxyfluorfen caused less stunting then did flumioxazin. Differences between flumioxazin timings were variable among locations, but injury was about equal between rates. The higher rate of flumioxazin reduced peppermint foliage weights in both timings at both locations (Table 3). Oil yields at the Chambers Farm were not significantly different.

Table 2. Visual evaluations of peppermint injury.

			Peppermint injury							
			Chambers		Jager		Avila		Landrus	
Treatment	Rate	Timing	4/2	5/31	4/2	6/10	5/8	7/2	5/8	6/5
	lb ai/A		%							
Oxyfluorfen	0.5	Fall	64	38	66	14	0	0	0	2
Flumioxazin	0.125	Fall	84	40	80	48	11	20	0	11
Flumioxazin	0.25	Fall	82	50	89	38	16	33	5	12
Sulfentrazone	0.25	Fall	45	32	54	15	0	3	0	0
Flumioxazin	0.125	Winter	74	44	86	42	12	27	4	21
Flumioxazin	0.25	Winter	75	25	91	58	20	15	11	25
Sulfentrazone	0.125	Winter	55	40	62	5	0	3	2	0
Untreated check	0		0	0	0	0	0	0	0	0
$LSD_{(0.05)}$			18	11	16	20	6	21	n.s.	4

Table 3. Peppermint fresh weight and oil yield

			Peppermint		
			Foliage fresh weight		Oil yield
Treatment	Rate	Timing	Chambers	Jager	Chambers
	lb ai/A		T/A		lb/A
Oxyfluorfen	0.5	Fall	12.8	11.5	56.4
Flumioxazin	0.125	Fall	13.1	9.4	57.9
Flumioxazin	0.25	Fall	10.4	8.0	44.3
Sulfentrazone	0.25	Fall	14.2	10.0	52.2
Flumioxazin	0.125	Winter	13.6	7.7	68.1
Flumioxazin	0.25	Winter	11.0	4.9	49.8
Sulfentrazone	0.125	Winter	14.5	10.8	61.2
Untreated check	0		16.3	11.6	63.1
$LSD_{(0.05)}$			3.6	3.7	n.s.

Tolerance of peppermint to norflurazon and sulfentrazone. Charles M. Cole, Richard P. Affeldt, Carol A. Mallory-Smith, Bill D. Brewster, and Jed B. Colquhoun. (Department of Crop and Soil Science, Oregon State University, Corvallis, OR 97331-3002) Three trials were conducted to evaluate herbicide treatments on dormant peppermint in western and central Oregon. Herbicide treatments were applied with a single-wheel, compressed-air plot sprayer that delivered 20 gpa through XR8003 nozzle tips at 20 psi. The experimental design was a randomized complete block with four replications; plots were 8 ft by 20 ft. Soil data and herbicide application information are presented in Table 1.

Table 1. Herbicide application and soil information.

	Soil			Application date	
Farm	Type	pH	O.M.	Fall	Winter
			%		
Chambers, Linn Co.	Chehalis silty clay loam	5.0	5.2	December 5, 2001	February 1, 2002
Davis, Crook Co.	Ochoco sandy loam	5.7	2.8	December 13, 2001	March 21, 2002
Schumacher, Marion Co.	McAlpin silty clay loam	5.6	6.2	December 4, 2001	February 1, 2002

Visual evaluations of peppermint injury were conducted through the spring. Final evaluations in May and June are presented in Table 2. Peppermint fresh weight was obtained by hand-harvesting peppermint in 3 sq yd in each plot. Samples were air dried and oil yield was obtained through steam distillation.

Table 2. Visual evaluation of peppermint injury at three locations.

			Peppermint injury		
			Chambers	Davis	Schumacher
Treatment	Rate	Timing	5/31	6/5	5/31
	lb ai/A		----------	%	----------
Norflurazon	0.79	Fall	0	0	0
Norflurazon	1.58	Fall	0	8	0
Sulfentrazone	0.125	Fall	0	15	0
Sulfentrazone	0.25	Fall	0	16	0
Norflurazon	0.79	Winter	0	29	0
Norflurazon	1.58	Winter	0	14	0
Sulfentrazone	0.062	Winter	0	24	0
Sulfentrazone	0.125	Winter	0	21	0
Untreated check	0		0	21	0
$LSD_{(0.05)}$				15	

Some peppermint stunting was observed at all locations soon after treatment, but persisted into late spring only at the Davis site. This stunting was probably a result of standing water on the trial site through much of the summer. There were no significant reductions in peppermint fresh weights or oil yields at either of the harvested sites (Table 3).

Table 3. Peppermint yields at two locations.

			Peppermint fresh weight			
			Chambers	Davis	Peppermint oil yield	
Treatment	Rate	Timing	8/6	8/8	Chambers	Davis
	lb ai/A		-------- T/A	--------	-------- lb/A	--------
Norflurazon	0.79	Fall	14.5	17.3	55	61
Norflurazon	1.58	Fall	13.2	17.7	45	52
Sulfentrazone	0.125	Fall	13.6	17.8	48	56
Sulfentrazone	0.25	Fall	13.2	20.5	50	59
Norflurazon	0.79	Winter	13.5	20.8	48	58
Norflurazon	1.58	Winter	13.3	20.3	41	62
Sulfentrazone	0.0625	Winter	12.0	18.5	46	63
Sulfentrazone	0.125	Winter	12.4	19.4	50	62
Untreated check	0		13.7	19.7	44	55
$LSD_{(0.05)}$			n.s.	n.s.	n.s.	n.s.

Tolerance of peppermint to sulfentrazone treatments. Charles M. Cole, Richard P. Affeldt, Carol A. Mallory-Smith, Bill D. Brewster, and Jed B. Colquhoun. (Department of Crop and Soil Science, Oregon State University, Corvallis, OR 97331-3002) Three trials were conducted in dormant peppermint in western and central Oregon. The experimental design was a randomized complete block with four replications; plots were 8 ft by 20 ft. Herbicide treatments were applied with a single-wheel, compressed-air plot sprayer that delivered 20 gpa through XR8003 flat fan nozzle tips at 20 psi. Herbicide application and soil data are presented in Table 1.

Table 1. Herbicide application and soil data.

Farm	Soil			Application date
	Type	pH	O.M.	
			%	
Cook, Linn Co.	Chehalis silty clay loam	5.4	4.8	February 1, 2002
Hansen, Benton Co.	Newberg loam	4.8	3.2	February 1, 2002
Davis, Crook Co.	Ochoco sandy loam	5.7	2.8	March 21, 2002

Visual evaluations were completed in late spring and plots at the Cook and Davis Farms were harvested in August. The harvested samples were air-dried and the oil yield was obtained through steam distillation.

Table 2. Visual evaluations of peppermint injury and peppermint yields.

Treatment	Rate	Peppermint injury			Peppermint fresh weight		Peppermint oil yield	
		Cook 5/31	Davis 6/5	Hansen 6/10	Cook 8/7	Davis 8/8	Cook	Davis
	lb ai/A	%			T/A		lb/A	
Sulfentrazone	0.0625	0	0	0	14.5	20.2	54	46
Sulfentrazone	0.125	0	0	0	14.0	20.1	50	43
Sulfentrazone + norflurazon	0.0625 + 1.18	0	0	0	13.6	17.8	45	43
Sulfentrazone + pendimethalin	0.0625 + 2.0	0	0	0	14.4	17.8	52	46
Sulfentrazone + clomazone	0.0625 + 0.5	0	0	0	13.4	18.6	56	46
Untreated check	0	0	0	0	12.4	20.0	45	44
$LSD_{(0.05)}$					n.s.	n.s.	n.s.	n.s.

None of the treatments caused visible symptoms on the peppermint in late spring, although stunting was observed earlier. Peppermint fresh weights and oil yields were not significantly affected by any of the treatments.

Annual bluegrass control in carbon-seeded perennial ryegrass. Charles M. Cole, Richard P. Affeldt, Carol A. Mallory-Smith, Bill D. Brewster, and Jed B. Colquhoun. (Department of Crop and Soil Science, Oregon State University, Corvallis, OR 97331-3002) Three trials were conducted near Corvallis, Crabtree, and Shedd, Oregon to evaluate herbicide combinations as alternatives to the standard treatments of diuron alone or diuron plus pronamide. Activated carbon was applied at 300 lb/A in a 1-in-wide band over the drill row while seeding the perennial ryegrass. Treatments were applied prior to weed and crop emergence. Soil data and application dates are presented in Table 1. Herbicides were applied with a single-wheel, compressed-air plot sprayer that delivered 20 gpa through XR8003 nozzle tips at 20 psi. The experimental design was a randomized complete block with four replications; individual plots were 8 ft by 25 ft. Seeded rows were 12 inches apart. Visual evaluation of annual bluegrass control and perennial ryegrass injury were conducted. The perennial ryegrass was threshed in July with a small-plot combine after swathing. The seed was then cleaned prior to weighing.

Table 1. Soil and herbicide application data for three sites in western Oregon.

Location	Soil Type	pH	O.M.	Application date
			%	
Corvallis	Woodburn silt loam	5.6	2.6	October 7, 2001
Crabtree	Holcomb silt loam	6.1	6.0	October 12, 2001
Shedd	Amity silt loam	6.1	4.2	October 9, 2001

Annual bluegrass control was better at Corvallis than at Crabtree or Shedd (Table 2), where diuron had been used for many consecutive years. Diuron combinations were often better than diuron alone. Diuron in combination with pronamide or norflurazon provided consistently better control than did diuron plus pyrithiobac or diuron plus azafenidin. Perennial ryegrass injury (Table 3) was greatest at Corvallis; the lower organic matter content of the soil at Corvallis may have contributed to the increased crop injury. The lower organic matter also may have contributed to greater annual bluegrass control at Corvallis, but herbicide-resistant annual bluegrass at the Crabtree and Shedd sites was probably the primary difference among sites. There were no differences in clean seed yield within experimental sites (Table 4).

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

		Annual bluegrass control					
		Corvallis		Crabtree		Shedd	
Treatment	Rate	11/13	3/5	11/30	3/18	11/30	3/18
	lb ai/A	%					
Diuron	2.4	99	94	90	32	88	50
Diuron + norflurazon	1.6 + 0.98	99	98	91	56	89	71
Diuron + norflurazon	1.6 + 1.96	99	98	95	78	86	81
Diuron + pronamide	0.6 + 0.38	99	96	98	89	86	89
Diuron + flumioxazin	1.6 + 0.05	95	85	90	50	80	59
Diuron + flumioxazin	1.6 + 0.1	95	90	90	75	79	81
Diuron + pyrithiobac	1.6 + 0.1	95	90	76	44	84	39
Diuron + azafenidin	1.6 + 0.1	88	96	82	38	79	69
Untreated check	0	0	0	0	0	0	0
$LSD_{(0.05)}$		3	8	7	11	3	13

Table 3. Perennial ryegrass injury at three sites in western Oregon.

		Perennial ryegrass injury					
		Corvallis		Crabtree		Shedd	
Treatment	Rate	11/13	3/5	11/30	3/18	11/30	3/18
	lb ai/A	%					
Diuron	2.4	0	0	0	0	0	0
Diuron + norflurazon	1.6 + 0.98	2	4	0	0	0	0
Diuron + norflurazon	1.6 + 1.96	21	11	10	0	0	0
Diuron + pronamide	0.6 + 0.38	18	0	0	0	8	0
Diuron + flumioxazin	1.6 + 0.05	0	0	0	0	2	0
Diuron + flumioxazin	1.6 + 0.1	0	5	0	0	0	0
Diuron + pyrithiobac	1.6 + 0.1	0	0	0	0	0	0
Diuron + azafenidin	1.6 + 0.1	0	0	0	0	0	0
Untreated check	0	0	0	0	0	0	0
$LSD_{(0.05)}$		6	7	4		4	

Table 4. Perennial ryegrass seed yield at three sites in western Oregon.

		Perennial ryegrass seed yield		
Treatment	Rate	Corvallis	Crabtree	Shedd
	lb ai/A	lb/A		
Diuron	2.4	622	1088	1224
Diuron + norflurazon	1.6 + 0.98	554	1172	1189
Diuron + norflurazon	1.6 + 1.96	555	977	1146
Diuron + pronamide	0.6 + 0.38	532	993	1122
Diuron + flumioxazin	1.6 + 0.05	597	1120	1219
Diuron + flumioxazin	1.6 + 0.1	584	1074	1192
Diuron + pyrithiobac	1.6 + 0.1	540	1139	1228
Diuron + azafenidin	1.6 + 0.1	610	1157	1206
Untreated check	0	444	1050	1172
$LSD_{(0.05)}$		n.s.	n.s.	n.s.

Improving competitiveness of sunflower with cultural systems. Randy L. Anderson. (USDA-ARS, Brookings SD 57006). Weed control in sunflower has been inconsistent in the Central Great Plains. One contributing factor may be that sunflower is not competitive with weeds because it is grown in wide rows (30 inches) and at low plant populations.

To strengthen the competitiveness of sunflower, we devised a production system comprised of several cultural practices and compared its impact on weeds with the conventional production system. Common practices for oil-seed sunflower in this region include plant populations of 16,000 plants/ac seeded in 30-inch rows, with N fertilizer applied broadcast (referred to as the conventional system in the Table). The cultural system was comprised of narrow row spacing (20 inches wide), increased plant population (19,000 plants/ac), and N fertilizer banded adjacent to the seed row (referred to as the cultural system). We compared these systems at two planting dates, early June (normal planting date) and planting two weeks later. Treatments were split into weed-free and weed-infested subplots. Glyphosate controlled weeds present at planting time; sulfentrazone and hand-weeding eliminated weeds in the weed-free treatments. The sunflower variety was Pioneer 6338.

The study was conducted at Akron CO in 1998 and 1999. The experimental design was a randomized complete block with four replications; plot size was 30 by 40 feet. Approximately 60% of each subplot was harvested for seed yield. Weed biomass samples were collected from four randomly located 0.5 m^2 quadrats when sunflower began flowering. The weed community was predominantly green foxtail (*Setaria viridus*), with redroot pigweed (*Amaranthus retroflexus*), and kochia (*Kochia scoparia*) also present. Average growing season precipitation (June-September) at Akron is 8.5 inches. In 1998, precipitation was 70% of normal whereas in 1999, precipitation was 155% of normal. Statistical analysis indicated that a year by treatment effect did not occur, therefore treatment means were averaged across years.

The cultural system reduced weed density two-fold compared to the conventional system at the early planting date (Table). Weed density in both production systems was reduced by delayed planting. Later planting provided an additional two weeks to control weeds. The cultural system reduced weed biomass 65% at the early planting, compared to the conventional system. Weed biomass was less in both systems at the later planting, with the cultural system reducing weed biomass 84% compared to the early-planted conventional system.

Yield loss due to weeds was less than 5% with the cultural system at either planting date. In contrast, with the conventional system, weeds reduced yield 24% at the early planting date. Delaying planting reduced yield loss in the conventional system to only 6%. Oil percentage in seeds did not differ among treatments at either planting date (data not shown).

Sunflower usually yields less when planted late, as shown with the conventional systems in weed-free conditions; later planting reduced yield 17%. Surprisingly, delayed planting did not reduce yield with the cultural system. We speculate that the cultural system improved growth efficiency of sunflower, which minimized the detrimental effect of late planting. Cultural systems not only improve sunflower's competitiveness with weeds, but also may widen the window for optimum planting.

Table. Density and biomass of weeds, sunflower seed yield, and yield loss due to weeds among various production systems. Data averaged across two years. Treatment means within a column followed by an identical letter do not differ based on Fisher's LSD (0.05). Study conducted at Akron CO.

Production System	Weed density	Weed biomass	Seed yield (weed-free)	Yield loss due to weeds
Early planting	plants/m^2	gm/m^2	lb/acre	%
Conventional System	35a	203a	1680a	24a
Cultural System	17b	72b	1810a	4b
Late Planting				
Conventional System	8c	69b	1440b	6b
Cultural System	6c	33c	1710a	2b

Weed control and crop response in tribenuron-tolerant sunflower. Paul Hendrickson and Richard Zollinger. (Carrington Research Extension Center, North Dakota State University, Carrington, ND 58421 and Department of Plant Sciences, North Dakota State University, Fargo, ND 58105). The study was conducted at the NDSU Carrington Research Extension Center on a loam soil with a 6.2 pH and 3.9% organic matter. Tribenuron-tolerant sunflower '02RL0009' and a conventional hybrid '63M80' were seeded May 23, 2002 into 30-inch rows at 22,000 seeds/A. Guard plots were present between treated plots. Individual plots were 5 ft by 30 ft and arranged in a randomized complete block design with three replications. Herbicide treatments were applied with a CO_2 pressurized hand-held plot sprayer. PRE treatments were applied at 20 gal/A and 20 psi through XR8003 flat fan nozzles. POST treatments were applied at 10 gal/A and 20 psi through XR80015 flat fan nozzles. Pendimethalin and sulfentrazone were applied PRE on May 27 with 66° F, 33% RH, 0% cloud cover, 0 mph wind, and 54° F soil temperature. The soil was dry to a depth of 2.5 inches with no significant rain for 12 days after application. All other herbicides were applied on June 29 with 76° F, 77% RH, 5% cloud cover, 6 mph wind, and 78° F soil temperature to 4- to 6-leaf sunflower, 1- to 6-leaf green and yellow foxtail, 2- to 8-inch marshelder, and emerging kochia. The sunflowers were harvested on October 21.

Broadleaf weed control was generally good to excellent (76 to 100%) with tribenuron (Table). Green and yellow foxtail control from quizalofop-P decreased as the tribenuron rate increased from 0.25 to 0.5 oz ai/A. Pendimethalin and sulfentrazone did not injure the crop when evaluated on 6/29 (data not shown). Tribenuron was relatively safe when applied to the tribenuron-tolerant sunflower with yields of 1700-1900 lb/A. Thifensulfuron, thifensulfuron + tribenuron, and foramsulfuron injured the crop and reduced yields when compared to the tribenuron treatments. Tribenuron applied at 0.125 oz ai/A seriously injured the conventional hybrid, causing a 90% reduction in height and zero seed yield.

Table. Weed control and crop response in tribenuron-tolerant sunflower.

		Weed control[2]							Sunflower			
		Setaria spp.			Marshelder			Kochia	Crop injury	Height reduct.	Seed yield	Test weight
Treatment[1]	Rate	6/29	7/12	9/4	6/29	7/12	9/4	9/4	7/12	9/4	--- 10/21 ---	
	oz ai/A	%									lb/A	lb/bu
Express-tolerant hybrid												
Pendimethalin+sulfentrazone	19.8+3	53	0	0	87	80	88	96	0	0	1685	29.1
Sulfentrazone / clethodim	3 / 1.5	77	94	100	88	90	98	100	0	0	1564	29.3
+PO+AMS	+1qt+2.5lb											
Sulfentrazone / quizalofop-P	3 / 0.99	80	98	100	94	93	98	100	0	0	1722	29.8
+PO+AMS	+1qt+2.5lb											
Tribenuron+clethodim	0.25+1.5	-	93	100	-	100	100	99	2	0	1811	29.9
+PO+AMS	+1qt+2.5lb											
Tribenuron+quizalofop-P	0.125+0.99	-	85	100	-	100	76	98	0	0	1906	29.7
+NIS	+0.5%v/v											
Tribenuron+quizalofop-P	0.187+0.99	-	83	100	-	100	100	98	0	0	1750	29.5
+NIS	+0.5%v/v											
Tribenuron+quizalofop-P	0.25+0.99	-	75	98	-	100	99	95	3	0	1907	29.7
+NIS	+0.5%v/v											
Tribenuron+quizalofop-P	0.5+0.99	-	37	7	-	100	99	93	15	0	1705	29.1
+NIS	+0.5%v/v											
Thifensulfuron+quizalofop-P	0.225+0.99	-	90	100	-	100	91	27	50	33	663	27.6
+NIS	+0.5%v/v											
Thifensulfuron+quizalofop-P	0.45+0.99	-	92	100	-	100	98	42	63	57	448	26.7
+NIS	+0.5%v/v											
Thifensulfuron+tribenuron+	0.15+.075+	-	85	100	-	100	98	83	37	13	1206	28.7
quizalofop-P+NIS	0.99+0.5%v/v											
Thifensulfuron+tribenuron+	0.3+0.15+	-	75	86	-	100	97	88	20	23	1249	28.1
quizalofop-P+NIS	0.99+0.5%v/v											
Foramsulfuron +	1.05+	-	96	97	-	100	100	17	75	67	0	0.0
MSO+28%	1.5pt+1.5qt											
Untreated check	0	0	0	0	0	0	0	0	0	0	1147	29.3
Conventional hybrid												
Tribenuron+quizalofop-P	0.125+0.99	-	92	100	-	98	17	17	83	90	0	0.0
+NIS	+0.5%v/v											
LSD (0.05)		6	12	11	11	3	20	18	8	7	327	1.0

[1]PO=petroleum oil concentrate (Peptoil), AMS=ammoniom sulfate, NIS=non-ionic surfactant (Preference), and MSO=methylated seed oil (MES100)

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

Imazamox application timing on imidazolinone-resistant sunflower. Richard K. Zollinger and Jerry L. Ries. (Dept. of Plant Sciences, North Dakota State University, Fargo 58105) An experiment was conducted near Prosper, ND, to evaluate the response of imidazolinone-resistant sunflower to imazamox applied at the V3 to V4 (early postemergence, EPOST), V5 to V7 (postemergence, POST), and V8 to V10 (late postemergence, LPOST) sunflower. On May 28, 2002, ethalfluralin at 1.1 lb/A was applied and incorporated for weed-free conditions. On June 4 each plot was planted consisting of four rows, two rows of USDA 'cmsHA425/RHA426' planted on the left side of each plot, and two rows of Mycogen 'X81359' planted on the right side of each plot. EPOST treatments were applied to V3 to V4 sunflower on June 27 at 10:00 am with 79 F air, 84 F soil surface, 64% relative humidity, 0% clouds, 5 mph NW wind, dry soil surface, moist subsoil, excellent crop vigor, and no dew present. POST treatments were applied to V5 to V7 sunflower on July 2 at 7:30 am with 70 F air, 72 F soil surface, 64% relative humidity, 75% clouds, 5 mph W wind, dry soil surface, moist subsoil, excellent crop vigor, and no dew present. LPOST treatments were applied to V8 to V10 sunflower on July 9 at 9:45 am with 73 F air, 78 F soil surface, 63% relative humidity, 50% clouds, 2 mph N wind, moist soil surface, wet subsoil, excellent crop vigor, and no dew present. Treatments were applied to the center two rows of the 10 by 40 foot plots with a bicycle-wheel-type plot sprayer delivering 8.5 gpa at 40 psi through 8001 flat fan nozzles. The experiment had a randomized complete block design with four replicates per treatment.

The study was handweeded to avoid any confounding and competition by weeds. For all visible injury ratings, slight injury was stunting but the higher injury ratings included yellowing. Both sunflower lines were tolerant when imazamox was applied at 0.031 and 0.063 lb/A to V3 to V4 and V5 to V7 sunflower. Unacceptable injury increased when imazamox was applied at 0.063 or 0.094 lb/A to V8 to V10 sunflower. Injury did not entirely disappear through time. Sunflower from the V3 to V10 stage exhibited excellent safety to imazamox at 0.031 lb/A. The USDA sunflower line exhibited more resistance to imazamox than the Mycogen line.

Table. Imazamox application timing on imidazolinone-resistant sunflower.

Sunflower stage and		July 3		July 11		July 16		July 23		July 30		August 13		Yield	
treatment[1]	Rate	Line A[2]	Line B[3]	Line A	Line B	Line A	Line B	Line A	Line B	Line A	Line B	Line A	Line B	Line A	Line B
	lb/A	--% injury --		--% injury --		--% injury --		--% injury --		--% injury --		--% injury --		----lb/A ----	
V3 to V4 (EPOST)															
Immx+NIS+28-0-0	0.031	0	0	0	0	0	5	0	0	0	0	0	0	1210	1560
Immx+NIS+28-0-0	0.063	0	10	0	10	0	5	0	0	0	0	0	0	1470	1580
Immx+NIS+28-0-0	0.094	0	20	0	15	0	10	0	10	0	0	0	0	1370	1360
Immx+MSO+28-0-0	0.094	0	0	0	0	0	0	0	0	0	0	0	0	1340	1600
V5 to V7 (POST)															
Immx+NIS+28-0-0	0.031	0	0	0	0	0	0	0	0	0	0	0	0	1090	1700
Immx+NIS+28-0-0	0.063	0	5	0	0	0	0	0	0	0	0	0	0	1380	1580
Immx+NIS+28-0-0	0.094	0	30	0	20	0	15	0	15	5	0	0	0	1380	1180
Immx+MSO+28-0-0	0.094	0	10	0	5	0	0	0	0	0	0	0	0	1500	1470
V8 to V10 (LPOST)															
Immx+NIS+28-0-0	0.031					0	5	0	0	0	0	0	0	1410	1380
Immx+NIS+28-0-0	0.063					10	20	10	10	5	5	0	5	1390	1480
Immx+NIS+28-0-0	0.094					20	35	15	25	7	15	5	10	1420	1480
Immx+MSO+28-0-0	0.094					25	45	25	35	10	15	5	15	1290	1230
Untreated		0	0	0	0	0	0	0	0	0	0	0	0	1340	1570
LSD (0.05)		NS	4	NS	4	4	5	4	5	3	3	NS	4	260	370

[1]Immx = imazamox; NIS = nonionic surfactant = Activator 90 at 0.25% v/v; 28-0-0 = ammonium sulfate at 2.5% v/v; MSO = methylated seed oil = Scoil at 1.25% v/v.
[2]Line A = USDA 'cmsHA425xRH426'.
[3]Line B = Mycogen'X81359'.

Clearfield sunflower. Richard K. Zollinger and Jerry L. Ries. (Dept. of Plant Sciences, North Dakota State University, Fargo 58105) An experiment was conducted near Valley City, ND, to evaluate crop response and weed control in sunflower to herbicides applied PRE and POST. PRE treatments were applied on May 31, 2002, at 11:30 am with 87 F air, 62 F subsoil to a depth of 4 inches, 62% relative humidity, 0% clouds, 3 to 5 mph S wind, dry soil surface, and damp subsoil. Mycogen 'X81359' sunflower was planted on May 29. POST treatments were applied June 28 at 11:30 am with 84 F air, 87 F soil surface, 51% relative humidity, 0% clouds, 5 to 12 mph S wind, dry soil surface, damp subsoil, excellent crop vigor, and no dew present to V4 to V6 sunflower. Weeds present were: 2 to 6 inch (15 to 100/ft^2) green and yellow foxtail (40:60 ratio); 6 to 10 inch (1 to 5/ft^2) wild oat; 6 to 10 inch (10 to 20/ft^2) volunteer barley; and 1 to 6 inch (2 to 20/yd^2) marshelder. Treatments were applied to the center 6.67 feet of the 10 by 30 foot plots with a bicycle-wheel-type plot sprayer delivering 17 gpa at 40 psi through 8002 flat fan nozzles for PRE treatments and 8.5 gpa at 40 psi through 8001 flat fan nozzles with an attached windscreen for POST treatments. The experiment had a randomized complete block design with four replicates per treatment.

On June 28, PRE treatments were evaluated prior to POST application. Pendimethalin averaged 40 to 60% green and yellow foxtail control and 20 to 30% volunteer barley control (data not shown). Dry spring conditions may have contributed to nonperformance of pendimethalin. No crop injury was observed with any treatment. Imazamox with NIS or MSO applied alone or with imazapyr controlled foxtail species, wild oat, and marshelder. Using any other ALS type herbicide, whether SU safened (AE 130360 01) or unsafened (tribenuron, thifensulfruon, nicosulfuron, or mefsulfuron), or TPS herbicide (cloransulam) either killed or seriously injured Clearfield sunflower. Clearfield sunflowers are tolerant only to imidazolinone type herbicides (imazamox, imazethapyr, imazapyr).

Table. Clearfield sunflower.

Treatment[1]	Rate	July 10				July 26			
		Sunflower	SETSS	AVEFA	IVAXA	Snfl	SETSS	AVEFA	IVAXA
	(lb/A)	% injury	------% control ------			% injury	------% control ------		
PRE									
Pendimethalin	1	0	10	0	20	0	13	0	28
Pendimethalin+sulfentrazone	0+0.125	0	0	0	48	0	28	5	46
PRE/POST									
Pendimethalin/imazamox+ NIS+28-0-0	1/0.031+ 0.25% v/v+1% v/v	0	86	83	99	0	91	91	99
Pendimethalin/imazamox+imazapyr+ NIS+28-0-0	1/0.031+0.014+ 0.25% v/v+1% v/v	0	95	91	99	0	98	97	99
Pendimethalin/imazamox+imazapyr+ NIS+28-0-0	1/0.022+0.01+ 0.25% v/v+1% v/v	0	85	78	99	0	94	92	98
Pendimethalin+sulfentrazone/imazamox+ NIS+28-0-0	1+0.125/0.031+ 0.25% v/v+1% v/v	0	95	91	99	0	95	94	99
Pendimethalin+sulfentrazone/imazamox+imazapyr+ NIS+28-0-0	1+0.125/0.022+0.01+ 0.25% v/v+1% v/v	0	95	93	99	0	97	97	99
POST									
Imazamox+NIS+28-0-0	0.031+0.25% v/v+1% v/v	0	78	81	99	0	85	88	99
Imazamox+MSO+28-0-0	0.031+0.25% v/v+1% v/v	0	85	84	99	0	95	95	99
Imazamox+imazapyr+ NIS+28-0-0	0.031+0.014+ 0.25% v/v+1% v/v	0	95	91	99	0	97	96	99
Imazamox+imazapyr+ NIS+28-0-0	0.022+0.01+ 0.25% v/v+1% v/v	0	71	71	89	0	86	85	98
Tribenuron+NIS	0.025+0.25% v/v	49	20	10	99	48	18	10	99
Tribenuron+NIS	0.014+0.25% v/v	33	0	0	99	31	0	0	99
Thifensulfuron+NIS	0.014+ 0.25% v/v	90	30	20	99	99	0	2	99
Thifensulfuron&tribenuron+NIS	0.014+0.25% v/v	83	30	20	99	99	0	13	99
Nicosulfuron+PO+28-0-0	0.031+1.5pt+1.5qt	68	53	58	99	65	76	92	99
AE 130360 01+MSO+28-0-0	0.066+1.5pt+1.5qt	70	58	68	99	68	73	86	99
Cloransulam+NIS	0.016+0.25% v/v	90	0	0	99	99	0	0	99
Metsulfuron+NIS	0.004+0.25% v/v	90	25	20	99	97	16	15	77
Untreated		0	0	0	0	0	0	0	0
LSD (0.05)		3	7	4	6	6	10	10	15

[1]NIS = nonionic surfactant = Activator 90; 28-0-0 = urea ammonium nitrate; MSO = methylated seed oil = Scoil; PO = petroleum oil concentrate = Herbimax.

Tribenuron-resistant cultivated sunflower. Richard K. Zollinger and Jerry L. Ries. (Dept. of Plant Sciences, North Dakota State University, Fargo 58105). An experiment was conducted near Prosper, ND, to evaluate weed control in sulfonylurea tolerant sunflower. Pioneer '02RL0004' sunflower was planted on June 4, 2002. PRE treatments were applied on June 6 at 10:30 am were 79 F air, 62 F soil to a depth of 4 inches, 33% relative humidity, 75% clouds, 12 mph S wind, dry soil surface, and damp subsoil. POST treatments were applied June 26 at 9:30 am with 78 F air, 80 F soil surface, 62% relative humidity, 0% clouds, 5 mph NW wind, dry soil surface, moist subsoil, excellent crop vigor, and dew present to V3 to V4 sunflower. Weed species present were: 2 to 10 inch (20 to 75/ft^2) yellow foxtail; 1 to 4 inch (1 to 5/ft^2) redroot pigweed; 1 to 5 inch (1 to 2/yd^2) common lambsquarters; 1 to 4 inch (1 to 5/yd^2) wild mustard. Treatments were applied to the center 6.67 feet of the 10 by 40 foot plots with a bicycle-wheel-type plot sprayer delivering 17 gpa at 40 psi through 8002 flat fan nozzles for PRE treatments, and 8.5 gpa at 40 psi through 8001 flat fan nozzles for POST treatments. The experiment had a randomized complete block design with three replicates per treatment.

Yellow foxtail was emerging at the time of planting which resulted in a early crop competition resulting in some sunflower stunting. POST treatments were applied on June 27, which was later than scheduled because up to six inches of rainfall on June 23. The advanced stage of the yellow foxtail and delay in application resulted in poor yellow foxtail control. It appears that tribenuron antagonizes quizalofop by controlling yellow foxtail when quizalofop was applied alone compared to when applied with tribenuron. On June 27, PRE treatments were rated and no crop injury was observed from tribenuron. Pendimethalin + sulfentrazone applied PRE and sulftentrazone applied PRE + clethodim or quizalofop applied POST controlled yellow foxtail. On July 3 (7 DAT) there was no sunflower injury on any tribenuron treatment. On July 10 (14 DAT) and July 24 (28 DAT), all treatments controlled wild mustard, redroot pigweed, and common lambsquarters. MSO type adjuvant enhanced yellow foxtail control from tribenuron and partially overcame tank-mix antagonism more than other adjuvants used. Other ALS herbicides used instead of tribenuron, namely thifensulfuron, thifensulfuron&tribenuron, and AE 130360 01, severely injured tribenuron resistant sunflower.

Table. Tribenuron-resistant cultivated sunflower.

Treatment[1]	Rate	June 27				July 10		July 24	
		SETLU	SINAR	AMARE	SOLSA	Sunflower	SETLU	Sunflower	SETLU
	lb/A	------------% control ------------				% injury	% control	% injury	% control
PRE									
Pendimethalin+sulfentrazone	1.24+0.187	89	89	99	99	0	96	0	92
PRE/POST									
Sulfentrazone/clethodim+PO+AMS	0.187/0.094	72	78	99	99	0	98	0	99
Sulfentrazone/quizalofop+PO+AMS	0.187/0.062	53	73	98	99	0	99	0	99
POST									
Tribenuron+clethodim+PO+AMS	0.016+0.094					0	70	0	67
Tribenuron+quizalofop+NIS	0.008+0.062					0	50	0	40
Tribenuron+quizalofop+NIS	0.012+0.062					0	50	0	30
Tribenuron+quizalofop+NIS	0.016+0.062					0	50	0	30
Tribenuron+quizalofop+NIS	0.031+0.062					0	50	0	50
Tribenuron+quizalofop+	0.016+0.062								
Liberate	1pt/100gal					0	30	0	30
Basic Blend	1% v/v					0	50	0	50
PO	1.5pt					0	50	0	40
L-132	0.75pt					0	60	0	72
MSO	1.5pt					0	60	0	85
Base	1% v/v					0	50	0	48
Z-64	1% v/v					0	50	0	73
Thifensulfuron+quizalofop+NIS	0.014+0.062					28	50	30	30
Thifensulfuron+quizalofop+NIS	0.028+0.062					52	50	70	30
Thifensulfuron&tribenuron+quizalofop+NIS	0.009&0.005+0.062					32	50	33	30
Thifensulfuron&tribenuron+quizalofop+NIS	0.018&0.01+0.062					50	50	50	30
AE 130360 01+MSO+28-0-0	0.056					57	50	60	72
LSD (0.05)		15	11	2	1	3	1	1	3

[1]PO = petroleum oil concentrate = Herbimax at 1qt/A; AMS = ammonium sulfate at 2.5lb/A; NIS = nonionic surfactant = Activator 90 at 0.5% v/v; Liberate = surfactant; Basic Blend = Quad 7; L-132 = MSO = methylated seed oil = Scoil at 1.5pt/A; Base = MSO basic blend; Z-64 = MSO basic blend; 28-0-0 = urea ammonium nitrate at 1.5qt/A.

Quizalofop preplant to wheat and barley. Joan Campbell and Donn Thill. (Crop and Weed Science Division, University of Idaho, Moscow, ID 83844-2339) Two experiments, one in wheat and one in barley, were established near Moscow, ID to evaluate crop injury with preplant applied quizalofop. Treatments were quizalofop at 0.034, 0.048, and 0.096 lb ai/A and glyphosate at 0.825 lb ai/A each applied 3, 2, and 1 wk before planting and the day of planting wheat or barley. Treatments were applied with a CO_2 pressurized backpack sprayer delivering 10 gpa at 3 mph and 32 psi (Table). The experimental design for both experiments was a randomized complete block with four replications and 8 by 30 ft experimental units. Soil pH, organic matter, and type were 6, 2.5%, and silt loam, respectively. 'Alpowa' spring wheat and 'Baronesse' spring barley were seeded April 29, 2002. Crop injury was evaluated visually.

Table. Environmental conditions.

Application date	April 8, 2002	April 16, 2002	April 24, 2002	April 29, 2002
Air temperature (F)	55	43	54	67
Soil temperature (F)	49	40	45	49
Relative humidity (%)	50	71	52	55
Cloud cover (%)	10	100	0	50

Weekly, visual observations from the time of wheat and barley emergence until heading indicated that quizalofop and glyphosate applied preplant to wheat and barley do not cause injury.

Effect of 2,4-D formulation on weed-free spring wheat. Bradley D. Hanson and Donald C. Thill. (Plant Science Division, University of Idaho, Moscow, ID 83844-2239) A trial was conducted near Moscow, Idaho to evaluate spring wheat phytotoxicity with 2,4-D acid and isooctyl ester applied at two timings. A second trial was conducted near Genesee, Idaho to evaluate spring wheat phytotoxicity with 2,4-D acid compared to the isooctyl ester and dimethylamine salt. The experimental design for both experiments was a randomized complete block with four replications and 8 by 30 ft plots. Herbicide treatments were applied with a CO_2 pressurized backpack sprayer calibrated to deliver 10 gpa at 30 psi (Table 1). Crop injury was evaluated visually 7 and 14 DAT and at heading. Wheat grain was harvested with a small plot combine at Genesee on August 30 and at Moscow on September 16, 2002.

Table 1. Herbicide application and soil data.

Location	Moscow, ID		Genesee, ID
Application date	May 17, 2002	June 3, 2002	June 7, 2002
Wheat growth stage	1 to 3 tiller	early joint	1 to 3 tiller
Air temperature (F)	66	59	38
Relative humidity (%)	52	70	70
Soil temperature (F)	64	52	45
Soil			
pH	4.3		5.8
OM (%)	5.1		3.4
CEC (meq/100 g)	33		23
Texture	loam		silt loam

Spring wheat at Moscow was slightly stunted (2%) at heading by 0.5 lb ae/A 2,4-D acid and ester regardless of timing and by 0.25 lb ae/A 2,4-D acid applied at early jointing (Table 2). No injury was observed at earlier ratings or with other treatments. Wheat grain yield was reduced 30% by 0.25 lb ae/A 2,4-D acid applied at the 1 to 3 tiller stage; no other treatments differed from the untreated control. At Genesee, slight stunting of spring wheat was observed at heading in plots treated 0.5 lb ae/A 2,4-D acid (Table 3). Grain yield was reduced 5 to 6% by 2,4-D acid at 0.25 and 0.5 lb ae/A.

Table 2. Effects of 2,4-D formulation and application timing on weed-free spring wheat near Moscow, ID in 2002.

Treatment[1]	Rate	Application timing	Spring wheat Injury[2]	Spring wheat Yield
	lb ae/A		%	lb/A
Untreated control	--	--	--	1371
2,4-D ester	0.25	1-3 tiller	0	1328
2,4-D ester	0.50	1-3 tiller	2	1189
2,4-D acid	0.13	1-3 tiller	0	1382
2,4-D acid	0.19	1-3 tiller	0	1263
2,4-D acid	0.25	1-3 tiller	1	964
2,4-D acid	0.50	1-3 tiller	2	1120
2,4-D ester	0.25	early joint	1	1031
2,4-D ester	0.50	early joint	2	1227
2,4-D acid	0.13	early joint	0	1253
2,4-D acid	0.19	early joint	0	1267
2,4-D acid	0.25	early joint	2	1092
2,4-D acid	0.50	early joint	2	1259
$LSD_{(0.05)}$			2	343

[1] All treatments included a nonionic, acidifying surfactant (LI 700) at 0.25% v/v and all 2,4-D acid treatments included an acidifier (PCC1174) at 0.5% v/v. 2,4-D ester = Salvo, 2,4-D acid = Savana, and 2,4-D amine = Saber.
[2] July 8, 2002 rating at wheat heading.

Table 3. Effects of 2,4-D formulation on weed-free spring wheat near Genesee, ID in 2002.

Treatment[1]	Rate	Spring wheat Injury[2]	Spring wheat Yield
	lb ae/A	%	lb/A
Untreated control	--	--	6646
2,4-D ester	0.25	0	6373
2,4-D ester	0.50	0	6440
2,4-D amine	0.25	0	6581
2,4-D amine	0.50	0	6454
2,4-D acid	0.13	0	6551
2,4-D acid	0.19	0	6563
2,4-D acid	0.25	0	6279
2,4-D acid	0.50	2	6308
$LSD_{(0.05)}$		1	317

[1] All treatments included a nonionic, acidifying surfactant (LI 700) at 0.25% v/v and all 2,4-D acid treatments included an acidifier (PCC1174) at 0.5% v/v. 2,4-D ester = Salvo, 2,4-D acid = Savana, and 2,4-D amine = Saber.
[2] July 9, 2002 rating at wheat heading.

Kochia control in spring wheat with varying rates of tribenuron and thifensulfuron. 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 Minidoka County, Idaho near Paul to compare the kochia control with different rates and combinations of tribenuron and thifensulfuron in irrigated spring wheat. 'Westbred 936' was planted April 6, 2002, at 120 lb/A seeding rate. Experimental design was a randomized complete block with four replications and individual plots were 8 by 25 ft. Soil type was a Portneuf silt loam (19% sand, 71% silt, and 10% clay) with an 7.8 pH, 1.5% organic matter, and CEC of 15-meq/100 g soil. Herbicides were applied early postemergence on May 24, 2002, using a CO_2-pressurized bicycle-wheel sprayer with 11001 flat fan nozzles calibrated to deliver 10 gpa at 24 psi. Environmental conditions at application were as follows: air temperature 60 F, soil temperature 51 F, relative humidity 48%, wind speed 5 mph, and 10% cloud cover. Crop injury and kochia control was evaluated visually 17 and 49 days after treatment (DAT) on June 10 and July 12, respectively. Grain was harvested August 20 with a small-plot combine.

None of the herbicide treatments injured the crop (Table). Kochia control with tribenuron + thifensulfuron and no other herbicide did not control kochia regardless of the rate applied. Adding bromoxynil & MCPA to tribenuron + thifensulfuron improved kochia control, but averaged only 64% over both rates and evaluation dates. The addition of fluroxypyr at 0.0625 to tribenuron + thifensulfuron improved kochia control to an average 91% at the July 12 evaluation date. Due to a late flush of wild oats, wheat yields were lower than expected. Ranking of wheat yields from lowest to highest followed a similar pattern as kochia control. The check averaged 13 bu/A and was not different from either tribenuron + thifensulfuron alone treatments. However, only the higher tribenuron + thifensulfuron rate plus bromoxynil & MCPA had a yield significantly higher than tribenuron + thifensulfuron alone.

Table. Spring wheat injury, kochia control, and grain yield in response to tribenuron + thifensulfuron combinations.

		Crop injury		Kochia control		Grain
Treatment	Rate	6/10	7/12	6/10/02	7/12/02	yield
	lb ai/A	%				bu/A
Check	-	-	-	-	-	13
Tribenuron + thifensulfuron + nonionic surfactant	0.0117 + 0.0117 + 0.25% v/v	0	0	16	0	18
Tribenuron + thifensulfuron + nonionic surfactant	0.0156 + 0.0156 + 0.25% v/v	0	0	13	0	21
Tribenuron + thifensulfuron + fluroxypyr + nonionic surfactant	0.0117 + 0.0117 + 0.0625 + 0.25% v/v	5	0	81	91	38
Tribenuron + thifensulfuron + fluroxypyr + nonionic surfactant	0.0156 + 0.0156 + 0.0625 + 0.25% v/v	0	4	88	92	41
Tribenuron + thifensulfuron + bromoxynil & MCPA + nonionic surfactant	0.0117 + 0.0117 + 0.312 + 0.25% v/v	5	0	65	61	40
Tribenuron + thifensulfuron + bromoxynil & MCPA + nonionic surfactant	0.0156 + 0.0156 + 0.312 + 0.25% v/v	0	0	66	63	49
LSD (0.05)		NS	NS	9	19	17

Table 2. Crop Injury, weed control, and sugar beet root yield response to application timings of postemergence sugar beet herbicides

Treatment [b]	Rate	Application date	Crop injury	Weed control [a] CHEAL	AMARE	KCHSC	SOLSA	Root yield
	lb ai/A		---------------	---------------	%---------------	---------------	---------------	ton/A
Check	-	-	-	-	-	-	-	4
Efs&dmp&pmp + triflusulfuron /	0.25 + 0.0156	5/23	0	94	84	69	83	14
Efs&dmp&pmp +	0.337	5/31						
triflusulfuron + clopyralid	0.0234 + 0.094							
Efs&dmp&pmp +	0.42	6/4						
triflusulfuron + clopyralid	0.0312 + 0.094							
Efs&dmp&pmp + triflusulfuron	0.25 + 0.0156	5/23	4	92	91	61	84	11
Efs&dmp&pmp	0.337	5/31						
triflusulfuron + clopyralid	0.0234 + 0.094							
Efs&dmp&pmp	0.42	6/04						
triflusulfuron + clopyralid	0.0312 + 0.094							
Efs&dmp&pmp	0.675	6/11						
Efs&dmp&pmp + triflusulfuron	0.25 + 0.0156	5/31	0	64	58	48	53	12
Efs&dmp&pmp	0.337	6/04						
triflusulfuron + clopyralid	0.0234 + 0.094							
Efs&dmp&pmp	0.42	6/11						
triflusulfuron + clopyralid	0.0312 + 0.094							
Efs&dmp&pmp + triflusulfuron	0.25 + 0.0156	6/04	8	65	59	65	48	9
Efs&dmp&pmp	0.337	6/11						
triflusulfuron + clopyralid	0.0234 + 0.094							
Efs&dmp&pmp	0.42	6/19						
triflusulfuron + clopyralid	0.0312 + 0.094							
Efs&dmp&pmp + triflusulfuron	0.337 + 0.0156	6/0	1	68	64	48	40	11
Efs&dmp&pmp	0.42	6/11						
triflusulfuron + clopyralid	0.0234 + 0.094							
clopyralid	0.094							
Efs&dmp&pmp	0.51	6/19						
triflusulfuron + clopyralid	0.0312 + 0.094							
Efs&dmp&pmp + triflusulfuron	0.42 + 0.0156	6/04	4	71	67	47	51	13
Efs&dmp&pmp	0.51	6/11						
triflusulfuron + clopyralid	0.0234 + 0.094							
Efs&dmp&pmp	0.59	6/19						
triflusulfuron + clopyralid	0.0312 + 0.094							
Efs&dmp&pmp + triflusulfuron	0.337 + 0.0156	6/11	4	74	63	58	41	14
Efs&dmp&pmp	0.42	6/19						
triflusulfuron + clopyralid	0.0234 + 0.094							
Efs&dmp&pmp	0.51	7/02						
triflusulfuron + clopyralid	0.0312 + 0.094							
Efs&dmp&pmp + triflusulfuron	0.42 + 0.0156	6/11	8	86	74	66	64	19
Efs&dmp&pmp	0.51	6/19						
triflusulfuron + clopyralid	0.0234 + 0.094							
Efs&dmp&pmp	0.59	7/02						
triflusulfuron + clopyralid	0.0312 + 0.094							
Efs&dmp&pmp + triflusulfuron	0.51 + 0.0156	6/11	14	75	75	60	61	14
Efs&dmp&pmp	0.59	6/19						
triflusulfuron + clopyralid	0.0234 + 0.094							
Efs&dmp&pmp	0.675	7/02						
triflusulfuron + clopyralid	0.0312 + 0.094							
Efs&dmp&pmp + triflusulfuron	0.76 + 0.0156	6/11	6	79	62	69	58	12
Efs&dmp&pmp	1.05	6/19						
triflusulfuron + clopyralid	0.0234 + 0.094							
Efs&dmp&pmp	1.12	6/11	11	63	50	56	38	9
triflusulfuron + clopyralid	0.0312 + 0.25							
LSD (0.05)			7	11	9	NS	22	4

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

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

Interaction of seeding rate and herbicide rate on weed control in spring wheat. Don W. Morishita, Michael J. Wille, and Michael P. Quinn. (Twin Falls Research and Extension Center, University of Idaho, Twin Falls, ID 83303-1827) The second year of a 2-year study to examine the interactive effects of spring wheat population density and reduced herbicide rates on broadleaf weed control and weed seed rain was conducted at the University of Idaho Research and Extension Center near Kimberly, Idaho. 'Westbred 936R' hard red spring wheat was seeded at 30, 60, 90, and 120 lb/A on April 8, 2002. The experiment was a four-by-four factorial design arranged as a split plot randomized complete block with four replications. Main plots were wheat seeding rate. Subplots were the herbicide rates, which included a standard rate and fractional increments of those rates. Fluroxypyr + tribenuron were applied at 0.125 + 0.00813 lb ai/A (1X rate), 0.094 + 0.00609 lb ai/A (0.75X), 0.0625 + 0.00406 lb ai/A (0.5X), and 0.0313 + 0.00203 lb ai/A (0.25X). Individual subplots were 8 by 25 ft. Soil type was a Portneuf silt loam (20% sand, 71% silt, and 9% clay) pH 8.1, 1.5% organic matter, and CEC of 17-meq/100 g soil. Kochia and common lambsquarters were the major weed species present. Herbicide treatments were applied May 24 with a CO_2-pressurized bicycle-wheel sprayer calibrated to deliver 10 gpa using 11001 flat fan nozzles when wheat had 4 to 5 leaves, and kochia and common lambsquarters were both 1 to 5 inches tall. Environmental conditions at application were as follows: air temperature 64 F, soil temperature 82 F, relative humidity 65%, and wind speed 7 mph. Plots were evaluated visually for weed control 52 days after treatment on July 15. Plots were harvested August 23 with a small-plot combine.

None of the herbicide treatments injured the crop (Table). Kochia control was not affected by seeding rate and averaged 76 to 78% control when averaged over all herbicide rates. Averaged over seeding rates, tribenuron + fluroxypyr controlled kochia 91% at the 0.25X rate and 98% with all higher rates. Similarly, the 0.5 X, 0.75 X, and 1.0X rates controlled common lambsquarters equally at 96%, compared to 86% control at the 0.25 X rate. Again, common lambsquarters was not controlled without herbicide treatment regardless of seeding rate, averaging 75% for all seeding rates regardless of herbicide treatment. Seeding rate and herbicide rate did not interact with respect to crop injury, kochia or common lambsquarters control. Grain yield was affected only by herbicide rate. Grain yields of all herbicide-treated plots ranged from 59 to 73 bu/A compared to 36 bu/A in untreated check plots. Yields from the three highest herbicide rates, 0.5X, 0.75X, and 1X, ranged from 69 to 73 bu/A when averaged over seeding rates, and did not differ among one another. Grain yields from all three of these rates were greater than from the 0.25X rate, which yielded 59 bu/A. Crop seeding rate and herbicide rate did not interact to affect grain yield.

Table. Winter wheat injury, broadleaf weed control, and grain yield response to crop seeding rate and reduced herbicide rates.

Seeding rate	Herbicide[b]	Application rate	Population density[a] TRZAX	KCHSC	CHEAL	Crop Injury	Control KCHSC	CHEAL	Grain Yield
lb/A			plants/ft²			%			bu/A
30			11	17	3	4	76	75	60
60			13	11	2	2	77	75	61
90			14	16	2	2	77	76	57
120			24	19	2	1	78	75	69
LSD (0.05)			ns	ns	ns	ns	ns	ns	ns
	Tribenuron +fluroxypyr	-	16	14	2	0	0	0	36
	Tribenuron +fluroxypyr	0.002 + 0.0313	17	16	2	4	91	89	59
	Tribenuron +fluroxypyr	0.004 + 0.063	16	18	3	3	98	96	70
	Tribenuron +fluroxypyr	0.006 + 0.098	18	15	3	1	98	96	73
	Tribenuron +fluroxypyr	0.008 + 0.125	16	15	2	1	98	96	69
LSD (0.05)			ns	ns	ns	ns	2	5	11
30	Tribenuron +fluroxypyr	-					0	0	25
60	Tribenuron +fluroxypyr	-					0	0	41
90	Tribenuron +fluroxypyr	-					0	0	25
120	Tribenuron +fluroxypyr	-					0	0	55
30	Tribenuron +fluroxypyr	0.002 + 0.0313					88	90	63
60	Tribenuron +fluroxypyr	0.002 + 0.0313					93	85	53
90	Tribenuron +fluroxypyr	0.002 + 0.0313					90	90	59
120	Tribenuron +fluroxypyr	0.002 + 0.0313					95	90	63
30	Tribenuron +fluroxypyr	0.004 + 0.063					98	95	60
60	Tribenuron +fluroxypyr	0.004 + 0.063					98	96	73
90	Tribenuron +fluroxypyr	0.004 + 0.063					98	96	73
120	Tribenuron +fluroxypyr	0.004 + 0.063					99	96	75
30	Tribenuron +fluroxypyr	0.006 + 0.098					98	95	78
60	Tribenuron +fluroxypyr	0.006 + 0.098					98	96	69
90	Tribenuron +fluroxypyr	0.006 + 0.098					99	96	70
120	Tribenuron +fluroxypyr	0.006 + 0.098					99	96	76
30	Tribenuron +fluroxypyr	0.008 + 0.125					99	96	74
60	Tribenuron +fluroxypyr	0.008 + 0.125					99	96	68
90	Tribenuron +fluroxypyr	0.008 + 0.125					98	98	57
120	Tribenuron +fluroxypyr	0.008 + 0.125					98	95	79
LSD (0.05)							2	5	11

[a]TRZAX, KCHSC, and CHEAL are spring wheat, kochia, and common lambsquarters, respectively.
[b]A nonionic surfactant was included with all herbicide applications at 0.25% v/v.

Weed control using carfentrazone with postemergence wild oat herbicides. Michael J. Wille and Don W. Morishita. (Twin Falls Research and Extension Center, University of Idaho, Twin Falls, ID 83303-1827) A study was conducted at the University of Idaho Research and Extension Center near Kimberly, Idaho to evaluate weed control with carfentrazone tank-mixed with postemergence wild oat herbicides. 'Treasure' spring wheat was planted April 6, 2002, at a seeding rate of 100 lb/A in rows 7 inches apart. Experimental design was a randomized complete block with four replications and individual plots were 8 by 25 ft. Soil type was a Portneuf silt loam (26% sand, 67% silt, and 7% clay), with a pH of 8, 1.5% organic matter, and a CEC of 15-meq/100 g soil. Wild oat, kochia, and common lambsquarters were the major weed species present at population densities of 8, 9, and 4 plants/ft^2, respectively. Herbicides were applied to 5-leaf wheat with two tillers on May 17, 2002 with a CO_2-pressurized bicycle-wheel sprayer calibrated to deliver 10 gpa using 11001 flat fan nozzles. Environmental conditions at application were as follows: air temperature 48 F, soil temperature 50 F, relative humidity 70%, wind speed 6 mph, and 40% cloud cover. Crop injury was evaluated visually 14 and 54 days after treatment (DAT) on May 31 and July 10, respectively. Grain was harvested on August 26 from the center of each plot with a small-plot combine.

No herbicide treatment injured spring wheat more than any other (Table). Wild oat control 14 DAT ranged from 41 to 91%. Herbicide treatments that contained fenoxaprop controlled wild oat 86 to 91%; those with clodinafop, 70 to 89%; those with flucarbazone, 45 to 62%; those with propoxycarbazone, 41 to 75%; and those with imazamethabenz, 65 to 71%. Fenoxaprop alone controlled wild oat ≥86%, as did clodinafop alone or with carfentrazone + tribenuron&thifensulfuron + MCPA. Tank-mixes of propoxycarbazone + carfentrazone + MCPA, imazamethabenz + carfentrazone + tribenuron&thifensulfuron + MCPA, and, clodinafop + carfentrazone + MCPA controlled wild oat 70 to 75%. Wild oat control with all other herbicide combinations was ≤65%. At 54 DAT, wild oat control ranged from 61 to 99%. Herbicide treatments containing fenoxaprop, clodinafop, or imazamethabenz controlled wild oat ≥80%, while those containing flucarbazone or propoxycarbazone controlled wild oat 61 to 78%. Kochia control 14 DAT ranged from 51 to100% among herbicide treatments that contained a broadleaf herbicide. Tank-mixes with any broadleaf herbicide combination plus either fenoxaprop or flucarbazone controlled kochia >80%. Kochia control 54 DAT ranged from 53 to 99% among herbicide treatments that contained a broadleaf herbicide. Kochia appeared to be controlled 9 to 60% 14 DAT, and 10 to 56% 56 DAT among herbicide treatments containing a wild oat herbicide alone. Common lambsquarters control was similar among tank-mix combinations containing a broadleaf herbicide, ranging from 71 to 96% 14 DAT, and from 90 to 100% 54 DAT. Herbicide treatments containing a wild oat herbicide alone appeared to control common lambsquarters 13 to 61% 14 DAT, and 18 to 71% 54 DAT. Grain yield of herbicide-treated plots ranged from 59 to 97 bu/A compared to 50 bu/A in the untreated check. Yield differences could not be detected between herbicide treatments or from the untreated check (P=0.11). Grain test weights were similar among all treatments, ranging from 52 to 58 lb/bu.

Table. Crop injury, weed control and grain yield response to carfentrazone tank-mixed with wild oat herbicides.

		Crop injury		Weed control[a]						Grain	
				AVEFA		KCHSC		CHEAL			
Treatment[b]	Rate	5/31	7/10	5/31	7/10	5/31	7/10	5/31	7/10	yield	test wt.
	lb ai/A									bu/A	lb/bu
Check	—	—	—	—	—	—	—	—	—	50	55
Fenoxaprop	0.0825	6	0	91	98	9	24	13	44	77	58
Fenoxaprop + carfentrazone + MCPA LVE + NIS	0.0825 + 0.012 + 0.25 + 0.25% v/v	9	3	89	90	86	85	92	100	83	56
Fenoxaprop + carfentrazone + MCPA LVE + thifen&triben + NIS	0.0825 + 0.012 + 0.25 + 0.014 + 0.25% v/v	6	1	86	81	100	99	96	100	78	57
Clodinafop + Score	0.0625 + 0.8% v/v	0	0	90	99	20	45	58	56	78	55
Clodinafop + Score + carfentrazone + MCPA LVE	0.0625 + 0.8% v/v + 0.012 + 0.25 +	3	0	70	81	73	60	79	94	83	55
Clodinafop + Score + carfentrazone + MCPA LVE + thifen&triben +	0.0625 + 0.8% v/v + 0.012 + 0.25 + 0.014 +	8	0	86	90	94	91	94	100	97	58
Flucarbazone + NIS	0.027 + 0.25% v/v	1	0	62	66	55	56	61	59	72	56
Flucarbazone + carfentrazone + MCPA LVE + NIS	0.027 + 0.012 + 0.25 + 0.25% v/v	1	3	45	61	91	84	90	100	68	57
Flucarbazone + carfentrazone + MCPA LVE + thifen&triben + NIS	0.027 + 0.012 + 0.25 + 0.014 + 0.25% v/v	0	5	58	78	84	65	90	100	81	57
Propoxycarbazone + NIS	0.04 + 0.25% v/v	0	0	41	73	35	10	47	18	59	54
Propoxycarbazone + carfentrazone + MCPA LVE + NIS	0.04 + 0.012 + 0.25 + 0.25% v/v	3	3	75	63	51	53	71	90	66	55
Propoxycarbazone + carfentrazone + MCPA LVE + thifen&triben + NIS	0.04 + 0.012 + 0.25 + 0.014 + 0.25% v/v	1	6	64	68	81	70	89	100	64	57
Imazamethabenz + NIS	0.41 + 0.25% v/v	3	8	64	83	60	49	60	71	82	52
Imazamethabenz + carfentrazone + MCPA LVE + NIS	0.41 + 0.012 + 0.25 + 0.25% v/v	4	4	65	80	75	72	79	100	76	56
Imazamethabenz + carfentrazone + MCPA LVE + thifen&triben + NIS	0.41 + 0.012 + 0.25 + 0.014 + 0.25% v/v	5	5	71	83	84	80	94	100	76	58
LSD (0.05)		ns	ns	13	18	25	36	15	17	ns	ns

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

[b]Fenoxaprop is a commercial formulation that contains the safener mefenpyr diethyl. Thifen&triben is a 1:1 commercial formulation of thifensulfuron and tribenuron. NIS is a nonionic surfactant, and Score is a proprietary surfactant.

Application timing for wild oat control in spring wheat with flucarbazone. 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, Idaho to compare the efficacy of flucarbazone applied alone or tank-mixed with other broadleaf or wild oat herbicides for wild oat control in spring wheat. 'Treasure' spring wheat was planted April 6, 2002, at a seeding rate of 100 lb/A. Experimental design was a randomized complete block with four replications and individual plots were 8 by 25 ft. Soil type was a Portneuf silt loam (20% sand, 71% silt, and 9% clay) with a pH of 8.1, 1.5% organic matter, and CEC of 17-meq/100 g soil. Wild oat population density was seven plants/ft^2. Herbicides were applied when wheat had 4 to 5 leaves and two tillers, fully tillered, or at early jointing on May 15, 28, and 31, respectively. Herbicides were applied with a CO_2-pressurized bicycle-wheel sprayer calibrated to deliver 10 gpa using 11001 flat fan nozzles calibrated to deliver 20 gpa. Environmental conditions at application are given in Table 1. Crop injury was evaluated visually 11 and 29 days after the last treatment (DALT) on June 11 and July 10, respectively. Weed control was evaluated July 10. Grain was harvested from the center of each plot with a small-plot combine on August 26.

Table 1. Environmental conditions at application.

Application date	May 15	May 28	May 31
Air temperature (F)	50	77	91
Soil temperature (F)	48	70	81
Relative humidity (%)	70	76	50
Wind speed (mph)	5	6	0
Cloud cover (%)	100	50	25

Crop injury ranged from 3 to 23% 11 DALT (Table 2). Winter wheat treated with flucarbazone + fenoxaprop at all three growth stages was injured only 3 to 5%, compared to flucarbazone + thifensulfuron & tribenuron, which caused 14 to 23% injury. All other herbicide treatments caused 6 to 14% injury. Crop injury ratings 42 DALT ranged from 8 to 16%, but did not differ among herbicide treatments. Wild oat control among all herbicide treatments and application timings ranged from 46 to 78 % and did not differ among each other except flucarbazone + fenoxaprop applied to fully tillered wheat controlled wild oat better (70 to 78%) than did flucarbazone + thifensulfuron & tribenuron applied to 4 to 5-leaf wheat (46%). All herbicide treatment and application timings controlled kochia 39 to 87% except flucarbazone + fenoxaprop, which did not control kochia at all at the first application timing. All treatment combinations controlled common lambsquarters 71 to 100% except flucarbazone + fenoxaprop applied to tillered wheat, which controlled common lambsquarters only 23%. Due to wide variability in grain growth, crop yields were similar among all treatments, including the untreated check.

Table 2. Crop injury, weed control, and grain yield response to flucarbazone tank-mixed with broadleaf herbicides in spring wheat near Kimberly, ID.

	Application		Crop injury		Weed Control[a]			Grain
Treatment[b]	Rate	Date[c]	6/11	7/10	AVEFA	KCHSC	CHEAL	yield
	lb ai/A		%					bu/A
Untreated	-	-	-	-	-	-	-	18
Flucarbazone + NIS	0.027 + 0.25% v/v	May 15	11	8	55	87	89	37
Flucarbazone + NIS	0.027 + 0.25% v/v	May 28	14	15	55	70	91	26
Flucarbazone + NIS	0.027 + 0.25% v/v	May 31	14	10	57	51	82	20
Flucarbazone + thifen&triben + NIS	0.027 + 0.028 + 0.25% v/v	May 15	14	10	46	53	100	35
Flucarbazone + thifen&triben + NIS	0.027 + 0.028 + 0.25% v/v	May 28	23	13	55	75	100	29
Flucarbazone + thifen&triben + NIS	0.027 + 0.028 + 0.25% v/v	May 31	20	12	53	70	91	24
Flucarbazone + thifen&triben + 2,4-D LVE + NIS	0.027 + 0.028 + 0.25 + 0.25% v/v	May 15	8	9	59	39	84	38
Flucarbazone + thifen&triben + 2,4-D LVE + NIS	0.027 + 0.028 + 0.25 + 0.25% v/v	May 28	11	8	56	79	100	33
Flucarbazone + thifen&triben + 2,4-D LVE + NIS	0.027 + 0.028 + 0.25 + 0.25% v/v	May 31	6	15	51	86	100	40
Flucarbazone + fenoxaprop + NIS	0.027 + 0.082 + 0.25% v/v	May 15	5	15	70	0	23	42
Flucarbazone + fenoxaprop + NIS	0.027 + 0.082 + 0.25% v/v	May 28	5	9	78	43	85	24
Flucarbazone + fenoxaprop + NIS	0.027 + 0.082 + 0.25% v/v	May 31	3	16	53	39	71	34
LSD (P=0.05)			10	NS	16	35	21	NS

[a]Weed control was evaluated July 10. Weeds evaluated for control were wild oat (AVEFA), kochia (KCHSC), and common lambsquarters (CHEAL).
[b]Thifen&triben is a 2:1 commercial formulation of thifensulfuron + tribenuron. NIS is a nonionic surfactant.
[c]Wheat growth stage at the May 15, 28, and 31 application dates were 4 to 5 leaf, tillered, and early jointing, respectively.

Comparison of postemergence wild oat herbicides tank-mixed with broadleaf herbicides. Michael J. Wille and Don W. Morishita. (Twin Falls Research and Extension Center, University of Idaho, Twin Falls, ID 83303-1827) A study was conducted in Minidoka County near Paul, Idaho to compare the effects of postemergence herbicide tank mixtures for wild oat and broadleaf weed control in irrigated spring wheat. 'Westbred 936' spring wheat was planted April 8, 2002, at a seeding rate of 120 lb/A. Experimental design was a randomized complete block with four replications and individual plots were 8 by 25 ft. Soil type was a Portneuf silt loam (20% sand, 71% silt, and 9% clay) with a pH of 8.1, 1.5% organic matter, and CEC of 17-meq/100 g soil. Kochia and wild oat were the major weed species present at population densities of 2 and 8 plants/ft^2, respectively. Herbicides were applied May 24 with a CO_2-pressurized bicycle-wheel sprayer using 11001 flat fan nozzles calibrated to deliver 10 gpa at 24 psi. Environmental conditions at application were as follows: air temperature 60 F, soil temperature 48 F, relative humidity 48%, wind speed 8 mph, and 10% cloud cover. Crop injury and kochia control was evaluated visually 17 and 49 days after treatment (DAT) on June 10 and July 12, respectively. Grain was harvested August 21 with a small-plot combine.

Tank mix combinations containing flucarbazone caused substantially more crop injury than other herbicide treatments on 17 DAT (Table). Flucarbazone + bromoxynil & MCPA injured spring wheat 10% while tank-mixtures with flucarbazone + tribenuron + thifensulfuron at either rate caused 20 to 24% injury. None of the other herbicide combinations injured spring wheat. On July 12 (49 DAT), crop injury with flucarbazone + bromoxynil & MCPA had been reduced to 5%, but crop injury in the two treatments of flucarbazone + tribenuron + thifensulfuron was still 10 to 13%, and greater than all other herbicide treatments. Primary injury symptom was stunted growth. Crop injury on August 8 was 6 and 9% for the same flucarbazone tank mix treatments. Wild oat control 17 DAT ranged from 69 to 93%. Tank-mix combinations of flucarbazone plus tribenuron + thifensulfuron at either 0.0117 or 0.014 lb ai/A each controlled wild oat better than 90%, whereas combinations of tralkoxydim + bromoxynil & MCPA 5EC, and combinations of fenoxaprop + thifensulfuron & tribenuron at 0.014 lb/A or thifensulfuron at 0.0187lb/A + MCPA at 0.374 lb ai/A controlled wild oat only 69 to 73%. Wild oat control 49 DAT was 80% or better with all herbicide treatments except tralkoxydim + bromoxynil & MCPA 5EC, which controlled wild oat only 68%. Kochia control 17 DAT ranged from 26 to 91%. All tank-mix combinations of fluroxypyr at either rate controlled kochia ≥80%. Tank-mixes containing any of the wild oat herbicides + bromoxynil & MCPA 5EC at either 0.50 or 0.75 lb/A controlled kochia 64 to 78%. Kochia control was <60% with any of the tank-mix combinations that contained any wild oat herbicide + thifensulfuron and/or tribenuron, except fenoxaprop + thifensulfuron + bromoxynil at 0.0825 + 0.014 + 0.25 lb ai/A, which controlled kochia 81%. Kochia control on July 12 averaged 97% for tank-mix combinations of fluroxypyr at either 0.047 or 0.094 lb/A. Combinations of bromoxynil & MCPA 5EC at 0.50 or 0.75 lb/A + any wild oat herbicide ranged from 87 to 95%, while tank mixes of any of the wild oat herbicides combined with thifensulfuron and/or tribenuron controlled kochia 37 to 86%. By August 13, kochia control ranged from 25 to 98% among all herbicide treatments and treatment differences were much less distinct. However, the general trends observed previously were still evident. Kochia control averaged 98% in plots that had been treated with fluroxypyr + any of the wild oat herbicides. Tank-mix combinations containing bromoxynil & MCPA 5EC at either rate + a wild oat herbicide tended to control kochia 70 to 89%, while tank-mixes containing tribenuron and thifensulfuron, tended to control kochia <70%. Grain yields ranged from 52 (untreated check) to 99 bu/A. Among the highest yielding treatments were fenoxaprop + thifensulfuron or bromoxynil & MCPA + fluroxypyr.

Table. Crop injury, weed control, and grain yield response to carfentrazone tank-mixed with wild oat herbicides, near Paul, ID.

					Weed control[a]					
		Crop Injury			AVEFA		KCHSC			Grain
Treatment[b]	Rate	6/10	7/12	8/13	6/10	7/12	6/10	7/12	8/13	yield
	lb ai/A	%								bu/A
Check	-	-	-	-	-	-	-	-	-	52
Fenoxaprop	0.0825	0	0	0	89	99	14	19	37	58
Clodinafop	0.05	0	0	0	75	98	69	92	87	94
bromoxynil & MCPA 5EC	0.75									
Score	0.8% v/v									
Flucarbazone	0.027	10	5	1	80	96	65	87	70	84
bromoxynil & MCPA 5EC	0.75									
NIS	0.25% v/v									
Tralkoxydim	0.18	0	1	1	71	68	64	91	75	82
bromoxynil & MCPA 5EC	0.75									
Supercharge	0.5									
Fenoxaprop	0.0825	1	3	0	76	86	78	94	87	95
bromoxynil & MCPA 5EC	0.75									
Fenoxaprop	0.0825	0	0	0	79	81	74	95	89	89
bromoxynil & MCPA 5EC	0.5									
Fenoxaprop	0.0825	0	0	3	79	88	40	60	46	74
thifensulfuron	0.014									
MCPA LVE	0.347									
NIS	0.25% v/v									
Fenoxaprop	0.0825	0	0	0	73	86	31	37	25	69
thifensulfuron	0.0187									
MCPA LVE	0.347									
NIS	0.25									
Fenoxaprop	0.0825	0	0	0	69	90	59	86	84	84
thifensulfuron & tribenuron	0.014									
MCPA LVE	0.347									
NIS	0.25% v/v									
Fenoxaprop	0.0825	0	0	0	83	95	85	95	98	88
MCPA LVE	0.347									
fluroxypyr	0.094									
Fenoxaprop	0.0825	0	0	0	90	99	91	98	98	99
thifensulfuron	0.014									
fluroxypyr	0.094									
NIS	0.25% v/v									
Fenoxaprop	0.0825	0	8	3	85	94	81	85	77	82
thifensulfuron	0.014									
bromoxynil	0.25									
NIS	0.25% v/v									
Fenoxaprop	0.0825	0	0	1	85	97	91	98	97	99
bromoxynil & MCPA 5EC	0.5									
fluroxypyr	0.047									
Clodinafop	0.06	0	1	0	84	97	51	80	66	72
tribenuron + thifensulfuron	0.0117 + 0.0117									
Score	0.8% v/v									
Clodinafop	0.06	0	3	0	81	94	41	68	58	81
tribenuron + thifensulfuron	0.014 + 0.014									
Score	0.8% v/v									
Flucarbazone	0.027	20	10	6	93	99	44	62	69	58
tribenuron + thifensulfuron	0.0117 + 0.0117									
NIS	0.25% v/v									
Flucarbazone	0.027	24	13	9	91	100	26	50	33	61
tribenuron + thifensulfuron	0.014 + 0.014									
NIS	0.25% v/v									
Fenoxaprop	0.0825	0	0	3	81	81	46	68	44	63
tribenuron + thifensulfuron	0.0117 + 0.0117									
NIS	0.25% v/v									
Fenoxaprop	0.0825	0	0	0	78	80	46	62	58	70
tribenuron + thifensulfuron	0.014 + 0.014									
NIS	0.25% v/v									
LDS (0.05)		3	5	ns	10	10	18	17	16	15

[a] Weeds evaluated for control were wild oat (AVEFA) and kochia (KCHSC).

[b] Bromoxynil & MCPA 5EC is a 1:1 commercial formulation of bromoxynil and MCPA containing 5 lb ai/gal. Thifensulfuron & tribenuron is a 2:1 commercial formulation of thifensulfuron and tribenuron. Score is a proprietary surfactant. NIS is a nonionic surfactant.

Prickly lettuce control in spring wheat with sulfentrazone. Joan Campbell and Donn Thill. (Crop and Weed Division, University of Idaho, Moscow, ID 83844-2339) An experiment was established near Moscow, ID in November 2001 to evaluate weed control and spring wheat safety with sulfentrazone. Treatments were applied with a CO_2 pressurized backpack sprayer delivering 10 gpa at 3 mph and 32 psi (Table 1). The experimental design was a randomized complete block with four replications and 8 by 25 ft experimental units. Wheat was seeded with a Haybuster no-till drill with disc openers on May 8, 2002. Prickly lettuce control was evaluated after bolting and wheat grain was harvested at maturity.

Table 1. Environmental and edaphic conditions.

Application date	November 7, 2001
Application timing	Preplant
Prickly lettuce density (plants/yd^2)	1
Air temperature (F)	43
Soil temperature (F)	35
Relative humidity (%)	69
Cloud cover (%)	0
Soil pH	5.8
OM (%)	3.8
CEC (cmol/kg)	30
Type	Palouse silt loam

Prickly lettuce control was 92% with sulfentrazone + glyphosate at 0.281 + 0.375 lb ai/A which was higher than sulfentrazone treatments at 0.094 lb ai/A or glyphosate at 0.375 lb ai/A (Table 2). Wheat yield and test weight were unaffected by treatments.

Table 2. Prickly lettuce control and spring wheat grain yield.

Treatment	Rate	Prickly lettuce control	Wheat grain yield	Wheat test weight
	lb ai/A[1]	%	lb/A	lb/bu
Sulfentrazone	0.094	63	3118	61
Sulfentrazone	0.141	76	3247	62
Sulfentrazone	0.188	66	2940	61
Sulfentrazone	0.281	74	3211	61
Sulfentrazone +	0.094			
glyphosate[2]	0.375	59	3203	61
Sulfentrazone +	0.141			
glyphosate[2]	0.375	81	3234	61
Sulfentrazone +	0.188			
glyphosate[2]	0.375	76	3065	61
Sulfentrazone +	0.281			
glyphosate[2]	0.375	92	3268	61
Glyphosate[2]	0.375	39		
Untreated	0	–	3077	61
LSD (0.05)		26	NS	NS

[1] Glyphosate rates are expressed as lb ae/A.

[2] Ammonium sulfate (Bronc) at 17 lb/100 gal was added to all glyphosate treatments.

Evaluation of wild oat herbicides for spring wheat. John O. Evans, Travis Osmond, and R. William Mace. (Department of Plants, Soils, and Biometeorology, Utah State University, Logan, Utah 84322-4820). Clearfield[R] spring wheat was planted April 1, 2002 on the Wallace Beutler farm in North Logan. Herbicide treatments including sulfosulfuron, fenoxyprop, flucarbazone-sodium, and MKH 6561 were applied to evaluate wild oat (AVEFA) and wild buckwheat (POLCO) control. Individual treatments were applied to10 by 30 foot plots with an CO_2 sprayer using flatfan Turbojet 015 nozzles providing a 10 foot spray width calibrated to deliver 25 gpa at 40 psi. The soil was millville loam with 7.9 pH and O.M. content of less than 2%. Treatments were applied postemergence May 20, 2002 in a randomized block design, with three replications. Wheat ranged in size from 5 to 6 inches tall. Wild oats were two to three inches tall with 2 to 3 leaves. Wild buckwheat had two to three leaves. Visual evaluations of crop injury and weed control were completed June 25, and July 26. Plots were harvested August 20, 2002.

There was no evidence of wheat injury with any treatment. Yields were not significantly different for any treatment but there was a trend for higher yield with MKH 6561+fenoxaprop with dosages above 0.038 lb/A. Generally, MKH 6561 at rates above 0.038 lb /A provided excellent control of wild oats with the mefenpyr safener or with the addition of fenoxaprop. Flucarbazone-sodium with either mefenpyr or 2,4-D gave excellent control of wild oats and wild buckwheat at the June evaluation date. Wild buckwheat control weakened by July for the lower 0.038 rate as new plants emerged. MKH 6561 treatments were generally poor for controlling wild buckwheat except for one treatment with MKH 6561+fenoxaprop at 0.057+0.041 lb/A. Sulfosulfuron provided acceptable control of wild oats but not wild buckwheat.

Table. Evaluation of wild oat control in wheat.

Treatment		Wheat			Weed control			
		Injury		Yield	AVEFA		POLCO	
	Rate	6/5	6/25	8/20	6/25	7/26	6/25	7/26
	lb /A	-------%-------		Bu/A	---------------%---------------			
Untreated		0.0	0.0	24.3	13.9	10.0	6.7	10.0
Sulfosulfuron[a]	0.041	0.0	0.0	32.8	73.3	88.3	46.7	40.0
MKH 6561[b]	0.057	0.0	0.0	25.8	100.0	93.3	0.0	56.7
MKH 6561[b]	0.172	0.0	0.0	31.2	98.3	100.0	80.4	75.0
MKH 6561[b] + mefenpyr	0.057+0.004	0.0	0.0	35.3	90.0	100.0	50.0	53.9
MKH 6561[b] + mefenpyr	0.172+0.012	0.0	0.0	35.8	100.0	100.0	50.0	70.0
MKH 6561[b] + mefenpyr	0.057+0.008	0.0	0.0	37.6	90.0	100.0	10.0	59.5
MKH 6561[b] + mefenpyr	0.172+0.024	0.0	0.0	20.5	100.0	100.0	40.0	31.7
MKH 6561[b] + mefenpyr	0.057+0.02	0.0	0.0	15.4	70.0	83.3	50.0	48.3
MKH 6561[b] + mefenpyr	0.172+0.06	0.0	0.0	35.5	98.3	100.0	36.7	55.0
MKH 6561[b] + mefenpyr	0.057+0.04	0.0	0.0	24.7	40.0	36.4	13.3	26.7
MKH 6561[b] + mefenpyr	0.172+0.12	0.0	0.0	36.5	95.7	100.0	16.7	60.0
MKH 6561[c]	0.038	0.0	0.0	29.9	55.7	46.7	23.3	13.3
MKH 6561[c] + fenoxaprop	0.038+0.041	0.0	0.0	30.0	56.7	100.0	16.7	53.3
MKH 6561[c] + fenoxaprop	0.038+0.021	0.0	0.0	31.1	63.3	73.3	33.3	50.0
MKH 6561[c] + fenoxaprop	0.057+0.041	0.0	0.0	42.4	80.0	80.0	83.3	84.5
MKH 6561[c] + fenoxaprop	0.057+0.021	0.0	0.0	44.6	83.3	86.7	81.7	63.3
MKH 6561[c] + fenoxaprop	0.076+0.021	0.0	0.0	44.4	86.7	96.7	67.9	66.7
Flucarbazone-sodium[c]	0.038	0.0	0.0	28.8	86.7	83.3	90.0	59.5
Flucarbazone-sodium[c]+2,4-D	0.038+0.149	0.0	0.0	32.3	100.0	100.0	86.7	66.7
Flucarbazone-sodium[c]+ mefenpyr	0.038+0.027	0.0	0.0	25.6	86.7	83.3	81.7	76.7
Flucarbazone-sodium[c]	0.114	0.0	0.0	26.1	81.7	100.0	96.1	53.3
Flucarbazone-sodium[c]+2,4-D	0.114+0.44	0.0	0.0	26.1	98.3	100.0	100.0	91.7
Flucarbazone-sodium[c]+ mefenpyr	0.114+0.081	0.0	0.0	27.9	96.7	93.3	90.0	85.0
LSD (0.05)				20.5	24.8	32.2	39.8	50.4

[a] Surf-90 0.5% v/v added.
[b] Surf-90 0.25% v/v added
[c] Activator 90 0.25% v/v added.

Evaluation of fenoxaprop for wild oat and wild buckwheat control in spring wheat. John O. Evans, Earl Creech, and R. William Mace. (Department of Plants, Soils, and Biometeorology, Utah State University, Logan, Utah 84322-4820). Clearfield[R] spring wheat was planted April 1, 2002 on the Wallace Beutler farm in North Logan. Herbicide treatments including, fenoxyprop, flucarbazone-sodium, and combinations with thifensulfuron, bromoxynil, MCPA and fluroxypyr were applied to evaluate wild oat (AVEFA) and wild buckwheat (POLCO) control. Individual treatments were applied to10 by 30 foot plots with a CO_2 sprayer using flatfan T-jet 015 nozzles providing a 10 foot spray width calibrated to deliver 25 gpa at 40 psi. The soil was millville loam with 7.9 pH and O.M. content of less than 2%. Treatments were applied postemergence May 23, 2002 in a randomized block design, with three replications. Wheat ranged in size from 5 to 6 inches tall. Wild oats were two to three inches tall with 2 to 3 leaves, and wild buckwheat had two to three leaves. Visual evaluations for crop injury and weed control were completed June 25, and July 26. Plots were harvested August 20, 2002.

There was no evidence of crop phytotoxicity at either evaluation date. Yields were not significantly different between treatments. Fenoxaprop alone provided excellent control of wild oats but did not control wild buckwheat. Wild oat control was exceptional for all other treatments as well at the July evaluation and only wild buckwheat control fell below 80 percent for treatment combinations fenoxaprop+thifensulfuron/tribenuron+MCPA and fenoxaprop+fluroxypyr+MCPA.

Table. Evaluation of wild oat and wild buckwheat control in wheat.

Treatment	Rate	Wheat Injury 6/5	Wheat Injury 6/25	Wheat Yield 8/20	Weed control AVEFA 6/25	AVEFA 7/26	POLCO 6/25	POLCO 7/26
	lb /A	-------%-------		Bu/A	------------------%-----------------			
Untreated		0.0	0.0	25.3	0.0	0.0	0.0	0.0
Fenoxaprop	0.1	0.0	0.0	35.9	100.0	100.0	6.7	0.0
Clodinafop+bromoxynil/MCPA[a]	0.05+0.75	0.0	0.0	28.3	100.0	100.0	99.3	100.0
Flucarbazone-sodium+ Bromoxynil/MCPA[b]	0.027+ 0.75	0.0	0.0	23.4	100.0	98.9	100.0	100.0
Tralkoxydim+ bromoxynil/MCPA[c]	0.18+0.75	0.0	0.0	24.7	100.0	100.0	100.0	98.3
Fenoxaprop+ bromoxynil/MCPA	0.1+0.75	0.0	0.0	22.4	100.0	100.0	100.0	93.3
Fenoxaprop+ bromoxynil/MCPA	0.1+0.5	0.0	0.0	30.1	98.4	100.0	93.0	94.1
Fenoxaprop+thifensulfuron+MCPA[b]	0.1+0.014+0.37	0.0	0.0	24.4	98.3	100.0	98.3	80.8
Fenoxaprop+thifensulfuron+MCPA[b]	0.1+0.02+0.37	0.0	0.0	29.1	100.0	100.0	98.1	85.8
Fenoxaprop+thifen/triben+MCPA[b]	0.1+0.014+0.37	0.0	0.0	28.8	96.7	93.3	100.0	60.0
Fenoxaprop+fluroxypyr+MCPA	0.1+0.37+0.09	0.0	0.0	20.3	93.3	100.0	93.3	75.8
Fenoxaprop+thifensulfuron+fluroxypyr[b]	0.1+0.014+0.09	0.0	0.0	34.7	96.7	100.0	95.0	90.0
Fenoxaprop+thifensulfuron+ bromoxynil[b]	0.1+0.014+ 0.6	0.0	0.0	20.0	100.0	100.0	100.0	99.3
Fenoxaprop+ bromoxynil/MCPA+ fluroxypyr[b]	0.1+0.5+ 0.9	0.0	0.0	24.1	100.0	100.0	100.0	96.7
Thifen/triben+ fluroxypyr[b]	0.019+0.06	0.0	0.0	25.5	93.3	86.7	95.0	98.3
Thifensulfuron+fluroxypyr[b]	0.02+0.06	0.0	0.0	23.4	56.7	93.3	88.3	80.0
LSD $_{(0.05)}$				11.4	16.3	8.2	8	12.8

[a] Score 0.8% v/v added.
[b] NIS 0.25% v/v added
[c] Turbocharge 0.5% v/v added.

Wild oat control in spring wheat. Joan Campbell and Donn Thill. (Plant Science Division, University of Idaho, Moscow, ID 83844-2339) An experiment was established to evaluate wild oat control in spring wheat south of Uniontown, WA. Wheat was seeded with a one pass drill with cross slot openers. Treatments were tralkoxydim, flucarbazone-sodium, and fenoxaprop applied alone and in combination with MCPA and thifensulfuron/tribenuron. Herbicides were applied with a CO_2 pressurized backpack sprayer delivering 10 gpa at 3 mph and 32 psi (Table 1). The experimental design was a randomized complete block with four replications and 8 by 30 ft experimental units. Wild oat control was evaluated after heading and wheat grain was harvested at maturity.

Table 1. Environmental and edaphic conditions.

Application date	June 12, 2002
Wheat growth stage	1 tiller
Wild oat growth stage	1 to 4 leaf
Wild oat density (plants/ft^2)	1
Air temperature (F)	61
Soil temperature (F)	58
Relative humidity (%)	71
Cloud cover (%)	5
Soil pH	5.4
OM (%)	4.6
CEC (cmol/kg)	26
Texture	Silt loam

Flucarbazone-sodium stunted wheat 5%, but no other treatment injured wheat (data not shown). Wild oat control was excellent (99%) with flucarbazone-sodium and tralkoxydim (Table 2). Wild oat control with fenoxaprop at 0.063 alone or fenoxaprop at 0.083 lb ai/A with broadleaf herbicides was 87 and 85%, respectively. Wheat grain yield was higher in all treated plots (3904 lb ai/A or greater) except fenoxaprop + MCPA + thifensulfuron/tribenuron (3887 lb ai/A) compared to the untreated control (3689 lb ai/A). Wheat test weight did not vary among treatments.

Table 2. Wild oat control and spring wheat grain yield and test weight.

Treatment	Rate	Wild oat control	Wheat grain yield	Wheat test weight
	lb ai/A	%	lb/A	lb/bu
Untreated control	--	–	3689	60.9
Flucarbazone-sodium +	0.0267	99	3904	60.5
NIS[1]	0.25% v/v			
Fenoxaprop/safener	0.083	90	3922	60.8
Fenoxaprop/safener	0.063	87	4093	60.8
Fenoxaprop/safener +	0.083	85	3887	60.7
MCPA ester +	0.38			
thifensulfuron/tribenuron +	0.014			
NIS[1]	0.25% v/v			
Tralkoxydim +	0.18	99	4064	61.0
COC/NIS[2] +	0.5% v/v			
AMS[3]	15 lb/100 gal			
Tralkoxydim +	0.24	99	4150	60.8
COC/NIS[2] +	0.5% v/v			
AMS[3]	15 lb/100 gal			
LSD (0.05%)		10	213	NS

[1] Nonionic surfactant (R11)

[2] Crop oil concentrate plus nonionic surfactant (Supercharge)

[3] Ammonium sulfate (Bronc)

Wild oat control with fenoxaprop in combination with broadleaf herbicides. Michael J. Wille and Don W. Morishita. (Twin Falls Research and Extension Center, University of Idaho, Twin Falls, ID 83303-1827) A study was conducted near Rexburg, Idaho to measure wild oat control in spring wheat ('Pennewawa') with fenoxaprop and mefenpyr diethyl tank-mixed with broadleaf herbicides. Wheat was seeded April 16, 2001, at 100 lb/A. Experimental design was a randomized complete block with four replications. Individual plots were 8 by 25 ft. Soil type was a Ririe silt loam. Herbicides were applied broadcast May 24 with a CO_2-pressurized bicycle-wheel sprayer calibrated to deliver 10 gpa using 11001 flat fan nozzles when wild oat was in the four leaf stage. Environmental conditions at application were as follows: air temperature 78 F, soil temperature 74 F, relative humidity 54%, and wind speed 3 mph. Plots were evaluated visually for crop injury and wild oat control 28 days after treatment and near maturity on June 21 and August 10, respectively. Plots were harvested August 27 with a small-plot combine.

No herbicide treatment injured spring wheat >4% on both evaluation dates and did not differ among each other on either date (Table). Wild oat control with the herbicide combinations ranged from 77 to 93% on June 21, and 66 to 91% on August 10. Due to variability in wild oat control, no significant differences were observed between herbicide treatments on either evaluation date. Grain yields among the herbicide treatments, ranged from 68 to 88 bu/A. All herbicide treatments had grain yield higher than the untreated check, which yielded 10 bu/A.

Table. Effect of fenoxaprop tank-mixed with broadleaf herbicides on crop injury, wild oat control, and grain yield in spring wheat.

Treatment [a]	Rate	Crop injury 6/21	Crop injury 8/10	Wild oat control 6/21	Wild oat control 8/10	Grain yield
	lb ai/A	%				bu/A
Check	-	-	-	-	-	10
Fenoxaprop	0.083	0	0	90	84	81
Clodinafop + bromoxynil & MCPA + Score	0.05 + 0.75 + 0.8% v/v	0	0	89	81	79
Fenoxaprop + thifensulfuron + MCPA ester + NIS	0.083 + 0.014 + 0.356 + 0.25% v/v	0	1	84	78	75
Fenoxaprop + MCPA ester + fluroxypyr	0.083 + 0.356 + 0.125	0	2	85	78	83
Fenoxaprop + thifensulfuron + fluroxypyr + NIS	0.083 + 0.014 + 0.125 + 0.25% v/v	0	3	88	88	81
Fenoxaprop + thifensulfuron + fluroxypyr + NIS	0.083 + 0.0187 + 0.125 + 0.25% v/v	0	3	93	89	82
Fenoxaprop + thifensulfuron + fluroxypyr + NIS	0.083 + 0.0234 + 0.125 + 0.25% v/v	0	0	92	91	88
Fenoxaprop + thifensulfuron + bromoxynil + NIS	0.083 + 0.014 + 0.25 + 0.25% v/v	0	0	77	78	75
Fenoxaprop + thifensulfuron + bromoxynil + NIS	0.083 + 0.0187 + 0.25 + 0.25% v/v	2	3	77	75	74
Fenoxaprop + thifensulfuron + bromoxynil + NIS	0.083 + 0.0234 + 0.25 + 0.25% v/v	0	3	88	70	70
Fenoxaprop + tribenuron & thifensulfuron + bromoxynil & MCPA + NIS	0.083 + 0.014 + 0.5 + 0.25% v/v	0	0	83	83	83
Fenoxaprop + bromoxynil & MCPA + thifensulfuron + NIS	0.083 + 0.5 + 0.014 + 0.25% v/v	4	0	84	66	68
Fenoxaprop + thifensulfuron + bromoxynil & MCPA 5EC+ NIS	0.083 + 0.014 + 0.5 + 0.25% v/v 0.25% v/v	0	1	90	78	77
Fenoxaprop + bromoxynil & MCPA	0.083 + 0.5	1	0	81	69	85
Fenoxaprop + bromoxynil & MCPA 5EC	0.083 + 0.5	3	3	85	76	75
LSD (0.05)		NS	NS	NS	NS	16

[a] Fenoxaprop applied as a commercial formulation of fenoxaprop and the safener, mefenpyr diethyl. Score is a proprietary adjuvant. NIS is nonionic surfactant. Bromoxynil & MCPA and bromoxynil & MCPA 5EC are commercial 1:1 bromoxynil and MCPA formulations containing 4 and 5 lb ai/gal, respectively. Thifensulfuron & tribenuron applied as a commercial 2:1 formulation.

Control of over-wintered glyphosate-resistant spring wheat with quizalofop. Curtis R. Rainbolt and Donald C. Thill. (Plant Science Division, University of Idaho, Moscow, ID 83844-2339) A field trial was established near Genesee, ID at the University of Idaho Kambitsch Research Farm to evaluate quizalofop for control of volunteer over-wintered glyphosate-resistant spring wheat (RRW). The experiment was located on a site where glyphosate-resistant wheat trials were conducted the previous year. Experimental design was a randomized complete block with four replications. Herbicide treatments were applied at the 2 to 4 and 7 to 9 leaf growth stage of the volunteer wheat (Table 1). Volunteer wheat control was evaluated visually and the study was terminated prior to heading to prevent seed production.

Table 1. Application data.

Application date	April 16, 2002		April 29, 2002
Wheat growth stage	2 to 4 leaf		7 to 9 leaf
Air temperature (F)	50		65
Soil temperature at 2 inches (F)	40		60
Relative humidity (%)	45		55
Wind (mph)	5		0 to 2
Soil			
pH		5.1	
OM%		2.4	
CEC (meq/100g)		21	
Texture		silt loam	

Glyphosate alone at either application timing provided no control of RRW (Table 2). On May 9, all rates of quizalofop applied at the 2 to 4 leaf stage controlled RRW 85 to 90%, while control with quizalofop applied at the 7 to 9 leaf stage ranged from 18 to 25%. By May 17, control was 60 to 63% for quizalofop treatments applied at the 7 to 9 leaf stage. On May 22, quizalofop treatments applied at the 2 to 4 leaf stage controlled RRW 97% on average compared to 85% for treatments applied at the 7 to 9 leaf stage. Control of RRW with quizalofop was not rate sensitive, and regardless of application timing, required approximately 23 days for control to reach acceptable (85% or higher) levels.

Table 2. Glyphosate resistant wheat (RRW) control near Genesee, ID in 2002.

		Application	RRW control		
Treatment[1]	Rate	timing	May 9	May 17	May 22
	lb ai/A			%	
Quizalofop + glyphosate	0.028 + 0.56	2-4 leaf	85	95	97
Quizalofop + glyphosate	0.034 + 0.56	2-4 leaf	90	93	97
Quizalofop + glyphosate	0.041 + 0.56	2-4 leaf	90	93	96
Quizalofop + glyphosate	0.048 + 0.56	2-4 leaf	89	94	97
Glyphosate (control)	0.56	2-4 leaf	0	0	0
Quizalofop + COC	0.048 + 1% v/v	2-4 leaf	90	94	96
Quizalofop + glyphosate	0.028 + 0.56	7-9 leaf	20	62	84
Quizalofop + glyphosate	0.034 + 0.56	7-9 leaf	23	60	84
Quizalofop + glyphosate	0.041 + 0.56	7-9 leaf	18	60	86
Quizalofop + glyphosate	0.048 + 0.56	7-9 leaf	25	60	85
Glyphosate (control)	0.56	7-9 leaf	0	0	0
Quizalofop + COC	0.048 + 1% v/v	7-9 leaf	25	63	86
LSD (0.05)			10	4	3

[1]The glyphosate formulation used was Roundup Ultra Max and the COC (crop oil concentrate) used was Moract.

Tolerance of imidazolinone-resistant winter wheat varieties to imazamox. Traci A. Rauch and Donald C. Thill. (Crop and Weed Science Division, University of Idaho, Moscow, ID 83844-2339) Three studies were established near Lewiston, Moscow, and Nezperce, Idaho to evaluate injury and yield of three imidazolinone-resistant winter wheat varieties treated with two rates of imazamox applied at two growth stages. The experimental design was a randomized complete block, complete factorial with four replications. Main plots were three wheat varieties (24 by 48 ft), subplots were two application times (24 by 24 ft) and sub-subplots were two imazamox rates and an untreated check (8 by 24 ft). Imazamox treatments were applied using a CO_2 pressurized backpack sprayer calibrated to deliver 10 gpa at 32 psi and 3 mph (Table 1). At Lewiston, the study was oversprayed with thifensulfuron/tribenuron at 0.014 lb ai/A to control broadleaf weeds. In all experiments, wheat injury was evaluated visually, and wheat seed was harvested on July 18, August 13, and 15, 2002 at Lewiston, Moscow, and Nezperce, ID, respectively.

Table 1. Application and soil data.

	Lewiston		Moscow		Nezperce	
Application date	3/29/2002	4/16/2002	4/8/2002	5/15/2002	4/24/2002	5/23/2002
Wheat growth stage	3 to 4 tiller	7 to 8 tiller	2 to 3 leaf	3 to 5 tiller	3 leaf	3 tiller
Air temperature (F)	50	50	55	56	51	50
Relative humidity (%)	58	58	49	45	58	75
Wind (mph, direction)	1, W	0	1, NW	3, SW	2, E	4, W
Cloud cover (%)	100	100	0	60	0	100
Soil temperature at 2 in (F)	43	45	46	50	41	41
pH	5.4		4.3		5.6	
OM (%)	2.8		5.1		5.7	
CEC (meq/100g)	21		33		30	
Texture	silt loam		loam		silt loam	

At Lewiston, 'Fidel', 'ID588', and 'ID587' wheat was injured 5, 4, and 3%, respectively [LSD (0.05) = 1]. Wheat injury was greater with imazamox at 0.094 lb ai/A (10%) than imazamox at 0.047 lb ai/A (1%) [LSD (0.05) = 2] and greater at the 7 to 8 tiller (5%) than the 3 to 4 tiller application time (3%) [LSD (0.05) = 2]. Wheat seed yield was lowest with the high rate of imazamox (89 bu/A) compared to the low rate of imazamox and the untreated check (93 and 94 bu/A) [LSD (0.05) = 4]. Test weight was 61.2, 59.4, and 57.8 lb/bu for 'Fidel', 'ID588', and 'ID587', respectively [LSD (0.05) = 1.2].

At Moscow, 'Fidel' wheat was visibly injured more than 'ID587' wheat (9 vs. 4%) but was not different from 'ID588' wheat injury (7%) [LSD (0.05) = 3]. Wheat injury was higher with imazamox at 0.094 lb ai/A (18%) than the 0.047 lb ai/A rate (2%) [LSD (0.05 = 4]. Wheat yield of 'Fidel' and 'ID587' decreased as imazamox rate increased (Table 2). The untreated check yielded more grain than the high rate of imazamox for 'Fidel' and 'ID587', but not 'ID588'. Test weight was lower in all varieties at the 3 to 5 tiller application time compared to the 2 to 3 leaf application time (Table 3). Test weight varied with imazamox rate and application time (Table 4).

At Nezperce, 'Fidel' and 'ID588' wheat injury was higher with imazamox at 0.094 lb ai/A compared to 0.047 lb ai/A (Table 2). At both application times, wheat injury increased with imazamox rate (Table 4). Wheat yield was higher with imazamox at 0.047 lb ai/A (105 bu/A) compared to imazamox at 0.094 lb ai/A (90 bu/A) but did not differ from the untreated check (103 bu/A) [LSD (0.05) =8]. Test weight was 61.3, 59.1, and 57.0 lb/bu for 'Fidel', 'ID588', and 'ID587', respectively [LSD (0.05) = 0.8]. At both application times, test weight decreased with increasing imazamox rate (Table 4).

Table 2. Wheat injury at Nezperce and wheat yield at Moscow averaged over imazamox application time in 2002.

Wheat variety	Imazamox rate[1]	Nezperce injury[2]	Moscow yield[3]
	lb ai/A	%	bu/A
Fidel	0	--	51
	0.047	0	51
	0.094	13	43
ID 588	0	--	32
	0.047	0	34
	0.094	23	29
ID 587	0	--	37
	0.047	5	31
	0.094	12	29
LSD (0.05)		8	4

[1]Imazamox treatments were applied with 90% nonionic surfactant (R-11) at 0.25% v/v and 32% urea ammonium nitrate at 1 qt/A.
[2]June 25, 2002 evaluation date.
[3]Two replications harvested at Moscow.

Table 3. Wheat test weight at Moscow averaged over imazamox rate in 2002.

Wheat variety	Application timing	Moscow test weight[1]
		lb/bu
Fidel	2 to 3 leaf	63.0
	3 to 5 tiller	61.7
ID 588	2 to 3 leaf	62.8
	3 to 5 tiller	62.3
ID 587	2 to 3 leaf	62.8
	3 to 5 tiller	62.4
LSD (0.05)		0.2

[1]Two replications harvested at Moscow.

Table 4. Wheat injury and test weight at Nezperce and wheat test weight at Moscow averaged over variety in 2002.

		Nezperce		Moscow[1]
Application time	Imazamox rate[2]	Injury[3]	Test weight	
	lb ai/A	%	-lb/bu-	
2 to 3 leaf	0	--	59.7	62.6
	0.047	0	59.7	62.8
	0.094	6	59.3	63.3
3 to 5 tiller	0	--	59.7	62.8
	0.047	4	59.0	62.3
	0.094	26	57.5	61.3
LSD (0.05)		6	0.4	0.3

[1]Two replications harvested at Moscow.
[2]Imazamox treatments were applied with 90% nonionic surfactant (R-11) at 0.25% v/v and 32% urea ammonium nitrate at 1 qt/A.
[3]June 25, 2002 evaluation date.

Downy brome control in winter wheat. Traci A. Rauch and Donald C. Thill. (Weed and Crop Science Division, University of Idaho, Moscow, ID 83844-2339) Four studies were established near Lewiston, Idaho in 'Fidel' imidazolinone-resistant winter wheat to evaluate weed control, and wheat injury and yield with imazamox and flufenacet/metribuzin combined with various herbicides, metribuzin combinations, propropcarbazone and broadleaf herbicide combinations, and propropcarbazone with various nitrogen rates. 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 (Tables 1 and 2). All studies, except the propropcarbazone and broadleaf combinations, were oversprayed with fluroxypyr at 0.124 lb ai/A to control catchweed bedstraw. In all experiments, wheat injury and weed control were evaluated visually, and wheat seed was harvested on July 31, 2002.

Table 1. Application and soil data for the imazamox and flufenacet/metribuzin study.

Application date	November 12, 2001	April 19, 2002	May 9, 2002
Wheat growth stage	preemergence	2 to 3 tiller	early jointing
Downy brome growth stage	preemergence	4 to 5 leaf	heading
Air temperature (F)	58	52	56
Relative humidity (%)	62	60	55
Wind (mph, direction)	0	2, N	0
Cloud cover (%)	90	50	100
Soil temperature at 2 in (F)	45	55	46
pH		5.4	
OM (%)		5.6	
CEC (meq/100g)		29	
Texture		silt loam	

Table 2. Application and soil data for the metribuzin combination, propropcarbazone and broadleaf herbicide combination, and propropcarbazone plus nitrogen studies.

	Metribuzin combination		Broadleaf combination	Propropcarbazone + nitrogen
Application date	April 4, 2002	April 25, 2002	April 4, 2002	April 19, 2002
Growth stage				
Wheat	3 leaf	4 tiller	3 leaf	2 to 3 tiller
Downy brome	3 leaf	5 leaf	3 leaf	4 to 5 leaf
Catchweed bedstraw	--	--	4 inches	--
Air temperature (F)	60	57	60	52
Relative humidity (%)	52	52	52	60
Wind (mph, direction)	3, N	2, N	1, N	8, N
Cloud cover (%)	0	0	0	80
Soil temperature at 2 in (F)	50	40	50	55
pH		5.4		
OM (%)		5.6		
CEC (meq/100g)		29		
Texture		silt loam		

In the imazamox and flufenacet/metribuzin study, imazamox combined with thifensulfuron/tribenuron plus bromoxynil/MCPA visibly injured wheat 20%, while the high rate of imazamox applied at heading injured wheat 6% (Table 3). The split application of imazamox (4 to 5 leaf and heading growth stage) and propropcarbazone and sulfosulfuron treatments controlled downy brome (BROTE) 93 to 98% but did not differ from imazamox at 4 to 5 leaf growth stage. Wheat yield with flufenacet/metribuzin plus sulfosulfuron (89 bu/A) was greater than flufenacet/metribuzin alone, metribuzin alone, flufenacet/metribuzin plus propropcarbazone at 0.0268 lb ai/A, all imazamox treatments, and the untreated check (30 to 77 bu/A). Wheat yield was poorly correlated with downy brome control due to a heavy non-imidazolinone volunteer winter wheat population. The volunteer population increased the competitiveness of the crop by increasing total crop density. In imazamox treated plots, all volunteer non-imidazolinone resistant wheat was killed and overall wheat stand reduced. Test weight did not differ among treatments.

In the metribuzin combination study, no treatment injured winter wheat (data not shown). At the three leaf timing, propropcarbazone alone and propropcarbazone plus metribuzin at 0.047 lb ai/A controlled downy brome 97 and 98%, respectively, but did not differ from any treatment applied at the three leaf growth stage or propropcarbazone + NIS + metribuzin at 0.187 lb ai/A at the five leaf growth stage (Table 4). Wheat yield and test weight ranged from 75 to 88 bu/A and 60 to 61 lb/bu, respectively, and did not differ among treatments.

In the broadleaf combination study, no treatment injured winter wheat (data not shown). All treatments controlled downy brome 98 to 99% (Table 5). Catchweed bedstraw (GALAP) control was best when propropcarbazone was combined with bromoxynil/MCPA, MCPA ester, fluroxypyr, carfentrazone, and thifensulfuron/tribenuron alone (68 to 63%), but was not adequate with any treatment. Wheat grain yield with fluroxypyr, carfentrazone, triasulfuron/dicamba, bromoxynil/MCPA, and thifensulfuron/tribenuron plus 2,4-D amine combinations (84 to 86 bu/A) was greater than propropcarbazone plus 2,4-D amine at 0.475 lb ae/A, propropcarbazone alone, and the untreated check (78 to 72 bu/A). Wheat seed test weight ranged from 59 to 61 lb/bu and did not differ among treatments.

In the propropcarbazone plus nitrogen study, propropcarbazone + NIS applied with nitrogen at 100% v/v injured wheat 11% on April 25, 2002, but did not differ from any treatment with nitrogen at 100% v/v (Table 6). Wheat was injured 6% by propropcarbazone + NIS applied with nitrogen at 50% v/v. By May 9, no treatment visibly injured wheat (data not shown). All treatments controlled downy brome 90 to 98%. Wheat grain yield was higher in all treatments compared to the untreated check but did not differ among treatments. Wheat test weight ranged from 59 to 60 lb/bu and did not differ between treatments or from the untreated check.

Table 3. Downy brome control and wheat injury, yield, and test weight in the imazamox and flufenacet/metribuzin study near Lewiston, Idaho in 2002.

Treatment[1]	Rate	Application timing[2]	Wheat injury[3]	BROTE control[4]	Wheat Yield	Wheat Test weight
	lb ai/A		--------------%--------------		bu/A	lb/bu
Flufenacet/metribuzin	0.425	preemergence	0	23	77	60
Sulfosulfuron	0.031	4-5 lf	0	93	85	60
Propropcarbazone	0.0268	4-5 lf	0	98	81	61
Propropcarbazone	0.04	4-5 lf	0	98	79	60
Metribuzin	0.188	4-5 lf	0	15	72	61
Imazamox	0.0313	4-5 lf	0	84	63	61
Flufenacet/metribuzin +	0.425	preemergence				
sulfosulfuron	0.031	4-5 lf	0	98	89	60
Flufenacet/metribuzin +	0.425	preemergence				
propropcarbazone	0.0268	4-5 lf	0	98	76	61
Flufenacet/metribuzin +	0.425	preemergence				
propropcarbazone	0.04	4-5 lf	0	98	88	60
Flufenacet/metribuzin +	0.425	preemergence				
metribuzin	0.188	4-5 lf	0	31	79	60
Imazamox +	0.0313	4-5 lf				
imazamox	0.0313	heading	4	96	64	61
Imazamox +	0.0313					
metribuzin	0.094	4-5 lf	4	71	59	61
Imazamox	0.039	heading	6	71	42	62
Imazamox +	0.039					
thifensulfuron/tribenuron	0.0156					
+ bromoxynil/MCPA	0.5	heading	20	75	30	61
Untreated check	--	--	--	--	65	62
LSD (0.05)			5	16	11	NS
Density (plants/ft^2)				15		

[1]90% nonionic surfactant (R-11) was applied at 0.25% v/v with propropcarbazone and imazamox and 0.5% v/v with sulfosulfuron. 32% nitrogen (UAN) was applied at 1 qt/A with imazamox.
[2]Application timing based on downy brome growth stage.
[3]May 29, 2002 evaluation date.
[4]June 21, 2002 evaluation date.

Table 4. Downy brome control and wheat yield and test weight in the metribuzin combination study near Lewiston, Idaho in 2002.

Treatment	Rate[1]	Application timing[2]	BROTE control[3]	Wheat Yield	Wheat Test weight
	lb ai/A		%	bu/A	lb/bu
Sulfosulfuron + NIS	0.031 + 0.5	3 leaf	94	84	60
Propropcarbazone + NIS	0.04 + 0.25	3 leaf	98	80	61
Propropcarbazone + metribuzin + NIS	0.04 + 0.047 + 0.25	3 leaf	97	83	61
Propropcarbazone + metribuzin + NIS	0.04 + 0.094 + 0.25	3 leaf	96	88	60
Sulfosulfuron + metribuzin + NIS	0.031 + 0.094 + 0.5	5 leaf	86	77	61
Sulfosulfuron + metribuzin + NIS	0.031 + 0.187 + 0.5	5 leaf	70	78	61
Propropcarbazone + metribuzin + NIS	0.04 + 0.094 + 0.25	5 leaf	86	80	61
Propropcarbazone + metribuzin + NIS	0.04 + 0.187 + 0.25	5 leaf	96	78	61
Propropcarbazone + metribuzin	0.04 + 0.187	5 leaf	63	76	61
Propropcarbazone + metribuzin +	0.04 + 0.187				
2,4-D amine + NIS	0.148 + 0.25	5 leaf	86	79	61
Untreated check	--	--	--	75	61
LSD (0.05)			11	NS	NS
Density (plants/ft^2)			15		

[1] NIS (90% nonionic surfactant) rate is in % v/v (R-11). 2,4-D rate is in lb ae/A.
[2] Application timing based on downy brome growth stage.
[3] June 21, 2002 evaluation date.

Table 5. Downy brome and catchweed bedstraw control and wheat yield and test weight in the propropcarbazone and broadleaf combination study near Lewiston, Idaho in 2002.

Treatment[1]	Rate[2]	BROTE control[3]	GALAP control[3]	Wheat Yield	Wheat Test weight
	lb ai/A	%	%	bu/A	lb/bu
Propropcarbazone	0.04	99	53	78	60
Propropcarbazone + metribuzin	0.04 + 0.14	99	20	80	60
Propropcarbazone + bromoxynil/MCPA	0.04 + 0.75	99	62	85	60
Propropcarbazone + MCPA ester	0.031 + 0.65	99	68	83	61
Propropcarbazone + fluroxypyr	0.031 + 0.187	99	67	86	60
Propropcarbazone + carfentrazone	0.04 + 0.008	99	67	84	61
Propropcarbazone + triasulfuron/dicamba	0.04 + 0.12	99	52	85	60
Propropcarbazone +	0.04				
thifensulfuron/tribenuron	0.014	99	63	81	60
Propropcarbazone +	0.04				
thifensulfuron/tribenuron + 2,4-D amine	0.014 + 0.148	98	45	84	60
Propropcarbazone + thifensulfuron +	0.04 + 0.0093				
tribenuron + metsulfuron	0.0046 + 0.0037	99	45	81	59
Propropcarbazone + 2,4-D amine	0.04 + 0.148	99	27	82	60
Propropcarbazone + 2,4-D amine	0.04 + 0.475	99	17	77	59
Untreated check	--	--	--	72	59
LSD (0.05)		NS	33	6	NS
Density (plants/ft^2)		15	7		

[1] All treatments were applied with a 90% nonionic surfactant (R-11) at 0.25% v/v.
[2] MCPA, fluroxypyr, and 2,4-D rates are in lb ae/A.
[3] June 21, 2002 evaluation date.

Table 6. Downy brome control and wheat injury, yield, and test weight in the propropcarbazone with nitrogen study near Lewiston, Idaho in 2002.

Treatment	Rate[1]	Wheat injury[2]	BROTE control[3]	Wheat Yield	Wheat Test weight
	lb ai/A	---------%---------		bu/A	lb/bu
Sulfosulfuron + NIS	0.031 + 0.5	0	93	81	59
Propropcarbazone + NIS	0.04 + 0.25	0	90	82	60
Propropcarbazone + nitrogen + NIS	0.04 + 50 + 0.25	3	98	82	60
Propropcarbazone + nitrogen + NIS	0.04 + 100 + 0.25	11	96	81	59
Propropcarbazone + nitrogen	0.031 + 50	4	96	83	60
Propropcarbazone + nitrogen	0.031 + 100	10	93	84	59
Propropcarbazone + 2,4-D ester + NIS	0.04 + 0.15 + 0.25	0	98	85	59
Propropcarbazone + 2,4-D ester + nitrogen	0.04 + 0.15 + 50	6	95	85	59
Propropcarbazone + 2,4-D ester + nitrogen	0.04 + 0.15 + 100	8	96	84	59
Untreated check	--	--	--	75	60
LSD (0.05)		4	NS	5	NS
Density (plants/ft^2)			15		

[1] NIS (90% nonionic surfactant, R-11) and nitrogen (32% urea ammonium nitrate) rates are in % v/v. 2,4-D rate is in lb ae/A.
[2] April 25, 2002 evaluation date.
[3] June 21, 2002 evaluation date.

The effect of time between mixing and spraying sulfonylureas combined with 2,4-D acid on mayweed chamomile control. Traci A. Rauch and Donald C. Thill. (Crop and Weed Science Division, University of Idaho, Moscow, ID 83844-2339) Historically, 2,4-D does not control mayweed chamomile as well as sulfonylurea herbicides. Under acidic conditions, sulfonylurea herbicides can be deactivated by hydrolysis. A study was established near Moscow, Idaho in winter wheat to evaluate mayweed chamomile control with seven sulfonylurea herbicides applied at 50% of the maximum use rate and combined with 2,4-D acid at three mix to spray times. Plots were 4 by 10 ft arranged in a randomized complete block design with four replications and included an untreated check. 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). Spray solution pH was measured at application time. The study was oversprayed with clodinafop at 0.063 lb ai/A on May 23, 2002 to control Italian ryegrass. Mayweed chamomile control was evaluated visually on June 17, 2002. The study was terminated prior to wheat grain maturity.

Table 1. Application and soil data.

Application date	May 31, 2002
Wheat growth stage	2 to 3 tiller
Mayweed chamomile growth stage	2 to 6 inches
Air temperature (F)	60 F
Relative humidity (%)	56
Wind (mph, direction)	3, W
Cloud cover (%)	0
Soil temperature at 2 in (F)	50
pH	5.1
OM (%)	3.7
CEC (meq/100g)	18
Texture	silt loam

Spray solution pH was six for all sulfonylurea herbicides alone and two for all treatments containing 2,4-D acid (Table 2). All treatments controlled mayweed chamomile better than 2,4-D acid alone (71%), except chlorsulfuron and thifensulfuron alone, all triasulfuron treatments, and sulfosulfuron + 2,4-D acid at the 48 hour mix-spray time. Time between mixing and spraying did not affect mayweed chamomile control. Sulfonylureas combined with 2,4-D acid averaged across all mix-spray times controlled mayweed chamomile as well or better than the sulfonylureas alone (86% vs. 80%).

Table 2. The effect of time between mixing and spraying sulfonylureas combined with 2,4-D acid on mayweed chamomile control in wheat near Moscow, ID in 2002.

Treatment[1]	Rate	Time between mixing and spraying	Spray solution pH at application	Mayweed chamomile control
	lb ai/A	hours		%
Chlorsulfuron	0.0078	1	6	76
Chlorsulfuron + 2,4-D acid	0.0078 + 0.5	1	2	88
Chlorsulfuron + 2,4-D acid	0.0078 + 0.5	24	2	88
Chlorsulfuron + 2,4-D acid	0.0078 + 0.5	48	2	89
Metsulfuron	0.00187	1	6	89
Metsulfuron + 2,4-D acid	0.00187 + 0.5	1	2	91
Metsulfuron + 2,4-D acid	0.00187 + 0.5	24	2	95
Metsulfuron + 2,4-D acid	0.00187 + 0.5	48	2	86
Triasulfuron	0.011	1	6	66
Triasulfuron + 2,4-D acid	0.011 + 0.5	1	2	76
Triasulfuron + 2,4-D acid	0.011 + 0.5	24	2	78
Triasulfuron + 2,4-D acid	0.011 + 0.5	48	2	73
Prosulfuron	0.0094	1	6	80
Prosulfuron + 2,4-D acid	0.0094 + 0.5	1	2	90
Prosulfuron + 2,4-D acid	0.0094 + 0.5	24	2	93
Prosulfuron + 2,4-D acid	0.0094 + 0.5	48	2	88
Tribenuron	0.0078	1	6	89
Tribenuron + 2,4-D acid	0.0078 + 0.5	1	2	93
Tribenuron + 2,4-D acid	0.0078 + 0.5	24	2	90
Tribenuron + 2,4-D acid	0.0078 + 0.5	48	2	89
Thifensulfuron	0.014	1	6	78
Thifensulfuron + 2,4-D acid	0.014 + 0.5	1	2	88
Thifensulfuron + 2,4-D acid	0.014 + 0.5	24	2	82
Thifensulfuron + 2,4-D acid	0.014 + 0.5	48	2	83
Sulfosulfuron	0.0156	1	6	85
Sulfosulfuron + 2,4-D acid	0.0156 + 0.5	1	2	89
Sulfosulfuron + 2,4-D acid	0.0156 + 0.5	24	2	82
Sulfosulfuron + 2,4-D acid	0.0156 + 0.5	48	2	80
2,4-D acid	0.5	1	2	71
LSD (0.05)			1	11
Density (plants/ft^2)				23

[1]All treatments, except 2,4-D acid alone, were applied with a nonionic surfactant at 0.25% v/v (R-11). All 2,4-D treatments were applied with an acidifier at 1% v/v (sulfuric acid/urea).

Imidazolinone resistant wheat and canola weed control. Joan Campbell and Donn Thill. (Crop and Weed Science Division, University of Idaho, Moscow, ID 83844-2339) Two experiments were established near Moscow, ID to evaluate weed control in imidazolinone resistant 'Columbia 23303' winter wheat and '46A76' spring canola. Treatments were applied with a CO_2 pressurized backpack sprayer delivering 10 gpa at 3 mph and 32 psi (Table 1). The experimental design for both experiments was a randomized complete block with four replications and 8 by 30 ft experimental units. Wheat was seeded October 6, 2001 and canola was seeded May 30, 2002. Weed control and crop injury were evaluated visually. Wheat grain and canola seed were harvested at maturity.

Table 1. Environmental and edaphic conditions.

Experiment	Wheat	Canola
Application date	May 12, 2002	June 15, 2002
Wheat growth stage	7 tiller and 10 inch tall	3 leaf
Mayweed chamomile size (inch) and density (plants/ft^2)	1 and 3	--
Canola growth stage	--	2 leaf
Volunteer pea growth stage	--	2 node
Air temperature (F)	60	68
Soil temperature (F)	56	70
Relative humidity (%)	40	61
Cloud cover (%)	0	0
Soil pH	4.8	5.6
OM (%)	5.2	2.6
CEC (cmol/kg)	35	20
Type	Loam	Silt loam

In the wheat experiment, mayweed chamomile control was 98 to 99% with all treatments containing thifensulfuron/tribenuron (Table 2). All other treatments did not provide adequate mayweed chamomile control (≤50%). Wheat was injured 19% with imazamox + thifensulfuron/tribenuron + bromoxynil/MCPA, but imazamox alone did not injure wheat. Wheat was injured 6 to 11% with flucarbazone and imazamethabenz + difenzoquat treatments. Wheat grain yield and test weight were lower compared to the untreated control with all treatments that showed visible injury except imazamethabenz + difenzoquat treatments.

In the canola experiment, both treatments controlled volunteer wheat 96 to 97%, but volunteer pea was not controlled with imazamox (Table 3). Canola seed yield was better than the untreated control with both treatments (orthoganol contrast P = 0.04 for quizalafop + clopyralid + ethametsulfuron and P = 0.06 for imazamox).

Table 2. Mayweed chamomile control and winter wheat injury, grain yield, and test weight near Moscow, ID in 2002.

Treatment	Rate	Mayweed chamomile control	Wheat Injury	Wheat Yield	Wheat Test weight
	lb ai/A	%	%	lb/A	lb/bu
Untreated control	--	--	0	3065	60.6
Imazamox[1]	0.031	26	0	2919	60.6
Imazamox[1]	0.039	50	0	2186	60.6
Imazamox[1]	0.047	49	0	2867	60.3
Imazamox[1] +	0.039	99	19	831	56.6
thifensulfuron/tribenuron +	0.0144				
bromoxynil/MCPA	0.25				
Flucarbazone[2]	0.027	16	9	2026	58.4
Clodinafop[3]	0.05	15	0	3376	60.5
Fenoxaprop	0.083	15	0	3370	60.7
Tralkoxydim[4]	0.25	10	0	3339	61.1
Imazamethabenz +	0.23	15	6	3081	60.3
difenzoquat[2]	0.5				
Thifensulfuron/tribenuron +	0.0144	99	0	2907	60.4
bromoxynil/MCPA[2]	0.25				
Flucarbazone +	0.027	99	11	2263	59.2
thifensulfuron/tribenuron +	0.0144				
bromoxynil/MCPA[2]	0.25				
Clodinafop[3] +	0.05	98	0	3436	60.3
thifensulfuron/tribenuron +	0.0144				
bromoxynil/MCPA	0.25				
Fenoxaprop +	0.083	99	0	3521	60.5
thifensulfuron/tribenuron +	0.0144				
bromoxynil/MCPA[2]	0.25				
Tralkoxydim +	0.25	98	0	2969	60.6
thifensulfuron/tribenuron +	0.0144				
bromoxynil/MCPA[4]	0.25				
Imazamethabenz +	0.23	98	10	2890	60.2
difenzoquat +	0.5				
thifensulfuron/tribenuron +	0.0144				
bromoxynil/MCPA[2]	0.25				
LSD (0.05)		18	5	500	0.5

[1] Applied with 28% urea ammonium nitrate at 2.5% v/v and nonionic surfactant (R-11) at 0.25% v/v.
[2] Applied with nonionic surfactant (R-11) at 0.25% v/v.
[3] Applied with crop oil concentrate (Score) at 0.31 qt/A.
[4] Applied with nonionic surfactant/crop oil concentrate (Supercharge) at 0.5% v/v and ammonium sulfate (Bronc) at 15 lb ai/100 gal.

Table 3. Weed control and canola seed yield near Moscow, ID in 2002.

Treatment	Rate	Volunteer pea control	Volunteer wheat control	Canola seed yield
	lb ai/A	%	%	lb/A
Imazamox [1]	0.031	14	97	604
Quizalafop +	0.055	97	96	634
clopyralid +	0.188			
ethametsulfuron[2]	0.0188			
Untreated control	--	--	--	384
LSD (0.05)		8	NS	NS

[1] Applied with 28% urea ammonium nitrate at 2.5% v/v and nonionic surfactant (R-11) at 0.25% v/v.
[2] Applied with nonionic surfactant (R-11) at 0.25% v/v.

Wild oat control in winter wheat. Joan Campbell and Donn Thill. (Crop and Weed Science Division, University of Idaho, Moscow, Idaho 83844) Four experiments were established in winter wheat south of Moscow Idaho to evaluate wild oat control. Herbicides were applied with a CO_2 pressurized backpack sprayer calibrated to deliver 10 gpa at 3 mph and 32 psi (Table 1). The experimental design in all experiments was a randomized complete block with four replications and 8 by 30 ft experimental units. Wild oat control was evaluated visually after surviving plants were headed. Cold spring conditions resulted in late emerging wild oat which allowed wheat to compete well. Wheat was not harvested since wild oat was not competitive even in the untreated plots.

Table 1. Environmental and edaphic conditions.

Experiment	One, two, three	Four
Application date	May 16, 2002	May 16, 2002
Wild oat growth stage	2 to 5 leaf	2 to 5 leaf
Wheat growth stage	3 to 7 tiller	3 to 7 tiller
Air temperature (F)	68	60
Soil temperature at 4 inches (F)	59	51
Relative humidity (%)	36	42
Cloud cover (%)	0	0
Soil moisture	High	
pH	5.5	
Organic matter (%)	4	
CEC (cmol/kg)	24	
Texture	Silt loam	

In experiment one, fenoxaprop/safener and mesosulfuron + methylated seed oil controlled wild oat better (99%) than tralkoxydim (97%) and flucarbazone (96%) (Table 2). Wild oat control with mesosulfuron + nonionic surfactant (98%) was better than with flucarbazone (96%). In experiment two, wild oat control was best (99%) with fenoxaprop/safener alone or in combination with bromoxynil/MCPA or MCPA ester + thifensulfuron/tribenuron, but these treatments were different only from fenoxaprop/safener + MCPA ester + tribenuron (95%) (Table 3). In experiment three, wild oat control was best (99%) with sulfosulfuron + fluroxypyr + fenoxaprop/safener and fenoxaprop/safener (Table 4). Wild oat control was not different among treatments in experiment four (Table 5).

Table 2. Wild oat control with fenoxaprop, flucarbazone, mesosulfuron, and tralkoxydim.

Treatment	Rate	Wild oat control
	lb ai/a	%
Untreated control	--	--
Fenoxaprop/safener	0.083	99
Flucarbazone[1]	0.027	96
Mesosulfuron + methylated seed oil[2]	0.009	99
Mesosulfuron + nonionic surfactant[3]	0.009	98
Tralkoxydim[4]	0.18	97
Tralkoxydim[4]	0.24	97
LSD (0.05%)		2

[1]Applied with 0.25% v/v nonionic surfactant (R-11)
[2]Applied with 1.5 pt/a methylated seed oil (Sunit-II), 0.018 lb/a mefenpyr-diethyl (safener), and 3.8 pt/a nitrogen solution (32%)
[3]Applied with 0.25% v/v nonionic surfactant (R-11), 0.018 lb/a mefenpyr-diethyl (safener), and 3.8 pt/a nitrogen solution (32%)
[4]Applied with 0.5% v/v crop oil concentrate/nonionic surfactant (Supercharge) and 15 lb/100 gal ammonium sulfate (Bronc)

Table 3. Wild oat control with fenoxaprop plus broadleaf herbicides.

Treatment	Rate	Wild oat control
	lb ai/a[1]	%
Untreated control	--	--
Fenoxaprop/safener	0.083	99
Fenoxaprop/safener + bromoxynil/MCPA	0.083 + 0.75	99
Fenoxaprop/safener + bromoxynil/MCPA + thifensulfuron/tribenuron[2]	0.083 +0.5 + 0.016	96
Fenoxaprop/safener + bromoxynil + thifensulfuron/tribenuron[2]	0.083 + 0.25 + 0.016	96
Fenoxaprop/safener + bromoxynil/MCPA + fluroxypyr	0.083 + 0.5 + 0.094	98
Fenoxaprop/safener + bromoxynil + fluroxypyr	0.083 + 0.25 + 0.094	98
Fenoxaprop/safener + bromoxynil + tribenuron[2]	0.083 + 0.25 + 0.008	96
Fenoxaprop/safener + MCPA ester + tribenuron[2]	0.083 + 0.374 + 0.008	95
Fenoxaprop/safener + MCPA ester + metsulfuron[2]	0.083 + 0.374 + 0.004	96
Fenoxaprop/safener + MCPA ester + thifensulfuron/tribenuron[2]	0.083 + 0.374 + 0.016	99
Fenoxaprop/safener + MCPA ester + thifensulfuron + fluroxypyr[2]	0.083 + 0.374 + 0.023 + 0.094	98
LSD (0.05)		3

[1]MCPA and fluroxypyr rates are expressed as lb ae/A.
[2]Applied with 0.25% v/v nonionic surfactant (R-11)

Table 4. Wild oat control with fenoxaprop and sulfosulfuron alone and with broadleaf herbicides.

Treatment[1]	Rate	Wild oat control
	lb ai/a[2]	%
Untreated check	--	--
Sulfosulfuron	0.031	94
Sulfosulfuron + 2,4-D ester + fenoxaprop/safener	0.031 + 0.375 + 0.083	95
Sulfosulfuron + bromoxynil + fenoxaprop/safener	0.031 + 0.25 + 0.083	96
Sulfosulfuron + MCPA ester + fenoxaprop/safener	0.031 + 0.5 + 0.083	96
Sulfosulfuron + dicamba + fenoxaprop/safener	0.031 + 0.153 + 0.083	94
Sulfosulfuron + fluroxypyr + fenoxaprop/safener	0.031 + 0.125 + 0.083	99
Sulfosulfuron + fenoxaprop/safener	0.031 + 0.083	96
Fenoxaprop/safener	0.083	99
Sulfosulfuron + fenoxaprop/safener	0.0155 + 0.041	96
LSD (0.05)		2

[1]All treatments except fenoxaprop/safener alone were applied with 0.5% v/v nonionic surfactant (R-11).
[2]MCPA, dicamba, fluroxypyr, and 2,4-D rates are expressed as lb ae/A.

Table 5. Wild oat control with clodinafop alone and with broadleaf herbicides.

Treatment[1]	Rate	Wild oat control
	lb ai/a[2]	%
Untreated	--	--
Clodinafop	0.05	99
Clodinafop	0.063	98
Clodinafop + clopyralid/2,4-D + fluroxypyr	0.063 + 0.8 + 0.125	99
Clodinafop + clopyralid/2,4-D + fluroxypyr	0.05 + 0.8 + 0.125	97
Clodinafop + clopyralid/2,4-D +thifensulfuron	0.05 + 0.8 + 0.028	98
Clodinafop + clopyralid/2,4-D + thifensulfuron	0.063 + 0.8 + 0.028	98
Clodinafop + prosulfuron + bromoxynil	0.05 + 0.018 + 0.375	99
Clodinafop + prosulfuron + bromoxynil	0.063 + 0.018 + 0.375	99
Clodinafop + thifensulfuron + bromoxynil	0.05 + 0.028 + 0.375	99
Clodinafop + thifensulfuron + bromoxynil	0.063 + 0.028 + 0.375	98
Clodinafop + thifensulfuron + fluroxypyr/MCPA ester	0.05 + 0.028 + 0.664	98
Clodinafop + thifensulfuron + fluroxypyr/MCPA ester	0.063 + 0.028 + 0.664	99
Clodinafop + thifensulfuron/tribenuron + MCPA amine	0.05 + 0.028 + 0.375	99
Clodinafop + thifensulfuron/tribenuron + MCPA amine	0.063 + 0.028 + 0.375	98
Clodinafop + thifensulfuron/tribenuron + bromoxynil/MCPA	0.05 + 0.028 + 0.5	99
Clodinafop + thifensulfuron/tribenuron + bromoxynil/MCPA	0.063 + 0.028 + 0.5	99
Clodinafop + thifensulfuron/tribenuron + bromoxynil	0.05 + 0.028 + 0.375	99
Clodinafop + thifensulfuron/tribenuron + bromoxynil	0.063 + 0.028 + 0.375	98
Clodinafop + prosulfuron + MCPA amine	0.05 + 0.018 + 0.375	99
Clodinafop + prosulfuron + MCPA amine	0.063 + 0.018 + 0.375	99
Fenoxaprop/safener + thifensulfuron + MCPA ester	0.083 + 0.023 + 0.375	98
LSD (0.05)		NS

[1]All treatments with clodinafop were applied with 0.8 pt/a crop oil concentrate (Score). Fenoxaprop/safener + thifensulfuron + MCPA ester was applied with 0.25% v/v nonionic surfactant (R-11).
[2]MCPA, fluroxypyr, clopyralid, and 2,4-D rates are expressed as lb ae/A.

Italian ryegrass control in winter wheat with various grass herbicides. Traci A. Rauch and Donald C. Thill (Plant Science Division, University of Idaho, Moscow, ID 83844-2339) Two studies were established near Genesee, Idaho in winter wheat to evaluate Italian ryegrass (LOLMU) control, wheat injury and yield with flufenacet/metribuzin alone and in combinations in experiment one and flufenacet/metribuzin, chlorsulfurorn/metsulfuron, flucarbazone-sodium and metribuzin alone and in combinations 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 (Table 1). In both experiments, wheat injury and Italian ryegrass control were evaluated visually on June 4 and July 9, 2002. Wheat seed was harvested on August 12, 2002. Only three replications were harvested from both experiments due to steep terrain.

Table 1. Application and soil data.

	Experiment one		Experiment two		
Application date	November 11, 2001	April 18, 2002	November 11, 2001	April 18, 2002	May 9, 2002
Wheat growth stage	1 leaf	2 tiller	1 leaf	2 tiller	4 tiller
LOLMU growth stage	spike	3 leaf	spike	3 leaf	5 leaf
Air temperature (F)	47	50	47	50	59
Relative humidity (%)	100	70	100	70	45
Wind (mph, direction)	0	0	0	0	2, SW
Cloud cover (%)	100	85	100	85	90
Soil temperature at 2 in (F)	45	45	45	45	52
pH	5.4				
OM (%)	2.3				
CEC (meq/100g)	23				
Texture	silt loam				

In experiment one on June 4, wheat was injured 0 to 6% and did not differ among treatments (Table 2). Flufenacet/metribuzin + triasulfuron treatments controlled Italian ryegrass 71 to 73%, but did not differ from the other treatments, except flufenacet/metribuzin at 0.34 lb ai/A, clodinafop, tralkoxydim and flucarbazone-sodium alone (23 to 45%). Wheat grain yield was greatest with flufenacet/metribuzin at 0.34 lb ai/A + triasulfuron (108 bu/A) but did not differ from triasulfuron, flufenacet/metribuzin + flucarbazone-sodium, and both rates of flufenacet/metribuzin alone (85 to 96 bu/A). Wheat seed test weight was 63 lb/bu for all treatments (data not shown).

In experiment two, all flucarbazone-sodium treatments applied at the 5 leaf growth stage injured wheat 16 to 24% on June 4 and, except in combination with metribuzin at 0.094 lb ai/A, 14 to 20% on July 9 (Table 3). Chlorsulfuron/metsulfuron and flufenacet/metribuzin in combination with flucarbazone-sodium applied at the 5 leaf growth stage controlled Italian ryegrass better (59 and 60%) than flucarbazone-sodium and metribuzin alone and in combination. Wheat grain yield was higher with flufenacet/metribuzin at 0.5107 lb ai/A and flufenacet/metribuzin (0.25 lb ai/A) + chlorsulfuron/metsulfuron (99 and 100 bu/A) than flucarbazone-sodium and metribuzin alone and in combination and the untreated check. Wheat seed test weight with all flucarbazone-sodium treatments applied at the 5 leaf growth stage was lower than all other treatments including the untreated check.

In both experiments, Italian ryegrass control was not adequate with any treatment due to a high plant density and large plants that survived from the 2001 growing season.

Table 2. Italian ryegrass control and wheat injury, yield and test weight in experiment one near Genesee, Idaho in 2002.

Treatment[1]	Rate	Application timing[2]	Wheat injury[3]	LOLMU control[4]	Wheat yield[5]
	lb ai/A		----------------%	----------------	bu/A
Flufenacet/metribuzin	0.34	spike	0	45	85
Flufenacet/metribuzin	0.425	spike	0	49	96
Triasulfuron	0.026	spike	0	59	91
Flufenacet/metribuzin +	0.34				
triasulfuron	0.026	spike	0	71	108
Flufenacet/metribuzin +	0.425				
triasulfuron	0.026	spike	5	73	82
Flufenacet/metribuzin +	0.34	spike			
tralkoxydim	0.24	3 leaf	4	50	83
Flufenacet/metribuzin +	0.34	spike			
clodinafop	0.063	3 leaf	0	54	83
Flufenacet/metribuzin +	0.34	spike			
flucarbazone-sodium	0.027	3 leaf	4	55	93
Tralkoxydim	0.24	3 leaf	6	31	75
Clodinafop	0.063	3 leaf	0	23	63
Flucarbazone-sodium	0.027	3 leaf	0	33	78
Untreated check	--	--	--	--	69
LSD (0.05)			NS	24	24
Density (plants/ft^2)				43	

[1]90% nonionic surfactant (R-11) was applied at 0.25% v/v with flucarbazone-sodium. Ammonium sulfate (Bronc) at 17 lb/100 gal and a crop oil concentrate/non-ionic surfactant blend (Supercharge) at 0.5% v/v were applied with tralkoxydim. Crop oil concentrate (Score) was applied at 0.4 qt/A with clodinafop.

[2]Application timing based on Italian ryegrass growth stage

[3]June 4, 2002 evaluation date.

[4]July 9, 2002 evaluation date.

[5]Three replications harvested.

Table 3. Italian ryegrass control and wheat injury, yield, and test weight in experiment two near Genesee, Idaho in 2002.

Treatment[1]	Rate	Application timing[2]	Wheat injury June 4	Wheat injury July 9	LOLMU control[3]	Wheat Yield[4]	Wheat Test weight
	lb ai/A		%	%	%	bu/A	lb/bu
Triasulfuron	0.026	spike	0	0	46	93	63
Flufenacet/metribuzin	0.425	spike	0	0	39	91	63
Flufenacet/metribuzin	0.5107	spike	0	0	50	99	63
Flufenacet/metribuzin +	0.25						
chlorsulfron/metsulfuron	0.0234	spike	0	0	49	100	63
Flufenacet/metribuzin +	0.34						
chlorsulfron/metsulfuron	0.0234	spike	0	0	49	94	63
Flufenacet/metribuzin +	0.425	spike					
metribuzin	0.281	5 leaf	0	0	50	93	63
Flucarbazone-sodium	0.0268	3 leaf	0	0	29	77	63
Flufenacet/metribuzin +	0.425	spike					
flucarbazone-sodium	0.0268	3 leaf	3	0	43	93	63
Chlorsulfron/metsulfuron +	0.0234	spike					
flucarbazone-sodium	0.0268	3 leaf	5	1	53	91	63
Flucarbazone-sodium	0.0268	5 leaf	21	14	28	71	61
Flufenacet/metribuzin +	0.425	spike					
flucarbazone-sodium	0.0268	5 leaf	24	16	60	89	61
Chlorsulfron/metsulfuron +	0.0234	spike					
flucarbazone-sodium	0.0268	5 leaf	20	20	59	91	62
Metribuzin	0.094	3 leaf	3	5	33	81	63
Metribuzin	0.188	3 leaf	3	0	21	74	63
Metribuzin	0.281	5 leaf	0	0	31	75	63
Metribuzin +	0.094	3 leaf					
flucarbazone-sodium	0.0268	5 leaf	16	11	31	71	61
Metribuzin +	0.188	3 leaf					
flucarbazone-sodium	0.0268	5 leaf	18	15	34	73	61
Diclofop	1	3 leaf	0	0	38	87	63
Untreated check	--	--	--	--	--	79	63
LSD (0.05)			6	8	23	16	1
Density (plants/ft^2)					44		

[1]90% nonionic surfactant (R-11) was applied at 0.25% v/v with flucarbazone-sodium.
[2]Application timing based on Italian ryegrass growth stage
[3]July 9, 2002 evaluation date.
[4]Three replications harvested.

Italian ryegrass control with imazamox in winter wheat. Traci A. Rauch and Donald C. Thill. (Crop and Weed Science Division, University of Idaho, Moscow, ID 83844-2339) Three studies were established near Moscow, Idaho in 'F2020' imidazolinone-resistant winter wheat to evaluate Italian ryegrass control and wheat yield with imazamox and flufenacet/metribuzin combinations, imazamox and broadleaf herbicide combinations, and imazamox combined with various adjuvants. 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 (Tables 1 and 2). All studies, except the imazamox and broadleaf herbicide combination study, were oversprayed with thifensulfuron/tribenuron at 0.014 lb ai/A and MCPA ester at 0.5 lb ae/A to control broadleaf weeds. In all experiments, Italian ryegrass control was evaluated visually, and wheat seed was harvested on August 19, 2002.

Table 1. Application and soil data for the imazamox and flufenacet/metribuzin study.

Application date	November 2, 2001	April 19, 2002	May 2, 2002
Wheat growth stage	1 leaf	3 to 4 leaf	2 tiller
Italian ryegrass growth stage	spike	2 leaf	4 leaf
Air temperature (F)	47	47	59
Relative humidity (%)	100	70	43
Wind (mph, direction)	0	1, W	0
Cloud cover (%)	100	15	30
Soil temperature at 2 in (F)	45	40	55
pH		5.1	
OM (%)		3.7	
CEC (meq/100g)		18	
Texture		silt loam	

Table 2. Application and soil data for the imazamox and broadleaf herbicides and the imazamox and adjuvant studies.

	Broadleaf study			Adjuvant study
Application date	April 19, 2002	May 16, 2002		April 30, 2002
Wheat growth stage	3 to 4 leaf	3 tiller		2 tiller
Italian ryegrass growth stage	2 leaf	5 leaf		4 leaf
Air temperature (F)	47	58		64
Relative humidity (%)	70	45		46
Wind (mph, direction)	1, W	0		0
Cloud cover (%)	15	0		80
Soil temperature at 2 in (F)	40	47		50
pH			5.1	
OM (%)			3.7	
CEC (meq/100g)			18	
Texture			silt loam	

In all studies, no treatment injured wheat (data not shown).

In the imazamox and flufenacet/metribuzin study, all flufenacet/metribuzin treatments, the split application of imazamox, and imazamox combined with thifensulfuron/tribenuron and bromoxynil/MCPA controlled Italian ryegrass 86 to 98% (Table 3). Italian ryegrass control with imazamox alone at 0.039 lb ai/A at the 2 leaf stage and 0.047 lb ai/A at the 4 leaf stage was 76 and 77%, respectively. Wheat yield with flufenacet/metribuzin treatments was greater than diclofop and all imazamox treatments applied only at the 4 leaf growth stage. All treatments yielded more grain than the untreated check. Wheat test weight of all treatments, except diclofop and imazamox at 0.047 lb ai/A, was higher than the untreated check (62 vs. 61 lb/bu).

In the imazamox and broadleaf herbicide study, Italian ryegrass control was reduced 60% with the addition of metribuzin applied at the 2 leaf stage and 26 and 31% with the addition of fluroxypyr and thifensulfuron/tribenuron, respectively, applied at the 5 leaf stage compared to imazamox alone at the same timings (Table 4). Wheat yield was highest with imazamox plus chlorsulfuron/metsulfuron (67 bu/A) and was better than all treatments applied at the 5 leaf stage and imazamox plus metribuzin applied at the 2 leaf stage. Wheat test weight ranged from 59 to 60 lb/bu and did not differ among treatments.

In the imazamox and adjuvant study, the high rate of imazamox (0.047 lb ai/A) with NIS and all treatments with MSO rates above 0.5% v/v controlled Italian ryegrass 71 to 88% (Table 5). Wheat yield (23 to 49 bu/A) and test weight (58 to 62 lb/bu) did not differ among treatments.

Table 3. Italian ryegrass control and wheat yield and test weight in the imazamox and flufenacet/metribuzin study near Moscow, Idaho in 2002.

Treatment[1]	Rate	Application timing[2]	LOLMU control[3]	Wheat Yield	Wheat Test weight
	lb ai/A		%	bu/A	lb/bu
Flufenacet/metribuzin	0.425	spike	94	86	62
Flufenacet/metribuzin + imazamox	0.425 + 0.039	spike + 4 leaf	98	83	62
Imazamox	0.039	2 leaf	76	76	62
Imazamox + imazamox	0.031 + 0.031	2 leaf + 4 leaf	86	78	62
Imazamox	0.039	4 leaf	65	66	62
Imazamox	0.047	4 leaf	77	66	61
Imazamox + thifensulfuron/tribenuron + bromoxynil/MCPA	0.047 + 0.016 0.5	4 leaf	89	75	62
Diclofop	1	2 leaf	64	69	61
Untreated check	--	--	--	52	61
LSD (0.05)			9	7	1
Density (plants/ft^2)			37		

[1]90% nonionic surfactant (R-11) at 0.25% v/v and 32% nitrogen (urea ammonium nitrate) at 1 qt/A were applied with imazamox.
[2]Application timing based on Italian ryegrass growth stage.
[3]July 9, 2002 evaluation date.

Table 4. Italian ryegrass control and wheat yield and test weight in the imazamox and broadleaf herbicides study near Moscow, Idaho in 2002.

Treatment[1]	Rate	Application timing[2]	LOLMU control[3]	Wheat Yield	Wheat Test weight
	lb ai/A		%	bu/A	lb/bu
Imazamox	0.031	2 leaf	75	64	60
Imazamox + dicamba	0.031 + 0.125	2 leaf	74	64	60
Imazamox + chlorsulfuron/metsulfuron	0.031 + 0.014	2 leaf	81	67	60
Imazamox + metribuzin	0.031 + 0.141	2 leaf	30	51	60
Imazamox + thifensulfuron/tribenuron	0.031 + 0.023	2 leaf	81	58	60
Imazamox + metsulfuron + 2,4-D ester	0.031 + 0.004 + 0.5	2 leaf	71	63	60
Imazamox	0.031	5 leaf	86	50	59
Imazamox + dicamba	0.031 + 0.125	5 leaf	80	47	59
Imazamox + 2,4-D ester (no UAN)	0.031 + 0.5	5 leaf	78	45	60
Imazamox + 2,4-D ester	0.031 + 0.5	5 leaf	88	44	60
Imazamox + dicamba + 2,4-D ester	0.031 + 0.125 + 0.5	5 leaf	85	39	59
Imazamox + thifensulfuron/tribenuron	0.031 + 0.023	5 leaf	59	41	59
Imazamox + metribuzin	0.031 + 0.141	5 leaf	68	37	59
Imazamox + metsulfuron + 2,4-D ester	0.031 + 0.004 + 0.5	5 leaf	79	36	60
Imazamox + bromoxynil/MCPA	0.031 + 0.75	5 leaf	88	51	60
Imazamox + fluroxypyr	0.031 + 0.124	5 leaf	64	32	60
Imazamox + clopyralid/MCPA	0.031 + 0.605	5 leaf	84	48	60
Untreated check	--	--	--	38	59
LSD (0.05)			20	14	NS
Density (plants/ft^2)			56		

[1]90% nonionic surfactant (R-11) was applied at 0.25% v/v with imazamox. 32% nitrogen (urea ammonium nitrate) at 1 qt/A was applied with imazamox (except with one 2,4-D ester treatment). Dicamba, 2,4-D, fluroxypyr, and clopyralid/MCPA rates are in lb ae/A.
[2]Application timing based on Italian ryegrass growth stage.
[3]July 12, 2002 evaluation date.

Table 5. Italian ryegrass control and wheat yield and test weight in the imazamox and adjuvant study near Moscow, Idaho in 2002.

Treatment[1]	Rate[2]	LOLMU control[3]	Wheat Yield	Wheat Test weight
	lb ai/A	%	bu/A	lb/bu
Imazamox + NIS + UAN	0.031 + 0.25 + 1	60	44	59
Imazamox + NIS + UAN	0.031 + 0.25 + 2.5	58	44	59
Imazamox + MSO + UAN	0.031 + 0.5 + 1	56	46	59
Imazamox + MSO + UAN	0.031 + 1 + 1	78	46	60
Imazamox + MSO + UAN	0.031 + 2.5 + 1	79	44	59
Imazamox + MSO + UAN	0.031 + 2.5 + 2.5	80	41	59
Imazamox + NIS + UAN	0.047 + 0.25 + 1	71	49	58
Imazamox + NIS + UAN	0.047 + 0.25 + 2.5	78	41	61
Imazamox + MSO + UAN	0.047 + 0.5+ 1	60	45	59
Imazamox + MSO + UAN	0.047 + 1 + 1	86	36	62
Imazamox + MSO + UAN	0.047 + 2.5 + 1	88	40	60
Imazamox + MSO + UAN	0.047 + 2.5 + 2.5	86	32	61
Diclofop	1	53	36	59
Untreated check	--	--	23	60
LSD (0.05)		18	NS	NS
Density (plants/ft^2)		51		

[1]NIS was a 90% nonionic surfactant (R-11). MSO was a methylated seed oil (Sun-It II). UAN was 32% urea ammonium nitrate.
[2]All adjuvants rates are in % v/v.
[3]July 12, 2002 evaluation date.

Influence of methylated seed oil on Italian ryegrass control with AE F130060 plus AE F107892. Richard P. Affeldt, Charles M. Cole, Carol A. Mallory-Smith, Jed B. Colquhoun, and Bill D. Brewster. (Department of Crop and Soil Science, Oregon State University, Corvallis, OR 97331-3002) Winter wheat was over-seeded with Italian ryegrass to prepare a study area at the OSU Hyslop Research Farm near Corvallis, OR. Herbicides were applied on December 9, 2001, to 4- to 5-leaf wheat and 3- to 4-leaf Italian ryegrass. Treatments were applied with a single-wheel, compressed-air plot sprayer that delivered 20 gpa through XR8003 nozzle tips at 20 psi. The herbicide AE F130060 was applied at three rates in a tank-mix with the crop safener AE F107892. The treatments were repeated with the addition of a methylated seed oil at 1% v/v. Visual evaluations were conducted on January 23 and April 17, 2002, and the wheat grain was harvested on July 31, 2002, with a small-plot combine. Soil characteristics and herbicide application conditions are presented in Table 1.

Table 1. Application conditions and soil type.

Soil type	Woodburn silt loam
pH	5.5
O.M. (%)	2.2
Condition	Muddy
Air temperature (F)	41
Soil temperature (F) (2 inch depth)	40
Relative humidity (%)	87
Wind	Calm

Italian ryegrass control improved as the rate of AE F130060 increased (Table 2). The addition of methylated seed oil caused a 5% to 7% increase in Italian ryegrass control and up to an 8 bu/A increase in wheat grain yield. The lowest rate of AE F130060 without methylated seed oil increased wheat grain yield by 29 bu/A over the untreated check.

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

		Italian ryegrass control		Wheat injury		Wheat grain yield
Treatment[1]	Rate	1/23	4/17	1/23	4/17	7/31
	lb ai/A	%				bu/A
AE F130060 + AE F107892	0.009 + 0.018	73	72	0	5	110
AE F130060 + AE F107892	0.011 + 0.022	68	79	0	6	112
AE F130060 + AE F107892	0.013 + 0.026	65	86	0	10	116
AE F130060 + AE F107892 + MSO	0.009 + 0.018	68	79	0	11	111
AE F130060 + AE F107892 + MSO	0.011 + 0.022	70	84	0	9	120
AE F130060 + AE F107892 + MSO	0.013 + 0.026	75	92	0	12	122
Untreated check	0	0	0	0	0	71
$LSD_{(0.05)}$		7	5		6	6

[1]MSO = SunIt II methylated seed oil.

Italian ryegrass and ventenata control in winter wheat with mesosulfuron. Traci A. Rauch and Donald C. Thill (Plant Science Division, University of Idaho, Moscow, ID 83844-2339) Two studies were established near Moscow, Idaho in winter wheat to evaluate Italian ryegrass (LOLMU) and ventenata (VETDU) control and wheat injury and yield with mesosulfuron. All plots were 8 by 30 ft arranged in a randomized complete block design with four replications. All herbicide treatments were applied using a CO_2 pressurized backpack sprayer calibrated to deliver 10 gpa at 32 psi and 3 mph (Table 1). In both experiments, wheat injury was evaluated visually on May 10, 2002. Weed control was evaluated visually on June 4 and July 12, 2002 in experiment one and on June 11 and 26, 2002 in experiment two. Wheat seed from experiment one was harvested on August 19, 2002. Experiment two was not harvested due to poor ventenata control throughout the study.

Table 1. Application and soil data.

	Experiment one	Experiment two
Application date	April 30, 2002	April 30, 2002
Wheat growth stage	2 tiller	2 tiller
Italian ryegrass growth stage	4 leaf	--
Ventenata growth stage	--	5 leaf
Air temperature (F)	64	66
Relative humidity (%)	45	40
Wind (mph, direction)	0	3, N
Cloud cover (%)	50	70
Soil temperature at 2 in (F)	55	55
pH	5.1	5.4
OM (%)	3.7	3.0
CEC (meq/100g)	18	18
Texture	silt loam	silt loam

In experiment one, no treatment visibly injured wheat (data not shown). The high rate of mesosulfuron with MSO controlled Italian ryegrass 95%, but did not differ from mesosulfuron at 0.0134 lb ai/A with NIS (75%) (Table 2). Italian ryegrass was suppressed 50 to 35% by the low rate of mesosulfuron and diclofop. Wheat yield did not differ among treatments but tended to be higher with mesosulfuron at 0.0134 lb ai/A. Wheat grain test weight was 60 lb/bu with all treatments, except the low rate of mesosulfuron (59 lb/bu). In experiment two, no injury was observed for any treatment (data not shown). Mesosulfuron treatments suppressed ventenata 49 to 66%, while diclofop generally had no activity on ventenata.

Table 2. Weed control and wheat yield and test weight in experiment one and two near Moscow, Idaho in 2002.

		Experiment one			Experiment two
Treatment[1]	Rate	LOLMU control[2]	Wheat yield	Wheat test weight	VETDU control[3]
	lb ai/A	%	bu/A	lb/bu	%
Mesosulfuron + MSO	0.0134 + 0.75 qt/A	95	60	60	49
Mesosulfuron + NIS	0.0134 + 0.5 %v/v	75	53	60	66
Mesosulfuron + MSO	0.0089 + 0.75 qt/A	50	45	59	58
Diclofop	1	35	46	60	2
Untreated check	--	--	44	60	--
LSD (0.05)		21	NS	1	20
Density (plants/ft^2)		54			78

[1]All mesosulfuron treatments included 32% urea ammonium nitrate applied at 2 qt/A, and a safener (mefenpyr-diethyl) at a 1:2 ratio of mesosulfuron to safener. The MSO (methylated seed oil) was Sun-It II and NIS (non-ionic surfactant) was R-11.
[2]July 12, 2002 evaluation date.
[3]June 16, 2002 evaluation date.

Longevity of volunteer wheat at Akron CO. Geoff Soper and Randy L. Anderson. (SEAGREEN Research, Pannetts Road, 4 R.D. Christchurch 8021, NZ; NGIRL, 2923 Medary Avenue, Brookings, SD 57006). These results call into serious question the common perception that wheat kernel viability in the soil will be less than one year. Instead a robust result for the 12 month longevity of the Akron volunteer wheat seedbank , conservatively estimated to average 6%, has been determined (p=0.75). A lowest possible limit to the average 12 month longevity of wheat volunteers was estimated at 3% (p=0.95), the best estimate itself amounting to 16%. The importance of the results so obtained to weed scientist, wheat breeder and crop agronomist cannot be over stressed.

The longevity fractions of volunteer wheat were calculated from Vona emergence count data obtained in the growing seasons subsequent to the wheat harvests of 1987 to 1989. Calculations were performed as follows. Total wheat crop grain numbers were calculated from wheat yields and 1000 kernel weights. Volunteer wheat seedbank ground-densities at wheat harvest were determined from crop grain numbers by assessing the yield fractions lost to the field by combine and by hailshatter. Longevity fractions were then calculated as the fractions of these seedbanks which emerged as volunteer wheat plants after 12 and after 14+ months in the field.

None of these four factors, i.e. yield, 1000 kernel weight, combine grainlosses, and hailshatter, were in fact measured directly, and each of them had to be estimated. Wheat harvest yields were estimated from the same year yields of Akron farm and of yield trials conducted within 500m of the emergence count sites. Wheat 1000 kernel weights were estimated from a series of same location trials conducted at and around this time, and from the yearly 1000 kernel weight statistics obtained by US Wheat Associates for the entire north-east CO and central-east CO wheat growing region north of Cheyenne Wells. Combine grainloss extent was estimated from analysis of on farm records of quite considerable UK surveys (detail given in companion report, this volume). Hailshatter extent was assessed from recalled severity, US Storm Prediction Centre hail records, incomplete Akron Station hail notes, and close questioning of onsite experts.

In order to rigorously assess the information to hand, longevity estimates were determined in three ways. By taking best estimates (BE) of all four of the above factors, by taking conservatively assessed estimates (CE) of these factors, or by taking extreme estimates (ME):

Values, consistent with known emergence count conditions, were averaged and assigned to BE estimates. The longevity values calculated using the best estimates (BE) of the four factors involved, were designed to provide an objective estimate of what the actual longevities may have been, and represent an averaging of the different results that might be legitimately inferred from the information to hand. There is no guarantee however that these BE longevity values did in fact occur. With this qualification then, the BE longevity estimates are intended to provide the best provisional idea of the volunteer wheat longevity values, that can be estimated from the available information.

The longevity values calculated using the extreme (ME) estimates of these factors were designed to determine the conceivable minimum value of volunteer-longevities, thus placing a lower limit (LL) on the volunteer wheat longevities, which the actually occurring longevities must certainly have exceeded. Low-extreme longevity estimates (ME) occur when the estimated volunteer wheat seed bank at harvest has it's maximal value, and thus when crop yield is maximal (ME), the 1000-kernel weight estimate is minimal (ME), the combine grainloss fraction is maximal (ME), and the hailshatter extent too is maximal (ME).

The CE longevity estimates were designed to provide conservative longevity estimates. Neither as high value and as partly assured as the BE longevity estimate values (which more or less represent the middle point of the possibilities), nor as low value and as certainly assured as the ME longevity estimates, the CE longevity estimates are intended to determine cautiously low longevity values with a high degree of assurance.

Where it was possible to legitimately assign probabilities, such as for combine grainloss or for crop yield, CE and ME estimates were determined at the p=0.75 and p=0.95 levels resp.. For the other factors, CE and ME estimates were assigned "even more" cautiously. Those readers who wish to pursue this matter in greater detail should contact the primary author for a full report, (gffspr.sgmrsrch@clear.net.nz).

In this manner three different types of useful information were determined.

At this point, it is worth noting that the simultaneous occurrence for all four factors of conservative (CE), or of extreme (ME), values, all at the same time, would have been most unlikely, and that the actual cumulative probabilities associated with CE and ME longevity estimates would be more extreme than that associated with the individual factors. That is, the CE and ME longevity estimates are more assured than the least justified of their four component factors.

Although space does not permit a detailed description of the lengthy estimation processes used, an example may prove instructive. For example, ME estimates of yields were assessed at 160% of same year Akron farm yield (p=0.95); ME combine grainlosses were assessed at 6% of crop yield (p=0.95); ME 1000 kernel weights were taken as 18.2 g for all three years (the minimum 1000 kernel weight found in the surrounding region over 1981 to 1990); while ME haillosses were assessed at 65%, 25%, and 25% of the crop yields for the 1987, 1988, and 1989 wheat harvests resp. (a yearly hailshatter of 5% to 10% occurs quite frequently; a yearly hailshatter of 25% might occur one year in ten; one of the above three harvest years may have incurred more considerable than usual hailshatter; two and possibly three of these years were recollected as having had unremarkable hailshatter).

The results of these calculations are provided (Figure, Table). The ME derived longevity values represent the conceivable minimum longevity of volunteer wheat occurring at Akron, and as such they place a lower limit (LL) on the actual Akron volunteer longevities occurring over this period. The one year longevity of the volunteer seedbank at Akron averaged 3% (ME or LL), 6% (CE), and 16% (BE); while the average longevity at 14 months averaged 1% (ME or LL), 2% (CE) and 5% (BE). All longevity results were averaged over three years (subsequent to the 1987, 1988, and 1989 wheat harvests), four blocks (replicates), two tillages (till and notill), four canopies (fallow, corn, sorghum, and proso-millet), and three samples (per treatment replicate). The robust nature of longevity results, the veracity of ME or LL longevity estimates, the usefulness of CE estimates, and the qualified representative nature of BE estimates are evident.

The longevity values found after 12 months in the field at Akron, are far in excess of the zero longevity results obtained after one year in the classical buried seed experiments of Duvel (1905) and Kjaer (1940); and of the 0.1 to 0.3% longevities obtained by Lewis (1958, pers. commun. 2002) after burial for one (and two) year(s). This difference appears to have arisen because the classical experiments, in fact, buried wheat grain which had been after-ripened in dry storage for six months and more, depending on experiment. Along these lines, after-ripened barley grain had zero longevity after six weeks burial, while the longevity after 12 months burial of freshly harvested barley grain amounted to some 3.4% (Rauber, 1987). Thus, the wheat longevities as observed in the classical studies would appear to have little bearing on volunteer wheat seedbank longevity, and seem to have had a prolonged and misleading influence on agronomic perception.

The longevity values obtained at 14+ months, are derived from emergence counts recorded after the sowing date of the next winter wheat crop in the Akron two year rotation, and are important for this reason. The implication being that significant genetic contamination of the succeeding wheat crop can and is likely to occur, at Akron and at other farm sites in the Central Great Plains of the US. Another implication is that wheat breeders or growers wishing to maintain genetic purity would be advised to observe a quarantine period of two years and more.

Finally it should be noted that the Akron longevities as determined from emergence counts, do not measure the extent of the volunteer seedbank remaining viable and dormant at the end of the emergence count period, and might therefore understate the actual Akron longevity values.

In summary, the Akron longevity results would appear to have far-reaching consequences for weed scientist, wheat breeder, crop agronomist, and farmer alike.

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Table: "Vona" volunteer wheat longevity fractions, Akron.

	Fallow Notill	Till	Av.	Canopy[1] Notill	Till	Av.	Cultivation Notill	Till	Av.
	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)
LL or ME estimates									
9 mo	8	2	5^-	5^+	2	4	6	2	4
12 mo	7	u[2]	4	4	u	2	5^-	u	3
14^+ mo	2	z[2]	1	1	u	u	1	u	1
CE estimates									
9 mo	17	3	10	11	4	7	13	4	8
12 mo	14	1	8	8	2	5^-	10	2	6
14^+ mo	4	z	2	2	1	2	3	1	2
BE estimates									
9 mo	47	9	28	30	10	20	36	10	23
12 mo	38	4	21	21	5^-	13	27	4	16
14^+ mo	11	u	6	5^+	3	4	7	3	5^-

[1] Canopy ~ average of corn, sorghum, and proso-millet treatments.
[2] u, z ~ *sic* "trace" values of < 1%; "u" rounds to unity, $0.5 \leq u < 1$; "z" rounds to zero, $0 < z < 0.5$.

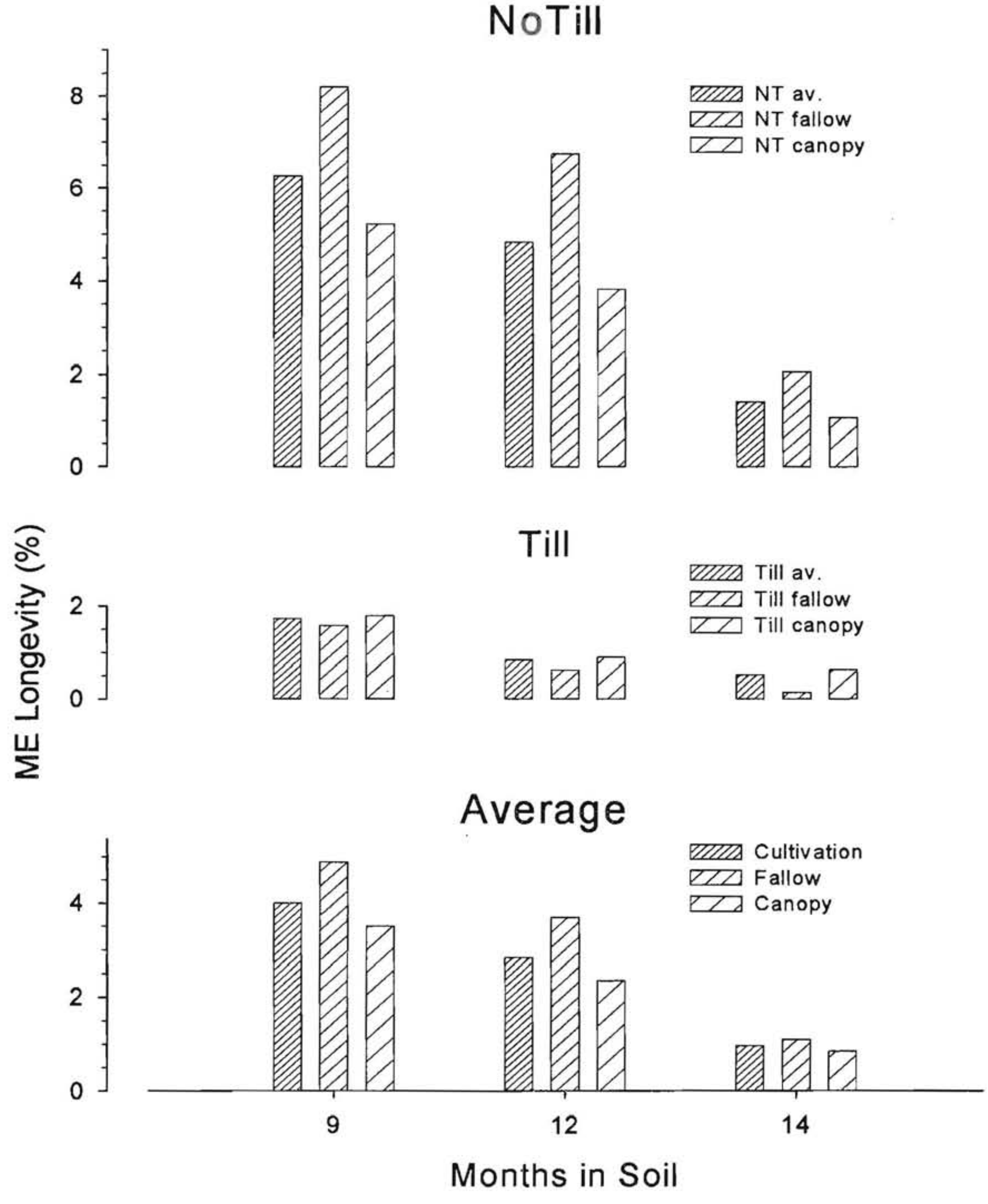

Figure. ME estimates of volunteer wheat longevities at Akron. A placing of lower limits on average volunteer wheat longevity values. Effects of average, till, notill, cultivation , fallow and canopy treatments.

BE, CE and ME longevities have very similar graph shapes, although their estimates are not strictly speaking proportional. In visual impact, more or less equivalent. CE longevity values are some 2 fold greater than the ME longevity values, with small variation (1.9 to 2.1). BE longevity values are some 5.4 fold greater than the graphed ME values, with more variability (4.9 to 5.8). Comparative BE, CE, and ME longevity values are given in Table.

Combine grainloss extent of wheat. I. Estimating average and extreme grainloss fractions. Geoff Soper. (SEAGREEN Research, Pannetts Road, 4 R.D. Christchurch 8021, NZ). All else equal, the scale of any volunteer wheat problem is directly related to the extent of wheat grainlosses to the field at harvest time. This report examines the likely extent of wheat grainlosses as incurred by combine harvester. In average case, these amount to 2% of wheat crop yield, with extreme losses of 6% possible (p=0.95).

Literature mention of combine wheat grain losses is restricted to Japanese measurement and citation of other Japanese results (Komatsuzaki ε Endo, 1996), and to a chain of citations which invoke a series of little known but fairly extensive UK surveys (Marshall *et al* 1989; Cussans, 1978; Hughes, 1974; Anon, 1973; and Anon 1971). Because of a number of mistakes that have arisen in this sequence, and because some of the implications of the original surveys were not fully realized, the original onfarm records have been reanalyzed with a view towards rigor and useful context.

To this end, on-farm crop yields were calculated from average combine rate of work (acres/hr) and average combine grain-threshing rates (tons/hr), as were determined for each onfarm case. With yields known, combine grainlosses as fractions of yield could then be calculated. The distributions of these combine grainloss-fractions for wheat were notably skew (refer Figure). On the basis of graph and curve-fit comparisons, it was judged that the actual empirical distributions were in fact neither normal nor lognormal, but were somewhere in between the two, more nearly approaching lognormal. Because of this assessment, calculations of grainloss likelihoods were undertaken for both assumed normal and assumed lognormal distributions, and the results interpreted with the above point in mind. Grainloss likelihoods were also assessed for the actually occurring empirical distributions themselves as an additional check. The results of these analyses are given in Table.

Wheat incurred an average harvester induced grainloss fraction of 1.9% in 1969, 2.2% in 1971, and 2.0% over both 1969 and 197, as averaged over 52, 22, and 74 onfarm cases respectively. For grainlosses sampled over both 1969 and 1971, an average of 2.0% was obtained, a median value (p=0.50) of 1.6%, a conservatively high value (p=0.75) of 3.2%, and a significance threshold value (p=0.95) of 6.0%. As a general rule, slightly lower results were obtained for 1969, the most extensively surveyed year, while generally higher results were obtained for the more sparsely sampled 1971 wheat harvest. Notably, an extreme significance threshold (p=0.95) value of 7.7% was generated for an assumed lognormal distribution of the 1971 grainloss fractions.

As a check on interpreted results, the observed yearly grainloss fractions and yearly log-transformed grainloss fractions were ordered and assigned Hazen probabilities (Table; Thode, 2002), and the conservative and significance-threshold values calculated directly from the empirical distributions. From these latter considerations, a median value (p=0.50) of 1.8% was obtained in 1971, a conservatively high (p=0.75) grainloss of 3.9% was indicated for 1971, and a significance threshold (p=0.95) value of 6.0% was found, again in 1971.

In summary then, UK survey data indicates an average grainloss of 2.0%, a median grainloss (p=0.50) value of 1.8%, a conservatively high grainloss (p=0.75) of 3.9%, and a significance threshold grainloss (p=0.95) of 6.0%. This last significance value is a matter of interpretation, discarding the high 7.7% value generated for an assumed-lognormal-distribution in 1971, in favour of the value assessed from the ordered empirical distribution and assigned Hazen probabilities.

If these results are taken as typical of combine grainloss extent in other years and other regions, then likely (average), median (p=0.50), conservatively high (p=0.75), and extreme (p=0.95) volunteer wheat seedbank renewal via combine grainlosses at harvest, might be estimated from crop yield and 1000 kernel weight, and the scale of potential volunteer problems better defined. In report II of this series, such average and extreme volunteer wheat seedbank analysis has been undertaken for a number of wheat growing locations and regions.

Table. Combine wheat grainloss fraction statistics.

		1969	1971	1969+71	1969	1971	1969+71
Sample		Grainloss fractions			Log (grainloss fraction) s		
		(%)	(%)	(%)	(%)	(%)	(%)
Statistics							
	mean	1.9	2.2	2.0	1.4	1.6	1.5-
	std. dev.	1.7	1.9	1.7	2.3×	2.4×	2.3×
	(n)	(52)	(22)	(74)	(52)	(22)	(74)
Assumed distributions		Normal			Lognormal		
		(%)	(%)	(%)	(%)	(%)	(%)
Confidence limits							
UL [1]	p=0.50	1.9	2.2	2.0	1.4	1.6	1.5-
	p=0.75	3.1	3.6	3.2	2.5+	3.0	2.6
	p=0.95	4.7	5.5+	4.9	5.7	7.7	6.0
Empirical distributions		Ordered grainloss fractions			Ordered log(grainloss fraction)s		
		(%)	(%)	(%)	(%)	(%)	(%)
Hazen p assignment [2]							
	p=0.50	1.6	1.8	1.6	1.6	1.8	1.6
	p=0.75	2.3	3.9	2.5+	2.3	3.9	2.5+
	p=0.95	4.4	6.0	4.5-	4.4	5.7	4.5-

[1] UL ~ upper limit at designated p value. Student t-test value modified for comparison of an observed "x" with an average calculated from n observations, $t_x = t\ \mathrm{sqrt}(1+1/n)$.

[2] p_i ~ the cumulative probability assigned the i-th ordered grainloss value ... Hazen $p_i = (i - 0.5) / n$, ... (Thode, 2002). Other methods of assigning such probabilities, include ... Alt. $p_i = i / (n+1)$, which is the other most commonly used method, and ... XL $p_i = (i-1) / (n-1)$, a fairly circumscribed method used by MS Excel. These latter two methods are characterized by built-in biases towards exaggeration and understatement respectively of the empirical distribution values associated with significant probabilities.

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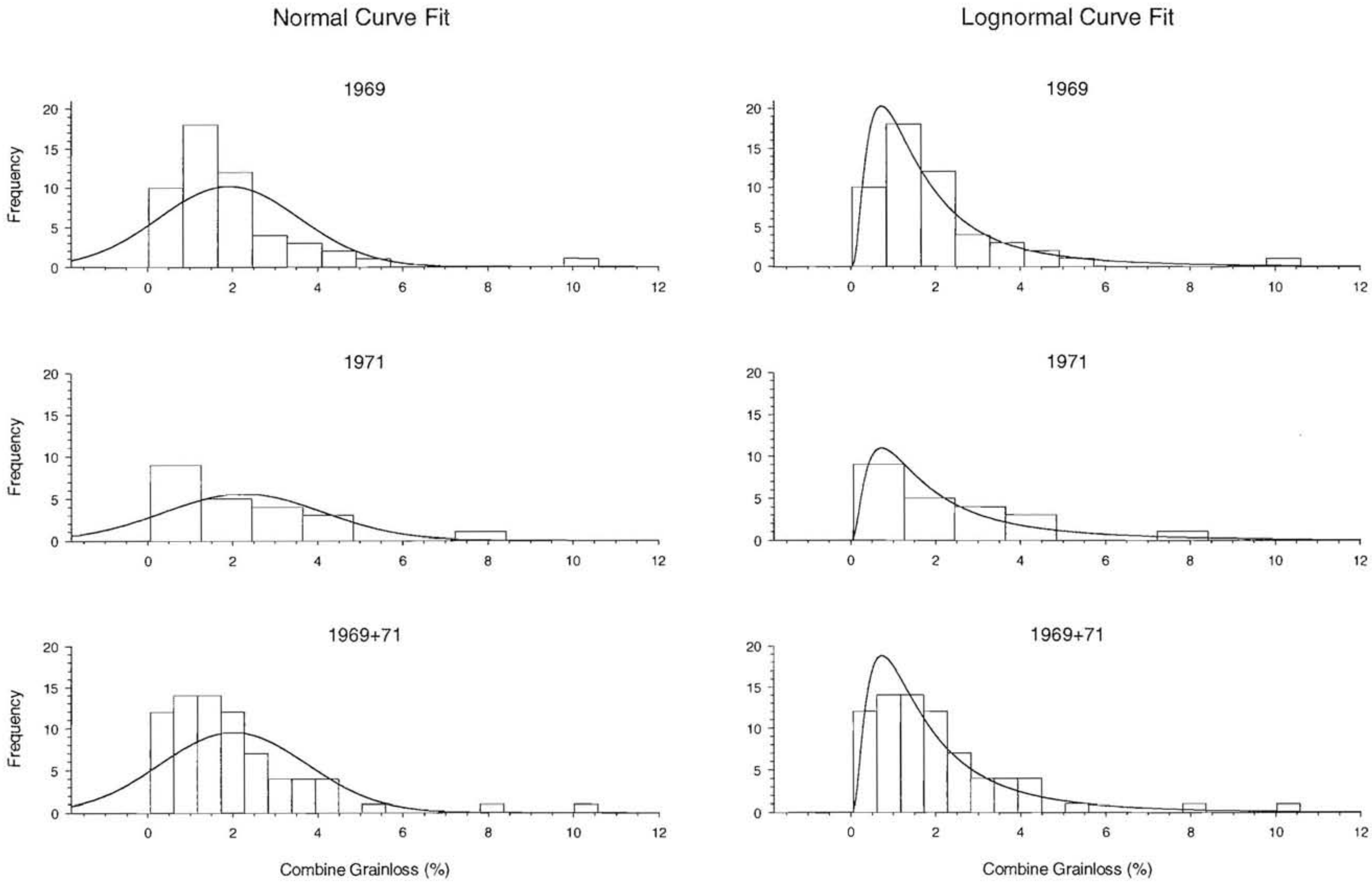

Figure. Distributions of yearly combine wheat grainloss fractions. Fit of the normal and lognormal curves defined by grainloss fraction (normal) and log grainloss fraction (lognormal) sample means and standard deviations.

Combine grainloss extent of wheat. II. Variabilty with location, yield, 1000-kernel weight, and loss fraction. Geoff Soper. (SEAGREEN Research, Pannetts Road, 4 R.D. Christchurch 8021, NZ). In the first report of this series, analysis of wheat combine grainloss records of UK survey indicated that some 2% of the wheat crop yield was lost by combine harvester to farmer field, on the average, and that most such wheat grainlosses by combine harvester were less than 6% of crop yield, at a cautiously assigned p=0.95 level (95% of onfarm cases). Assuming that these UK combine loss fractions hold more or less true for combine-harvester operation in other years and other regions, the numbers of grains likely to be lost to farm field might be determined from wheat crop yield and 1000-kernel weights (TKW) at specific location, the likely extent of the volunteer wheat seed-bank estimated, and in this manner the scale of potential volunteer problems better understood. Estimation of the likely scale of volunteer wheat problems at various sites is undertaken in this report.

Table 1 summarizes the likely grainloss numbers lost to the field by combine-harvester, as predicted for various sites around the world. At UK, Japanese and NZ locations, average wheat grainlosses are estimated at some 280 kernels m^{-2}, with extreme values up to 850 kernels m^{-2} possible. At Akron CO, grainloss estimates of this extent are only likely in highest yielding years. In average-yielding year, combine-harvester induced ground-densities at Akron are estimated to be 30% lower, with 220 kernels m^{-2} likely, and with ground-densities of up to 650 kernels m^{-2} possible on more extreme occasion.

Table 2 explores the differences in harvester-induced wheat-seed ground densities that might occur at the same site or region. Likely average ground-densities might be expected to vary by up to 50 to 80% depending on yield and TKW swing. At Akron CO, it is estimated that average combine-induced ground densities might range from 180 to 280 kernels m^{-2}. In the Canterbury region of NZ, the likely average values might range from 200 to 360 kernels m^{-2}. The relatively lower Akron values, appear to be related to the fact that although grain-yields and kernel-sizes are both much less at Akron, the proportional difference in grain yields is greater than the proportional difference in kernel-sizes.

Higher combine-induced ground-densities occur in regions of greater yield capacity. The higher-yielding larger-grain CA (California) HRWW (hard red winter wheat) crop has higher values of harvester-induced ground-density estimates, than those of the lower-yielding smaller-grain 7-State (KS, OK, TX, CO, NE, MT, SD) HRWW crop (refer Figure). For the 1990 wheat harvest, the average yield for the CA HRWW crop was about 5.3 t ha^{-1}, more than twice as high as the average 7-State HRWW yield of 2.4 t ha^{-1} (Table 2). In this year, the average 1000-kernel weight (TKW) for the CA crop of around 36g was nearly 50% higher than the 25g average 7-State value. In 1990, the estimated ground-densities induced by harvester amounted to around 290 wheat kernels m^{-2} in average CA HRWW field, and to around 190 wheat kernels m^{-2} in the average 7-State HRWW field. Similar results occurred over the 1991 to 2000 harvests.

The combine-harvester induced ground-densities over the 1990 to 2000 harvest period for the various US wheat classes are displayed in Figure, while Table 3 provides their average values over this period. Over these 11 years, average combine ground-density estimates were as little as 110, 140 and 170 kernels m^{-2} for N. Great Plains Durum, N. Great Plains HRSW (hard red spring wheat), and Midwestern HRWW (hard red winter wheat) respectively. Over this same period, ground-density estimates averaged 230, 250, 260, and 270 kernels m^{-2} respectively for the SRWW (soft red winter wheat) of the E. States, the SWW (soft white wheat) of the Pacific N.W., the HRWW (hard red winter wheat) produced in CA, and the Durum wheat produced in the Pacific S.W..

All else equal. the two factors, wheat crop yield and wheat grain-size as measured by wheat 1000-kernel weight, strongly influence estimated combine-induced ground-densities. Of these two factors, the effect of grain yield is the more considerable.

As various Akron trials indicated, quite severe yield stresses made little if any difference to 1000-kernel weights among various yield-affecting treatments. Thus one might expect that grain-size would not vary greatly at neighbouring locations, all else equal. At the same time one might expect both yield and 1000-kernel weights to increase in a good year, and both to decrease in a poor year. Although this latter observation might be true often enough, it is definitely not true in all cases. For both the CA and the 7-State HRWW crops, the 1990 yields were higher on average than the 2000 yields, yet average 1000-kernel weights were lower in 1990.

In Rothamsted experiment, increasing the light intensity or lowering the temperature, over one or both of two consecutive16 day periods after anthesis, increased the final 1000-kernel weights of wheat. These effects were found to be generally independent of each other and additive (Thorne ε Ford, 1971). In a similar trial, 1000-kernel weights were decreased for plants grown at warmer temperatures over the first 14 days after head initiation, although yields were unaffected. The possible effect on final TKW of water shortage or sufficiency over these periods was not examined, and remains unknown.

In summary then, in regions of Japan, UK, and NZ, combine harvest operations are estimated to incur average wheat grainlosses of 280 kernels m^{-2}. In the US, estimates of combine-induced ground-densities were generally lower. For example, US combine losses for the HRWW wheat class are estimated to average 260, 220 and 170 wheat kernels m^{-2} for CA, Akron CO, and the 7-State Midwestern growing regions (or location) respectively.

An eleven year comparison of combine-induced ground-density estimates for US wheat class, indicates that in the Pacific SW region they were generally slightly higher than those of the Pacific NW, which themselves were slightly higher than those of the Eastern States, on the average. The Midwestern ground density estimates were substantially lower. Lowest ground density estimates were found for wheat grown in the N. Great Plains.

Onfarm values of up to three times the average yearly values are quite possible ($p=0.95$). Generally speaking, regions of greater yield capacity had higher combine induced wheat kernel ground densities.

Both grain yield and grain size (TKW) affected estimate value, with the effect of regional or site yield capacity more dominant. Factors affecting TKW are incompletely understood. However, higher temperatures and lower light intensities over the period following anthesis can decrease crop TKW and, depending on the size and direction of any concurrent yield change, might increase volunteer wheat ground densities.

Finally, it should be noted that hailshatter might be considerable in some US regions, and in these regions it too will affect the scale of volunteer wheat problems. An enquiry into hailshatter extent with US region is underway, but might not be completed for report in this volume. In this regard, reader observations on wheat hailshatter extent in their growing regions would be welcomed. The author may be contacted at gffspr.sgrnrsrch@clear.net.nz.

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Table 1. Variability of combine grainloss estimate with site, yield, TKW [1] and loss-fraction.

		yield	TKW	grainloss fractions 2%	6%	
		(t ha^{-1})	(g)	(kernels m^{-2})		
UK	ADAS survey	4.4	50	180	550	Soper (unpubl.), Anon.a (1971, 1973)
UK	Rothamsted	6.6	49	270	800	Bacon *et al* (1998), Thorne ε Ford (1971)
Japan	Ibaraki	4.6	33	280	850	After Komatsuzaki ε Endo (1996)
NZ	Canterbury	7.0	48	290	900	Midrange, local consensus
US	Akron high yield	3.9	28	280	850	Anderson (1984, 1993), Halvorson *et al*
	mid yield	2.7	25	220	650	(1994), Merle Vigil (pers. commun.)

[1] 1000-kernel weight.

Table 2. Regional variability of combine grainloss estimates.

	category	yield	TKW [1]	grainloss fractions 2%	6%	
		(t ha^{-1})	(g)	(kernels m^{-2})		
NZ, Canterbury	high range	10.0	55	360	1100	local consensus
	mid range	7.0	48	290	900	
	low range	4.0	40	200	600	
US, Akron	high range	3.9	28	280	850	Anderson (1984, 1993),
	mid range	2.7	25	220	650	Halvorson *et al* (1994), and
	low range	2.0	22	180	550	Merle Vigil (pers. commun.)
US, HRWW [2]	CA av.1990	5.3	36	290	880	Anon.b (1992), Anon.c (1991)
	av.2000	4.9	38	260	770	Anon.b (2002), Anon.c (2001)
US, HRWW	7-State av.1990	2.4	25	190	580	Anon.b (1992), Anon.c (1991)
	av.2000	2.3	27	170	520	Anon.b (2002), Anon.c (2001)

[1] 1000-kernel weight. [2] hard red winter wheat.

Table 3. Combine grainloss ground-density estimates for US wheat class, averaged over 1990 to 2000. [1]

loss fraction	durum N Great Plains	hard red spring N Great Plains	hard red winter Mid W	soft red winter E States	soft white [2] Pacific NW	hard red winter CA	durum Pacific SW
	(kernels m^{-2})	(kernels m^{-2})	(kernels m^{-2})	(kernels m^{-2})	(kernels m^{-2})	(kernels m^{-2})	(kernels m^{-2})
2%	110	140	170	230	250	260	270
6%	320	420	510	680	740	770	800

[1] after (Anon.b, 1992, ..., 2002; Anon.c, 1991, ..., 2001). [2] uses USWA production, NASS yields, assumes 80% winter wheat.

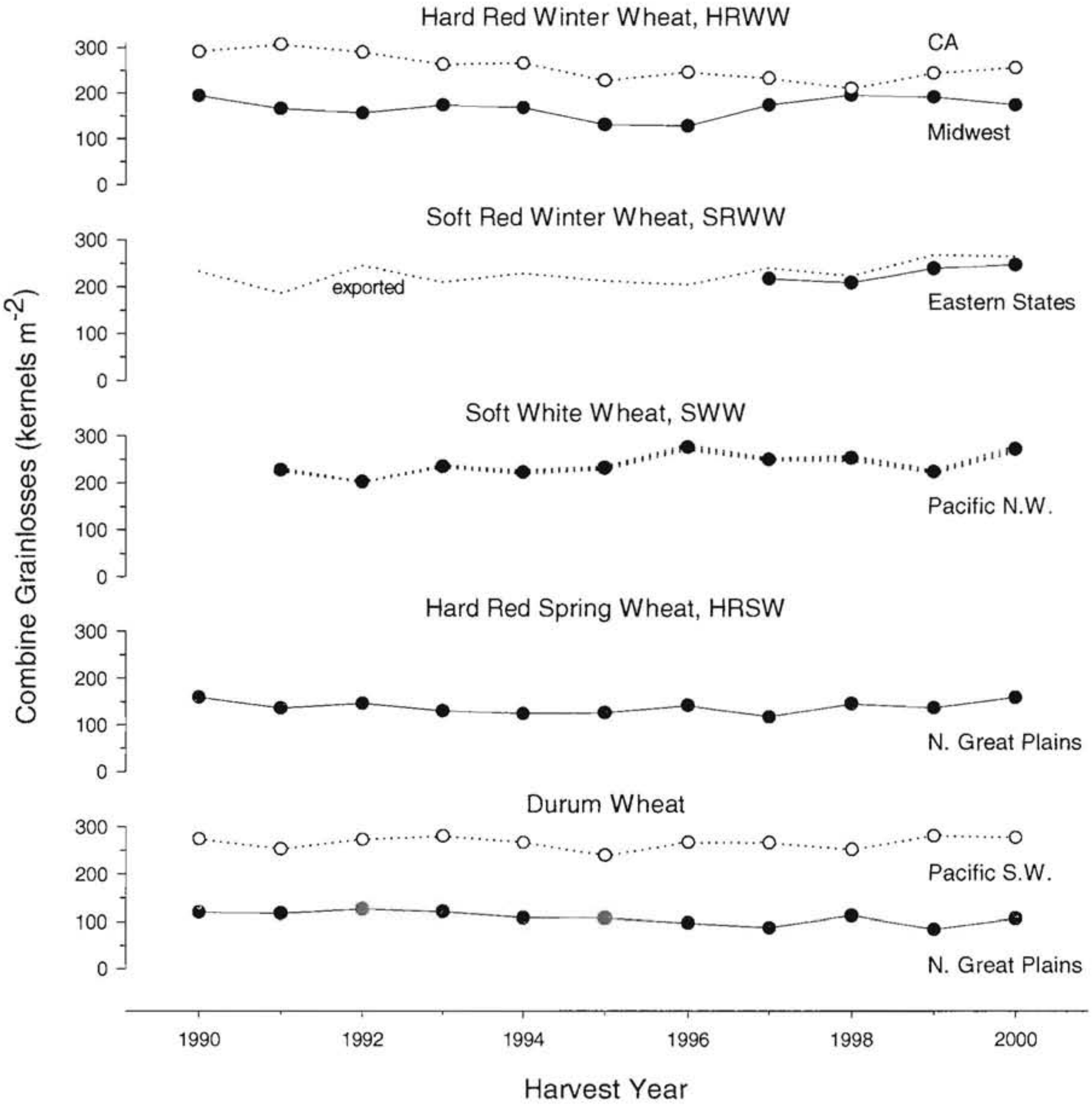

Figure. Average combine grainloss estimates for US wheat class over the harvest years of 1990 to 2000. Wheat 1000 kernel weights and bushel weights were taken as the harvest averages determined by US Wheat Associates (USWA) for the various wheat classes. Wheat class yield calculations follow USWA use of NASS data.

The HRWW (hard red winter wheat) crop is mostly produced by the seven Midwestern states (KS, OK, TX, CO, NE, MT, SD) plus CA; the SRWW (soft red winter wheat) crop by 16 Eastern states, AL, AR, GA, IL, IN, KY, LA, MD, MI, MS, MO, NC, OH, SC, TN, VA; the SWW (soft white wheat) crop by three Pacific N.W. states, WA, OR, and ID; the HRSW (hard red spring wheat) crop by four states of the N. Great Plains, MT, ND, SD, and MN; and the US durum crop by two states of the Pacific S.W. (CA, AZ) and by two states of the N. Great Plains (MT, ND). Roughly speaking, these produce some 97, 97, 90, 94 and 99% respectively of the US total for that wheat class, although these percentages alter with year. Qualifying statements made by USWA for wheat class may apply.

Graphed SWW values use USWA production estimates and NASS yields, assuming 70 to 90% was grown as winter wheat. For the SRWW class, USWA harvest data was incomplete. The export-cargo derived graph has been added.

Combine grainloss extent of wheat. III. Variability across combine transect. Geoff Soper. (SEAGREEN Research, Pannetts Road, 4 R.D. Christchurch 8021, NZ). In the first report of this series, analysis of combine induced wheat grainloss records, of UK survey, indicated that on the average some 2% of the wheat crop yield was lost to farm field, and that most such wheat grainlosses were less than 6% of the crop yield, at a cautiously assigned p=0.95 level (95% of onfarm cases). In the second report of this series, these results were applied to predict the likely average and extreme wheat grain ground-densities induced by combine, at differing sites and regions. However as many farmers can attest, volunteer densities usually alter with position across combine transect. This report examines the systematic variability in wheat grainlosses that occurs behind combine harvester, as indicated by the strike (emergence flush) of volunteers immediately after harvest. Some derivative thoughts on the better design of volunteer wheat experiment, and on the redesign of harvester to minimize the volunteer wheat seedbank, are also offered.

To this end, a sampling of onfarm volunteer wheat strike across combine transects was undertaken some four weeks (25 days) after grain harvest, using a 1m × 1m sampling grid subdivided into a 10 cm × 10 cm lattice. The combine harvester used was an axial-flow 1992 model with 6.1 m (20-foot) cut and a 1.2 m (4-foot) wide rear trash outlet. The axial-flow models create coherent "tubes" of straw and smaller trash, thus tending to concentrate trash and grain passing through the combine into narrow strips by reducing the trash settling width and the extent of any wind spread. Trash had not been chopped and spread behind harvester, and had been burnt, baring the soil for ploughing and later autumn sowing. Conditions were opportunistically optimal for volunteer strike and volunteer-count measurement. Counts were undertaken in meter wide transects across four combine widths at three locations separated by 50 m (Figure). More extensive sampling was prevented by the completion of the ploughing operation in progress.

The volunteer counts across combine transects are provided in Figure. As was visually apparent from the green strips occurring across the field along the lines of trash outlet, volunteer numbers were concentrated in narrow strips. These strips were mostly of about 1m wide, and sometimes less, but on patchy occasion spreading out into strips of up to 2m and sometimes 3m wide. In the intervening transect portions between trash outlet strips, volunteer counts were much reduced and similar in magnitude to each other. At these latter positions, there was in fact a fine-scale tendency towards events of single isolated volunteers or of isolated several-volunteer clusters.

Volunteer wheat extent systematically varied some 15 fold over combine-wide transect. For particular combine transect, the same pattern occurred but to a different degree, this systematic variation ranging from 6 to 37 fold.

Averaged over 12 combine transects, densities of 164, 32 and 11 volunteers m^{-2} were recorded over the central meter, over the meter downwind, and over the other four meters or so of the actual combine cut respectively. Assuming that the volunteer densities were in direct proportion to the combine-induced grainlosses four weeks earlier, this points to a combine imposed pattern on volunteers. In this instance some 15 fold, and 3 fold more kernels were distributed by combine-harvester over the central meter and downwind meter positions than were distributed over the other four meters odd, out of the actual combine cut.

There was also recurring evidence of greater grainlosses arising at the crop shearing end of the cutter-bar, compared to those arising at other cutter bar positions (see Figure).

Combine grainlosses of wheat can be subdivided into those that occur at cutter and reel, and those that pass through the header and emerge at rear trash outlet. In survey of UK wheat crop harvests, these front and rear combine grainloss components were fairly similar on average, although either might amount to insignificant or to major fractions of the total combine grainlosses in particular onfarm case (Anon, 1971, 1973; Soper, unpubl.)

Logically speaking, combine front losses might be expected to be more or less uniformly spread over combine intake width. If so, and if also grainlosses at combine front equalled those at combine rear, then the 6.1m (20-foot) and 1.2m (4-foot) cutter and trash-outlet combine dimensions, would ensure that grainlosses were six fold more concentrated central to combine cut than at non-central positions. The real situation is more complicated, in that the intake in the current onfarm case averaged around 5.7m (=18.6 feet), the variable effects of wind in spreading rear grainlosses, the fact that the trash tube for a high cut crop may not necessarily be as much as 1.2m (4-foot) or even 0.9m (3-foot) wide, and that grainlosses occurring at front and rear may not have been equal or nearly equal.

In general case, the condition of the crop at harvest, and the operation of combine harvester will both affect this pattern. Four other factors also systematically affect grainloss concentrations on the ground, and the consequent volunteer occurrence pattern. Firstly, there is the effect of the relative losses incurred at combine front and combine rear (by the impact of cutter and reel, and by the efficiency of the threshing mechanisms, respectively). Secondly, there is the concentration effect afforded by the relative widths of combine cut and combine trash outlet. Thirdly there is the effect of subsequent wind spread of trash, and of any mechanical trash dispersal or removal. Fourthly there is likely to be an effect of combine design type.

In the observed case presented here, approximately 25% of the total grainlosses arose at the combine front and approximately 75% of the total arose at combine rear. That is, the rear (threshing efficiency) grainlosses were some three fold greater than those incurred at the combine front. At the same time, the actual-cut width to trash-outlet concentration factor affecting rear grainloss concentrations, amounted to some 4.5 fold. In the observed example, wind spread was not a major factor, and trash was not mechanically dispersed or removed.

Trash chopping and dispersal behind harvester reduces the extent of systematic variation of volunteers imposed by combine-harvester, but does not remove it. In the observed case, a uniform rear-grain dispersal over say 2.8m (9.3 feet) would still have resulted in a seven fold systematic grainloss variation across the average combine width.

A strong implication for any realistic field studies of wheat volunteers, is that sampling would be best undertaken in transects across the direction of combine travel, in sampling units of exact numbers of actual combine cut-widths wide. Or failing this, a less labour-costly equivalent method justified. "Inverse sampling" or "Poisson-distribution" orientated methods of weed-sampling, such as were used to good effect by Felton *et al* (1994) and Wicks *et al* (2000) for numerous weed species, may not be appropriate for estimating volunteer wheat densities determined by combine. The limitations of measuring volunteer wheat occurrence via ordinary random samples may not be as great, but such measurement would still require more care than usual, in that more samples might be needed.

Finally, recognition of the combine grainloss concentration pattern imposed on wheat volunteers offers opportunities for new methods of volunteer wheat control. One that comes to mind, is the use of the weed spot-spraying techniques developed by Felton *et al* (1991), possibly redesigned to take advantage of concentrated volunteer wheat occurrence in fairly well defined strips. Another might be to restrict a tillage method to the volunteer-dense strip. A lower release by combine of trash "fines" over a more confined outlet width could increase strip-till effectiveness.

There might also be a window of opportunity for combines redesigned to retain small trash and associated grain off the field, rather than dispersing them with the larger trash. This with redesign minimizing the numbers of grains retained in the partly threshed ears attached to the larger trash. Such higher grain, higher protein, higher feed value "seconds chaff" might have commercial value, which might offset the extra handling cost involved, or some of it. With the advent of herbicide resistant wheat volunteers, such methods may merit revival or redevelopment.

Thought too might be given to the killing or damaging of the volunteer grains within small trash before dispersal. E.g. a grinding of "fines", through rollers or otherwise, might damage the grain or seed coat sufficiently to promote either immediate decay or immediate germination in any unkilled wheat kernels remaining. This method would seem to offer considerable promise at low cost. More so, for regions where hailshatter is not a significant factor.

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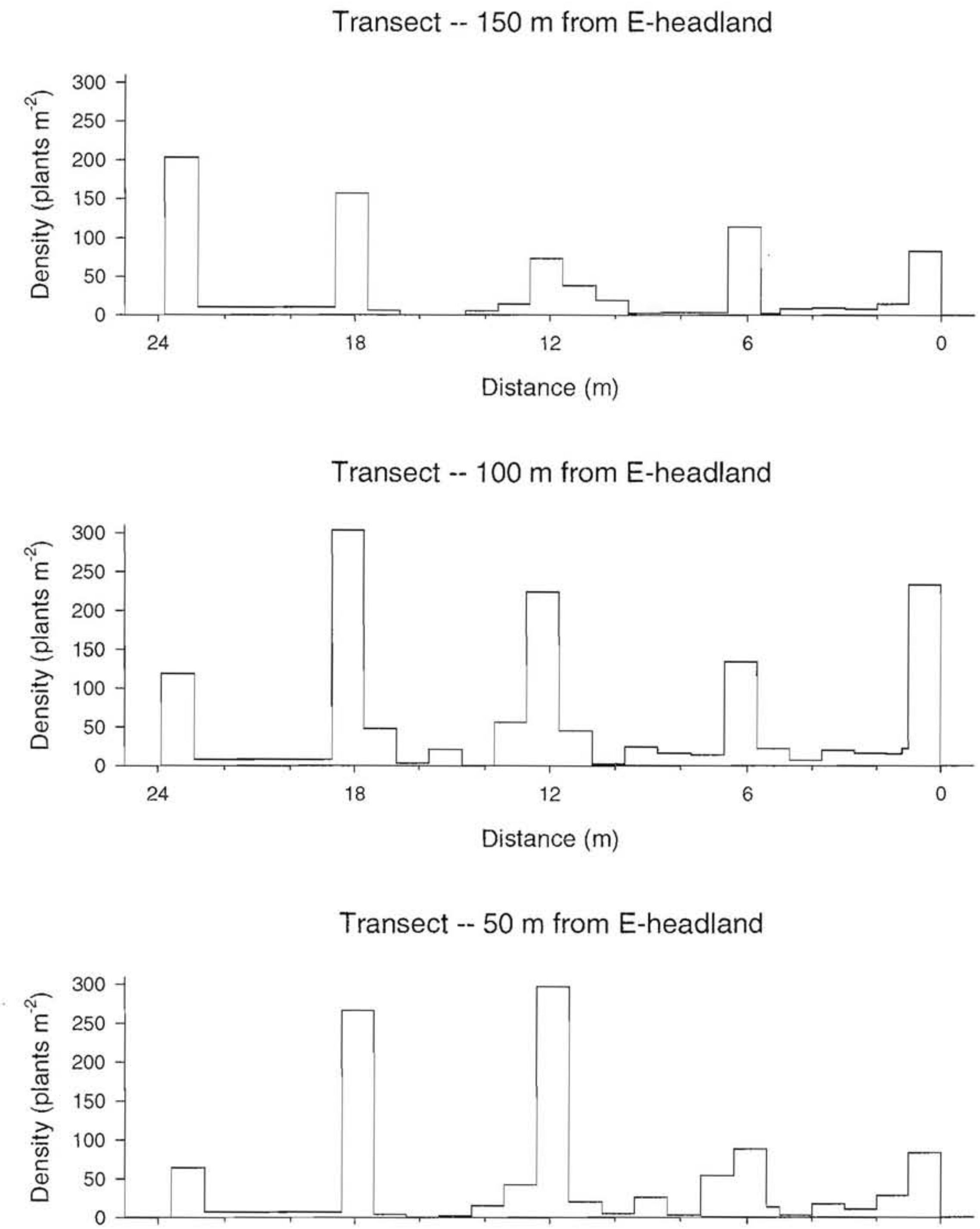

Figure. Volunteer wheat density across combine-width transects, nearly four weeks after harvest. An axial-flow 1992 combine was used with 6.1m (20-foot) cut, and 1.2 m (4-foot) trash outlet. Straw and stubble had been burnt.

Interrupted windgrass control in winter wheat. Joan Campbell and Donn Thill. (Crop and Weed Science Division, University of Idaho, Moscow, Idaho 83844) Two experiments were established in winter wheat near Deary, Idaho to evaluate interrupted windgrass control. The objective of the first experiment was to compare efficacy of various graminicides on interrupted windgrass. The objective of the second experiment was to determine broadleaf herbicide antagonism to clodinafop. Herbicides were applied with a CO_2 pressurized backpack sprayer delivering 10 gpa at 3 mph and 32 psi (Table 1). The experimental design was a randomized complete block with three replications and 8 by 30 ft experimental units. Weed control was evaluated after interrupted windgrass headed. Both experiments were oversprayed with thifensulfuron/tribenuron for broadleaf weed control which suppressed interrupted windgrass. Wheat was not harvested since interrupted windgrass competition was low.

Table 1. Environmental and edaphic conditions.

Experiment	One	Two
Application date	April 8, 2002	April 21 , 2002
Windgrass growth stage	1 to 2 leaf	2 leaf to 2 tiller
Wheat growth stage	3 leaf	4 leaf
Air temperature (F)	49	60
Soil temperature at 4 inches (F)	40	50
Relative humidity (%)	64	56
Cloud cover (%)	0	100
Soil moisture	High	High

Interrupted windgrass control was 92% or greater with all treatments except metribuzin (87%) and clodinafop (80%) in the first experiment (Table 2). In the second experiment, interrupted windgrass control was best (95%) with fenoxaprop/safener + thifensulfuron + MCPA ester and this treatment was better than all clodinafop treatments containing broadleaf herbicides other than thifensulfuron (Table 3). Interrupted windgrass control was better with treatments containing clodinafop alone or clodinafop and thifensulfuron (85%) compared to clodinafop plus the other broadleaf herbicide combinations (45%) (orthoganol contrast P>0.0001).

Table 2. Interrupted windgrass control with graminicides.

Treatment[1]	Rate	Interrupted windgrass control
	lb ai/A	%
Untreated	0	--
Flucarbazone	0.04	98
Propropcarbazone	0.04	98
Sulfosulfuron	0.031	98
Imazamethabenz	0.47	98
Imazamethabenz + thifensulfuron	0.47 + 0.0234	96
Fenoxaprop/safener	0.083	92
Clodinafop	0.05	80
Tralkoxydim	0.24	98
Metribuzin	0.25	87
LSD (0.05)		7

[1] Flucarbazone and imazamethabenz treatments were applied with 0.25% v/v nonionic surfactant (R-11). Propropcarbazone and sulfosulfuron were applied with 0.5% v/v R-11. Clodinafop was applied with 0.32 qt/A crop oil concentrate (Score). Tralkoxydim was applied with 0.5% v/v crop oil concentrate plus nonionic surfactant (Supercharge).

Table 3. Interrupted windgrass control with clodinafop alone and with broadleaf herbicides.

Treatment[1]	Rate	Interrupted windgrass control
	lb ai/A[2]	%
Untreated	--	--
Clodinafop	0.05	87
Clodinafop	0.063	72
Clodinafop + MCPA ester	0.05 + 0.375	65
Clodinafop + MCPA ester	0.063 + 0.375	38
Clodinafop + dicamba	0.05 + 0.094	33
Clodinafop + dicamba	0.063 + 0.094	40
Clodinafop + clopyralid/2,4-D	0.05 + 0.607	53
Clodinafop + clopyralid/2,4-D	0.063 + 0.607	38
Clodinafop + dicamba dimethyl amine	0.05 + 0.094	40
Clodinafop + dicamba dimethyl amine	0.063 + 0.094	57
Clodinafop + MCPA amine	0.05 + 0.375	37
Clodinafop + MCPA amine	0.063 + 0.375	63
Clodinafop + prosulfuron	0.05 + 0.0179	29
Clodinafop + prosulfuron	0.063 + 0.0179	37
Clodinafop + bromoxynil/MCPA	0.05 + 0.5	48
Clodinafop + bromoxynil/MCPA	0.063 + 0.5	43
Clodinafop + 2,4-D amine	0.05 + 0.375	57
Clodinafop + 2,4-D amine	0.063 + 0.375	40
Clodinafop + thifensulfuron + MCPA ester	0.05 + 0.028 + 0.375	93
Clodinafop + thifensulfuron + MCPA ester	0.063 + 0.028 + 0.375	87
Clodinafop + thifensulfuron/tribenuron + MCPA ester	0.05 + 0.028 + 0.375	90
Clodinafop + thifensulfuron/tribenuron + MCPA ester	0.05 + 0.028 + 0.375	82
Fenoxaprop/safener + thifensulfuron + MCPA ester	0.083 + 0.028 + 0.375	95
LSD (0.05)		28

[1]All treatments with clodinafop were applied with 0.8 pt/A crop oil concentrate (Score). Fenoxaprop/safener + thifensulfuron + MCPA ester was applied with 0.25% nonionic surfactant (R-11).
[2]MCPA, dicamba, clopyralid, and 2,4-D rates are expressed as lb ae/A.

Soil persistence of ethametsulfuron. Janice M. Reed and Donald C. Thill. (Plant Science Division, University of Idaho, Moscow, ID 83844-2339) Studies were conducted near Nezperce and Potlatch, Idaho to evaluate soil persistence of ethametsulfuron. Plots were 16 by 30 feet arranged in a randomized complete block with four replications. Ethametsulfuron treatments were applied to spring canola with a CO_2 pressurized backpack sprayer calibrated to deliver 10 gpa at 30 psi and 3 mph (Table 1). Canola injury was evaluated visually. Canola seed was harvested with a small plot combine on August 28 and September 5, 2001 at Nezperce and Potlatch, respectively. 'Cashup' winter wheat was no-till seeded at Nezperce on September 23, 2001 and 'Rely' winter wheat was no-till seeded at Potlatch on September 15, 2001. Ethametsulfuron persistence was evaluated by visual wheat injury and wheat yield in 2002. Winter wheat was harvested on August 1 and 5, 2002 at Nezperce and Potlatch, respectively.

No rate of ethametsulfuron injured canola in 2001 (data not shown). Canola yield at Nezperce ranged from 1788 to 1937 lb/A and did not differ among treatments (Table 2). At Potlatch, canola yield from plots treated with ethametsulfuron averaged 18% more than the untreated check and were not significantly different from each other. This was likely due to competition from wild oat, common lambsquarter, and field pennycress at Potlatch.

In 2002, no visual wheat injury was noted at either location early in the growing season; however, a difference in stand height and maturity was noted just prior to harvest (data not shown). Wheat plants treated with the 2X and 4X rates (0.054 and 0.108 lb ai) of ethametsulfuron at both locations were slightly shorter and greener compared to the untreated check and the 1X rate (0.027 lb ai). Wheat yield at Nezperce ranged from 81 to 88 bu/A and did not differ among treatments or from the untreated check. At Potlatch, wheat yield from plots treated with 0.054 lb ai ethametsulfuron was lower than the untreated check and the 0.027 lb ai rate.

Table 1. Application and soil data.

Location	Nezperce	Potlatch
Application date	May 30, 2001	June 6, 2001
Canola growth stage	4 leaf	2 to 4 leaf
Air temp (F)	63	65
Relative humidity (%)	49	54
Wind (mph, direction)	3.5, NW	3, W
Cloud cover (%)	25	75
Soil temp at 2 in (F)	60	50
pH	4.9	5.2
OM (%)	5.9	2.9
CEC (meq/100g)	32	19
Texture	Silt loam	Silt loam

Table 2. The effect of ethametsulfuron on canola and wheat yield near Potlatch and Nezperce, Idaho in 2001 and 2002.

		2001 Canola yield		2002 Wheat yield	
Treatment[a]	Rate	Nezperce	Potlatch	Nezperce	Potlatch
	lb ai/A	---------------lb/A--------------		-----------------bu/A-----------------	
Untreated check	----	1792	1124	88	100
Ethametsulfuron	0.027	1937	1326	81	102
Ethametsulfuron	0.054	1927	1422	81	90
Ethametsulfuron	0.108	1788	1381	83	95
LSD (0.05)		NS	171	NS	7

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

Spring barley, potato, and sugar beet follow-crop response to imazamox and quinclorac applications in winter wheat. Michael J. Wille and Don W. Morishita. (Twin Falls Research and Extension Center, University of Idaho, Twin Falls, ID 83303-1827) A study was conducted at the University of Idaho Research and Extension Center near Kimberly, Idaho to assess the potential for injury to sugar beet, potato, and spring barley planted one cropping year after imazamox applications. Imazamox and quinclorac was applied to Clearfield® winter wheat ('Fidel') in the fall 2000 and spring 2001. Each crop was grown separately and thus evaluated as separate experiments. Experimental design for each crop was a randomized complete block with four replications. Individual potato and sugar beet plots were four rows by 35 ft, and barley plots were 8 by 25 ft. Potato row spacing was 36 inches and sugar beet row spacing was 22 inches. Soil type was a Portneuf silt loam (29% sand, 65% silt, and 6% clay) with an 8.1 pH, 1.6% organic matter, and CEC of 14-meq/100 g soil. Clearfield® winter wheat was planted October 9, 2000. All herbicide applications were broadcast-applied using a CO_2-pressurized bicycle-wheeled sprayer calibrated to deliver 10 gpa with 11001 flat-fan nozzles. Fall treatments were applied to frozen soil on December 7, 2000, when wheat had 1 to 2 leaves. Spring treatments were applied April 11, 2001, when wheat had 4 leaves. Soil and environmental conditions at herbicide application is shown in Table 1. The wheat crop was managed and harvested using standard production practices for irrigated winter in southern Idaho. Spring barley was planted April 9, 2002, at a rate of 100 lb/A in 7-inch rows. 'Russet Burbank' potato was planted at 1 ft intervals on May 1, 2002. 'HM 2984RZ' sugar beet was planted April 26, 2002, at a seeding rate of 57,024 seed/A. Due to a late freeze May 7 and 8, the experiment was replanted on May 14 with 'HM 2980RZ' sugar beet. Each crop was kept weed-free using both chemical weed control and hand hoeing. Crop injury was evaluated visually June 6 and August 9. Barley was harvested September 3 from the center of each plot with a small-plot combine. Potato and sugar beet were harvested from the center two rows of each plot on September 19 and October 8, respectively.

Table 1. 1Environmental conditions at herbicide application.

	Application timing	
	Fall	Spring
Application date	Dec. 7, 2000	April 11, 2001
Air temperature (F)	25	48
Soil temperature (F)	28	52
Relative humidity (%)	100	78
Wind speed (mph)	0	5
Cloud cover (%)	100	100

Evaluation ratings for crop injury were not significantly different, due to variability among treatments within each crop. Barley yield ranged from 55 to 75 bu/A in herbicide treated plots, and 55 bu/A in untreated check plots. Yields of herbicide treatments were all greater than the untreated check, but did not differ among each other except fall-applied imazamox, which was lower than all other herbicide-treated plots and equal to the untreated check. Grain test weights ranged from 40 to 45 lb/bu and were similar among all treatments. Potato yields ranged from 307 to 368 cwt/A and did not differ among each other or from the untreated check. Potato yields did not differ among treatments with respect to either grade, or specific gravity (data not shown). Sugar beet root yields ranged from 22 to 27 tons/A, and from 6020 to 7380 lb extractable sugar/A (data not shown). Neither sugar beet root yield nor extractable sugar yield differed among any treatments.

Table 2. Spring barley injury and yield response in to imazamox applied to soil in fall 2000, and spring 2001.

Treatment[1]	Application		Crop injury		Grain	
	Rate	Timing	6/4	8/9	Yield	Test wt
	lb ai/A		— % —		bu/A	lb/bu
Check	-	-	-	-	55	44
Imazamox + UAN + NIS	0.077 + 1.25 + 0.25% v/v	Fall 2000	0	0	55	45
Imazamox + UAN + NIS	0.154 + 1.25 + 0.25% v/v	Fall 2000	9	3	75	40
Imazamox + UAN + NIS	0.077 + 1.25 + 0.25% v/v	Spring 2001	16	0	73	44
Imazamox + UAN + NIS	0.154 + 1.25 + 0.25% v/v	Spring 2001	28	3	62	44
Imazamox + UAN + NIS / Imazamox + UAN + NIS	0.077 + 1.25 + 0.25% v/v / 0.077 + 1.25 + 0.25% v/v	Fall 2000 Spring 2001	15	1	66	45
LSD (0.05)			NS	NS	13	NS
Prob (F)			0.21	0.44	0.01	0.32

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

Table 3. Potato injury and yield response in to imazamox applied to soil in fall 2000 and spring 2001.

	Application		Sugar beet			Potato								
			Crop injury		Root	Crop injury		U.S. # 1						
Treatment[a]	Rate	Timing	6/4	8/9	yield	6/4	8/9	4-6 oz	6-12 oz	> 12 oz	Total	U.S. # 2	Culls	Total wt.
	lb ai/A		%		ton/A	%		cwt/A						
Check	-	-	-	-	30	-	-	30	85	70	185	91	48	324
			0	3	35									
Imazamox + UAN + NIS	0.048 + 1.25 + 0.25% v/v	Fall 2000				0	3	35	82	89	206	64	55	324
Imazamox + UAN + NIS	0.096 + 1.25 + 0.25% v/v	Fall 2000	5	0	36	0	11	47	70	63	180	82	54	316
Imazamox + UAN + NIS	0.048 + 1.25 + 0.25% v/v	Spring 2001	0	3	29	1	4	31	99	86	216	93	58	368
Imazamox + UAN + NIS	0.096 + 1.25 + 0.25% v/v	Spring 2001	4	0	33	0	3	27	65	79	170	94	62	326
Quinclorac	0.38	Fall 2000	1	0	33	0	10	31	81	71	182	87	43	312
Quinclorac	0.76	Fall 2000	6	1	37	0	6	34	77	88	198	105	38	341
Imazamox + quinclorac + UAN + NIS / Imazamox + quinclorac + UAN + NIS	0.048 + 0.38 + 1.25 + 0.25% v/v / 0.048 + 0.38 + 1.25 + 0.25% v/v	Fall 2000 / Spring 2001	0	2	31	1	10	34	75	37	147	99	61	307
LSD (0.05)			NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Prob (F)			0.41	0.55	0.45	0.59	0.21	0.09	0.46	0.09	0.10	0.31	0.53	0.33

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

Tolerance of winter wheat, spring barley, sugar beet, and potato follow crops to imazamox applied in imidazolinone-resistant winter wheat fall and spring the previous growing season. Pamela J.S. Hutchinson, Felix E. Fletcher, and Brent R. Beutler. (Aberdeen Research and Extension Center, University of Idaho, Aberdeen, ID 83210). The objective of this trial is to determine winter wheat, spring barley, sugar beet, and potato follow crop response to fall and spring imazamox applications in the previous winter wheat growing season.

Imazamox at 0, 0.04, or 0.8 lb/A (0, 1X, 2X rates) was applied to imidazolinone-resistant winter wheat November 2, 1999 or May1, 2000 at the Aberdeen Research and Extension Center in Aberdeen, Idaho, in a 'Declo' loam soil with 1.1% organic matter and pH 8.3. A fall + spring sequential 0.04 lb/A treatment was included in the trial. Treatments of fall 1999 applied 1X and 2X rates with a simulated winter kill by May 01, 2000 glyphosate applications, and plant-back to non-Clearfield spring wheat ('Treasure' planted May 30, 2000) were included in the trial. Experimental design was a randomized complete block with four replications. Plot size was 50 by 40 feet. Imidazolinone-resistant and 'Treasure' wheat was harvested fall 2000 and plots were kept intact. The trial was maintained weed-free throughout all growing seasons. Irrigation, and fertilizer, insect, and disease control plot maintenance was performed as necessary throughout all growing seasons.

Winter wheat ('Dawes') was planted September 9, 2000, and 'Baroness' barley, 'PM9' sugar beet, and 'Russet Burbank' potato were planted April 11, April 18, and April 24, 2001, respectively. The winter wheat follow-crop planting-date was approximately 10 and 4 months after the fall 1999 and spring 2000 imazamox applications, respectively. The spring 2001 follow-crop planting-dates were approximately 17.5 and 11.5 months after the fall 1999 and spring 2000 imazamox applications, respectively. Yield data in the 'Treasure' spring wheat planted in simulated winter-kill plots 7 months after fall 1999 imazamox applications were not collected. No crop response or yield loss was observed in 'Dawes' winter wheat planted into the trial area fall 2000 (data not shown). While 'Baroness' spring barley planted in 2001 was stunted in the 2X spring 2000 plots, yields were not reduced (data not shown). At mid-season, 'Russet Burbank' potato were injured (stunted) 12.5% in the simulated winter-kill treated plots (Table). Although there was a trend for lower U.S. No. 1 tuber yields in the simulated winter-kill plots, potatoes yields were not significantly affected. Overall % visual injury ranged from 24 to 56% for sugar beets planted spring 2001 (Table). Only the fall 1999 1X rate with simulated winter-kill resulted in reduced sugar beet yield.

Table. Follow crop response to imazamox applied fall or spring in the previous growing season.

				Sugar beet crop response		Potato crop response		
			Planting timing[2]	%crop injury		% crop injury	Tuber yield	
Treatment	Rate	App. code[1]	MAT	7/24	Yield	7/24	U.S. No. 1	Total
	lb/A				T/A		-----------cwt/A----------	
Weed-free control	-	-	-	0	32.08	0	170.8	232.1
Imazamox	0.04	A	17.5	25	31.79	0	213.9	262.1
Imazamox	0.08	A	17.5	23.8	29.87	1.3	202.6	258.5
Imazamox + Imazamox	0.04 + 0.04	A B	17.5 11.5	27.5	29.68	2.5	203.2	250.5
Imazamox WK[3]	0.04	A	17.5	56.3	19.34	12.5	118.6	214.1
Imazamox WK	0.08	A	17.5	28.8	33.94	12.5	122.8	206.7
Imazamox	0.04	B	11.5	28.8	31.61	1.3	173.5	237.6
Imazamox	0.08	B	11.5	23.8	32.65	3.8	215.6	279.4
LSD (0.05)	-	-	-	17.6	4.9	4.4	68.5	74.1

[1] A = November 2, 1999 application date; B = May 1, 2000 application date. All treatments applied with 1 qt/A 32% N + 0.25% v/v NIS

[2] Sugar beet 'PM9' planted April 18, 2001; 'Russet Burbank' potato planted April 24, 2001. MAT = months after treatment

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

Rotational crop response to imazamox persistence. Traci A. Rauch and Donald C. Thill. (Plant Science Division, University of Idaho, Moscow, ID 83844-2339) Two studies were established at the University of Idaho Plant Science Farm near Moscow, ID to examine rotational crop response to imazamox persistence. One study was established in fall 2000 in 'Fidel' imidazolinone-resistant winter wheat and the other in spring 2001 in 'Triangle' imidazolinone-resistant spring wheat. In both studies, the experimental design was a randomized split-block with four replications. Main plots were two rotational crops, spring barley and yellow mustard in experiment one and spring pea and yellow mustard in experiment two (16 by 80 ft) and subplots were four herbicide treatments and an untreated check (16 by 32 ft). Herbicide treatments were applied in 2000 or 2001 using a CO_2 pressurized backpack sprayer calibrated to deliver 10 gpa at 30 psi and 3 mph (Table 1). Experiment one was moldboard plowed and cultivated prior to seeding rotational crops, while rotational crops were direct-seeded into standing wheat stubble in experiment two. In experiment one, 'Camas' spring barley and 'Idagold' yellow mustard were seeded on April 22, 2002. In experiment two, 'Granger' winter pea and 'Athena' winter canola were seeded in fall 2001 but winterkilled due to poor fall establishment. 'Karita' spring pea and 'Idagold' yellow mustard were seeded as replacement rotational crops on April 26, 2002. Spring pea was oversprayed with bentazon at 1 lb ai/A on June 5, 2002 for broadleaf weed control. In both studies, rotational crop injury was evaluated visually on June 4 and July 10, 2002, and seed was harvested with a small plot combine on August 13, 2002.

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

	Experiment one		Experiment two
Previous crop	'Fidel' winter wheat		'Triangle' spring wheat
Application date	November 2, 2000	April 24, 2001	May 31, 2001
Wheat growth stage	1 leaf	3 to 5 tiller	3 to 4 tiller
Air temperature (F)	50	50	74
Relative humidity (%)	73	86	60
Wind (mph, direction)	2, E	4, E	0
Cloud cover (%)	30	10	5
Soil temperature at 2 in (F)	44	40	70
pH	4.7		4.6
OM (%)	2.8		4.3
CEC (meq/100g)	16		19
Texture	loam		loam
Primary tillage	moldboard plow		none (no-till)

In experiment one, spring barley and yellow mustard were not visibly injured by any treatment (data not shown). The treatment by crop interaction and the treatment main effect were not significant for seed yield. Seed yield ranged from 734 to 1016 lb/A for yellow mustard and 3683 to 4213 lb/A spring barley (Table 2). Spring barley test weight was not different among treatments.

In experiment two, yellow mustard injury increased with imazamox rate and was 35 and 28% at the highest rate of imazamox on June 4 and July 10, 2002, respectively (Table 3). Yellow mustard injury tended to decrease with time at all rates. Seed yield ranged from 1778 to 1950 lb/A for yellow mustard and 919 to 1233 lb/A for spring pea and did not differ among treatments. Seed yield for spring pea and yellow mustard tended to be slightly lower at the highest rate of imazamox compared to the untreated check.

Table 2. The effect of imazamox on yellow mustard yield and spring barley yield and test weight in experiment one near Moscow, Idaho in 2002.

		Application	Yellow mustard	Spring barley[1]	
Treatment[2]	Rate	timing	yield	Yield	Test weight
	lb ai/A		lb/A	lb/A	lb/bu
Imazamox	0.04	fall 2000	870a	4213a	52a
Imazamox	0.08	fall 2000	734a	4066a	52a
Imazamox	0.04	spring 2001	1016a	3953a	51a
Imazamox	0.08	spring 2001	757a	3683a	51a
Untreated check	--	--	771a	3792a	51a

[1]Means within a column followed by the same letter are not significantly different ($P > 0.05$).

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

Table 3. The effect of imazamox on spring pea and yellow mustard injury and yield in experiment two near Moscow, Idaho in 2002.

		Crop injury[1]				Yield[1]	
		Spring pea		Yellow mustard			
Treatment[2]	Rate	June 4	July 10	June 4	July 10	Spring pea	Yellow mustard
	lb ai/A	-------------------------%-----------------------				-----------lb/A------------	
Imazamox	0.032	0a	0a	1a	0a	1950a	1186a
Imazamox	0.04	0a	0a	8a	4a	1847a	1233a
Imazamox	0.064	0a	0a	16a	11a	1906a	1026a
Imazamox	0.08	4a	0a	35b	28b	1778a	919a
Untreated check		--	--	--	--	1877a	1135a

[1]Means within a column followed by the same letter are not significantly different ($P > 0.05$).

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

Spring barley and yellow mustard response to imazamox and other grass herbicides persistence. Traci A. Rauch and Donald C. Thill. (Crop and Weed Science Division, University of Idaho, Moscow, ID 83844-2339) Studies were established near Moscow, Tammany, and Bonners Ferry, Idaho to examine spring barley and yellow mustard response to imazamox, sulfosulfuron, flucarbazone-sodium, and propropcarbazone persistence. The experimental design at all locations was a randomized split-block with four replications. Main plots were two rotational crops, spring barley and yellow mustard (15 by 144 ft), and subplots were eight herbicide treatments and an untreated check (16 by 30 ft). All herbicide treatments were applied in 2001 using a CO_2 pressurized backpack sprayer calibrated to deliver 10 gpa at 30 psi and 3 mph (Table 1). The study at Moscow was moldboard plowed in the fall and cultivated in the spring, and at Bonners Ferry, the experiment was cultivated in the spring prior to seeding rotational crops. At Tammany, all rotational crops were direct-seeded into standing wheat stubble. 'Camas' spring barley and 'Idagold' yellow mustard were seeded on April 9, 20, and 23, 2002 at Bonners Ferry, Tammany, and Moscow, Idaho, respectively. At Bonners Ferry, spring barley was oversprayed with carbaryl at 0.5 lb ai/A to control cereal leaf beetle on May 8, 2002 and with tralkoxydim at 0.24 lb ai/A to control wild oat on May 8 and June 3, 2002. Yellow mustard at Bonners Ferry was oversprayed with carbaryl at 0.5 lb ai/A to control flea beetle on May 8, 2002 and with quizalofop at 0.069 lb ai/A to control wild oat on May 8 and June 3, 2002. Rotational crop injury was evaluated visually, and barley and mustard seed was harvested with a small plot combine on August 13 (Moscow), 20 (Tammany), and 21 (Bonners Ferry), 2002.

Table 1. Application and soil data for Moscow, Tammany, and Bonners Ferry, Idaho locations.

Location	Moscow, Idaho	Tammany, Idaho	Bonners Ferry, Idaho
Application date	May 8, 2001	April 26, 2001	May 17, 2001
Wheat growth stage	4 tiller	3 to 4 tiller	4 to 6 tiller
Air temperature (F)	62	65	62
Relative humidity (%)	45	51	58
Wind (mph, direction)	2, W	1, W	3, SW
Cloud cover (%)	25	60	90
Soil temperature at 2 in (F)	60	50	50
pH	4.7	5.0	5.3
OM (%)	2.8	4.0	20
CEC (meq/100g)	16	25	49
Texture	loam	silt loam	loam
Primary tillage	moldboard plow	none (no-till)	field cultivator

At Moscow, no treatment at any evaluation date injuried spring barley or yellow mustard (data not shown). At Tammany on June 21, spring barley was injured 0 to 31% but did not differ among treatments (Table 2). By July 15, flucarbazone-sodium at 0.027 lb ai/A, propropcarbazone at 0.08 lb ai/A and both rates of sulfosulfuron injured spring barley 31 to 39% and did not differ from the low rate of propropcarbazone (26%). The high rate of sulfosulfuron and propropcarbazone injured yellow mustard 25 and 29%, respectively, on June 21 and did not differ from propropcarbazone at 0.04 lb ai/A and the high rate of imazamox (14 and 16%). By July 15, the high rate of sulfosulfuron and propropcarbazone injured yellow mustard 30 and 36%, respectively, and the high rate of imazamox injured yellow mustard 15%. At Bonners Ferry on June 14, spring barley was injured 0 to 9% and did not differ among treatments. By July 16, both rates of sulfosulfuron injured spring barley 16 to 26% and were not different from the propropcarbazone treatments (8 and 10%). Yellow mustard was injured 16% by the high rate of imazamox and propropcarbazone on June 3 and did not differ from sulfosulfuron at 0.062 and propropcarbazone at 0.04 lb ai/A. By June 14, propropcarbazone at 0.08 lb ai/A injured yellow mustard more than all other treatments (28%), except the high rate of imazamox and sulfosulfuron.

At Moscow, spring barley yield (3488 to 5978 lb/A) and test weight (50 to 53 lb/bu) and yellow mustard yield (524 to 1120 lb/A) did not differ among herbicide treatments or from the untreated check (Table 3). At Tammany, spring barley yield was highest with the high rate of imazamox and did not differ from the low rate of imazamox or flucarbazone-sodium at 0.054 lb ai/A. All three treatments yielded more than the untreated check. Barley yield was poor in the untreated check due to a reduced barley stand from an alleopathic effect of or disease in the downy brome residue. Spring barley test weight ranged from 49 to 51 lb/bu and did not differ among treatments. Yellow mustard seed yield was highest with flucarbazone-sodium at 0.027 lb ai/A but did not differ from the high rates of imazamox and flucarbazone-sodium, sulfosulfuron at 0.031 lb ai/A, and the untreated check. Both rates of propropcarbazone reduced yellow mustard seed yield compared to the untreated check. At Bonners Ferry, spring barley yield was highest with both rates of imazamox. All other treatments did not differ from the untreated check, except flucarbazone-sodium at 0.054 lb ai/A. Spring barley seed test weight ranged from 51 to 52 lb/bu, and yellow mustard yield ranged from 2062 to 2722 lb/A.

Table 2. Spring barley and yellow mustard injury near Tammany and Bonners Ferry, Idaho in 2002.

		Tammany				Bonners Ferry			
		Spring barley		Yellow mustard		Spring barley		Yellow mustard	
Treatment[1]	Rate	June 21	July 15	June 21	July 15	June 14	July 16	June 3	June 14
	lb ai/A	%							
Imazamox	0.04	0	0	0	0	0	0	5	3
Imazamox	0.08	0	0	16	15	0	0	16	18
Sulfosulfuron	0.031	31	33	3	0	0	16	1	5
Sulfosulfuron	0.062	18	31	25	30	9	26	10	24
Flucarbazone-sodium	0.027	11	31	6	0	3	0	4	8
Flucarbazone-sodium	0.054	0	1	0	0	4	0	3	4
Propropcarbazone	0.04	18	26	14	11	0	8	8	14
Propropcarbazone	0.08	24	39	29	36	3	10	16	28
LSD (0.05)		NS	29	17	15	NS	12	10	11

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

Table 3. Yellow mustard and spring barley yield and spring barley test weight near Moscow, Tammany, and Bonners Ferry, Idaho in 2002.

		Moscow			Tammany			Bonners Ferry		
		Spring barley		Y. mustard	Spring barley		Y. mustard	Spring barley		Y. mustard
Treatment[1]	Rate	Yield	Test weight	yield	Yield	Test weight	yield	Yield	Test weight	yield
	lb ai/A	lb/A	lb/bu	lb/A	lb/A	lb/bu	lb/A	lb/A	lb/bu	lb/A
Imazamox	0.04	3488	50	524	3239	51	1409	5575	52	2650
Imazamox	0.08	3664	51	748	3750	51	1240	5469	52	2465
Sulfosulfuron	0.031	4227	52	854	2202	51	1317	3729	52	2359
Sulfosulfuron	0.062	3805	51	869	2335	50	1267	3094	52	2113
Flucarbazone-sodium	0.027	5978	53	1120	2151	51	1473	3843	51	2722
Flucarbazone-sodium	0.054	4462	51	891	2944	50	1357	4424	51	2238
Propropcarbazone	0.04	4672	53	957	2617	51	1043	3849	51	2318
Propropcarbazone	0.08	5347	53	1073	2475	49	707	3554	52	2062
Untreated check	--	4864	52	1085	1658	51	1380	3303	52	2219
LSD (0.05)		NS	NS	NS	990	NS	199	750	NS	NS

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

Rotational crop response following mesotrione application in field corn. J. Earl Creech, John O. Evans, and R. William Mace. (Plants, Soils, and Biometeorology Dept., Utah State University, Logan, UT 84322-4820). A study was conducted at the Utah State University Greenville Farm in North Logan, UT to evaluate the potential of mesotrione to persist in the soil and affect rotational crops. The soil at the Greenville Farm was a Millville silt loam with 1.2 % O.M. and 8.0 pH. In the spring of 2001, herbicide treatments were applied to plots that measured 20 by 200 ft and were arranged in a completely randomized design with three replications. Treatments were applied using an ATV sprayer that was calibrated to deliver 12 gpa at 30 psi. Preemergence treatments were applied May 18 and postemergence were applied on June 18. Corn was planted on May 18 and chopped for silage on September 15. The field was then subject to two secondary tillage operations, a fall disking and a spring harrowing. Rotational crops were planted across the herbicide treatments in the spring of 2002. Visual evaluations of crop injury were completed June 10 and July 11 and plots were harvested as individual crops reached maturity.

No injury to any of the crops due to the herbicide treatments was observed. Slight differences in plant height were observed but were attributed to soil fertility differences because the trend was seen across treatments in particular areas of the field. Yields were not significantly different among treatments.

Table 1. Crop variety, seeding rate, planting date, and harvest date.

Crop	Variety	Seeding Rate	Planting Date	Harvest Date
Winter Wheat	CV9804	100 lb/A	25 September 2001	20 August 2002
Spring Wheat	Fidel	100 lb/A	5 April 2002	20 August 2002
Spring Barley	Steptoe	70 lb/A	5 April 2002	20 August 2002
Alfalfa	DK125	15 lb/A	5 April 2002	12 July 2002
Yellow Mustard	Tilney	12 lb/A	5 April 2002	1 September 2002
Sunflower	Pioneer 63A70	25,000 seeds/A	2 May 2002	1 September 2002
Sugarbeets	PM21	80,000 seeds/A	2 May 2002	15 October 2002
Safflower	-----[1]	30 lb/A	5 April 2002	15 October 2002

[1]Unknown variety

Table 2. Crop injury following mesotrione application.

Treatment	Rate	Timing	Crop injury							
			Winter wheat	Spring wheat	Barley	Alfalfa	Yellow mustard	Sunflower	Sugar beet	Safflower
	g/ha		--%--							
Mesotrione	140	PRE	0	0	0	0	0	0	0	0
Mesotrione	140	POST	0	0	0	0	0	0	0	0
Mesotrione	140	POST	0	0	0	0	0	0	0	0
+ atrazine	560									
Untreated			0	0	0	0	0	0	0	0
LSD (0.05)			NS	NS	NS	NS	NS	NS	NS	NS

Table 3. Crop yield following mesotrione application.

Treatment	Rate	Timing	Crop yield							
			Winter wheat	Spring wheat	Barley	Alfalfa	Yellow mustard[1]	Sunflower[2]	Sugar beet	Safflower
	g/ha		-----------bu/A-----------			----------------------T/A----------------------				lb/A
Mesotrione	140	PRE	112	75	116	2.0	1.3	8.4	14.6	2313
Mesotrione	140	POST	117	96	130	1.8	1.3	10.0	8.3	3239
Mesotrione	140	POST	93	106	131	2.2	1.1	11.5	14.5	1705
+ atrazine	560									
Untreated			94	93	108	2.4	1.4	10.0	8.7	1741
LSD (0.05)			NS	NS	NS	NS	NS	NS	NS	NS

[1] Plant biomass

[2] Head weight

Sugar beet tolerance to sulfentrazone applied in potatoes the previous growing season. Pamela J.S. Hutchinson, Felix E. Fletcher, and Brent R. Beutler. (Aberdeen Research and Extension Center, University of Idaho, Aberdeen, ID 83210). This trial was designed to evaluate sugar beet tolerance to sulfentrazone that had been applied to a potato crop the previous year. On May 26, 2000, sulfentrazone was applied preemergence at 0, 0.094, or 0.188 lb/A to potatoes at the Aberdeen Research and Extension Center in Aberdeen, Idaho, in a 'Declo' loam soil with 1.4% organic matter and pH 8.4. Plot size was 48 by 30 feet with three replications. The trial was maintained weed-free throughout the growing season. Potatoes were harvested fall 2000 and plots were kept intact.

The experimental area was fertilized with 50 lb N/A before planting 'PM21' sugar beets approximately 10.5 months after sulfentrazone application on April 17, 2001 at 57,024 seed/A on 22-inch rows. Sugar Beets were planted over the entire area to create a randomized block design with 48 by 30 foot plots. Sugar beets were sprinkler irrigated and received two applications of 25 lb N/A through the irrigation system during the season.

Sugar beets were treated with 0.54 lb/A phenmediphan/desmediphan on May 17 and May 23, 2001, and maintained weed-free by hand weeding throughout the growing season. Beets were also treated with 0.93 lb/A aldicarb for insect control on June 25, 2001. Sugar beets were harvested from two rows of 20 feet each in the center of the plots, using a two-row mechanical harvester on October 10, 2001.

No visual injury was observed during the sugar beet growing season (data not shown). Sugar beet yield, % sugar content, % sugar extraction, and estimated recoverable sugar were not affected by sulfentrazone applied to potato the previous growing season (Table).

Table. Yield and sugar properties of sugar beets planted following sulfentrazone application in potatoes.

		Sugar beet			
Treatment	Rate	Root yield	Sugar content	Extraction	Estimated recoverable sugar
	lb/A	T/A	%	%	lb/A
Weed-free control		32.8	17.18	85.60	9681
Sulfentrazone	0.094	33.8	16.81	85.55	9763
Sulfentrazone	0.188	31.4	16.58	85.12	8873
LSD (0.05)	-	ns	ns	ns	ns

Newly reported exotic species in Idaho. Sandra S. Robins and Timothy S. Prather. (Idaho Agricultural Experiment Station, University of Idaho, Moscow, Idaho, 83844-2339). The Lambert C. Erickson Weed Diagnostic Laboratory received 319 specimens for identification in 2002. One species, *Sorbaria sorbifolia* was found to be new to the Pacific Northwest (Idaho, Oregon and Washington). One species, *Campanula persicifolia* was found to be a new record for Idaho. Twenty-six counties submitted weed identifications of the 44 counties for Idaho. The lab identified 44 exotic species and 2 native species designated as noxious weeds that were new to county records not previously documented for Idaho by the Erickson Weed Diagnostic Laboratory (see table).

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

County	Family	Scientific Name	Common Name
Ada	Brassicaceae	*Lepidium campestre*	field pepperweed
Ada	Fabaceae	*Onobrychis viciifolia*	sainfoin
Adams	Caryophyllaceae	*Gypsophila paniculata*	baby's breath
Bear Lake	Solanaceae	*Lycium barbarum*	matrimony vine
Bingham	Fabaceae	*Astragalus cicer*	chickpea milkvetch
Bonner	Polygonaceae	*Polygonum sachalinense*	giant knotweed
Boundary	Boraginaceae	*Asperugo procumbens*	catchweed
Boundary	Brassicaceae	*Descurainia Sophia*	flixweed
Boundary	Brassicaceae	*Draba verna*	spring whitlowgrass
Boundary	Lamiaceae	*Nepeta cataria*	catnip
Boundary	Plantaginaceae	*Plantago lanceolata*	buckhorn plantain
Boundary	Scrophulariaceae	*Veronica arvensis*	corn speedwell
Butte	Malvaceae	*Abutilon theophrasti*	velvetleaf
Butte	Asteraceae	*Sonchus oleraceus*	annual sowthistle
Camas	Polygonaceae	*Polygonum lapathifolim*	pale smartweed
Canyon	Chenopodiaceae	*Atriplex micrantha*	weedy orache
Canyon	Poaceae	*Digitaria sanguinalis*	large crabgrass
Cassia	Geraniaceae	*Geranium pusillum*	smallflower geranium
Clark	Euphorbiaceae	*Euphorbia myrsinites*	myrtle spurge
Custer	Lamiaceae	*Origanum vulgare*	wild marjoram
Gem	Poaceae	*Echinochloa crus-galli*	large barnyard grass
Gem	Haloragaceae	*Myriophyllum spicatum*	Eurasian watermilfoil
Idaho	Poaceae	*Elymus canadensis*	Canada wildrye
Idaho	Rosaceae	*Sorbaria sorbifolia*	false spiraea
Kootenai	Malvaceae	*Abutilon theophrasti*	velvetleaf
Kootenai	Brassicaceae	*Berteroa incana*	hoary alyssum
Kootenai	Campanulaceae	*Campanula persicifolia*	willow bellflower
Kootenai	Brassicaceae	*Lunaria annua*	honesty
Kootenai	Polygonaceae	*Polygonum cuspidatum*	Japanese knotweed
Kootenai	Rosaceae	*Sorbaria sorbifolia*	false spiraea

Table cont.

County	Family	Scientific Name	Common Name
Latah	Asteraceae	*Acroptilon repens*	Russian knapweed
Latah	Rubiaceae	*Galium pedemontanum*	piedmont
Latah	Caryophyllaceae	*Spergula arvensis*	corn spurry
Lewis	Boraginaceae	*Lithospermum arvense*	corn gromwell
Lewis	Polygonaceae	*Polygonum aviculare*	prostrate knotweed
Lewis	Brassicaceae	*Thlaspi arvense*	field pennycress
Nez Perce	Euphorbiaceae	*Euphorbia dentate*	toothed spurge
Nez Perce	Solanaceae	*Solanum rostratum*	buffalo bur
Nez Perce	Poaceae	*Ventenata dubia*	ventenata
Owyhee	Apiaceae	*Pastinaca sativa*	wild parsnip
Power	Campanulaceae	*Campanula rapunculoides*	creeping bellflower
Shoshone	Campanulaceae	*Campanula rapunculoides*	creeping bellflower
Shoshone	Brassicaceae	*Draba verna*	spring whitlowgrass
Shoshone	Euphorbiaceae	*Euphorbia cyparissias*	cypress spurge
Twin Falls	Chenopodiaceae	*Atriplex hortensis*	garden orache
Twin Falls	Euphorbiaceae	*Euphorbia peplus*	petty spurge

Evaluation of herbicides for purple loosestrife control. Rodney G. Lym. (Department of Plant Sciences, North Dakota State University, Fargo, ND 58105) Purple loosestrife is not widely established in North Dakota but isolated patches continue to be found especially in urban areas. Biological control agents have become established in the larger infestations, but mosquito control programs often reduce the biocontrol agent population and thus purple loosestrife control. The purpose of this research was to evaluate 2,4-D, triclopyr, and glyphosate for purple loosestrife control at two locations in North Dakota.

The first experiment was established in Chautauqua Park along the Sheyenne River in Valley City, ND, on August 1, 2000. Purple loosestrife was beginning to flower and ranged from 0.5 to 6 feet tall. Cattails were present and were approximately 6 feet tall. Herbicides were applied with a single-nozzle backpack sprayer with a hollow cone nozzle delivering approximately 60 gpa at 35 psi. The air temperature was 82 F with a dew point of 67 F. The plots were 8 by 30 feet with two replicates and followed the shoreline of the river. Evaluations were based on percent stand reduction compared to the untreated control.

2,4-D acid as the NB30380 formulation provided much better purple loosestrife control 13 months after treatment (MAT) than as the NB20652 formulation and averaged 81 compared to 26% control, respectively (Table 1). Purple loosestrife control from glyphosate and triclopyr averaged 92% 13 MAT which was similar to control reported in previous experiments conducted at North Dakota State University. Glyphosate also provided near complete control of cattails (data not shown). The high level of purple loosestrife control continued through the second growing season (23 MAT), and averaged 83% with all treatments except NB20652.

A second experiment to evaluate the NB30380 formulation of 2,4-D acid compared to triclopyr and glyphosate for purple loosestrife control was established along a city drain in an open green space within the Fargo, ND, city limits. Purple loosestrife had been established for at least 5 yr, was flowering, and was approximately 18 inches tall when herbicides were applied on July 20, 2001. In this experiment, herbicides were applied with a hand-held 4-nozzle boom sprayer delivering 8.5 gpa at 35 psi. There were three replicates which paralleled the drain.

As in the first experiment, the NB30380 formulation of 2,4-D acid provided good initial purple loosestrife control, which averaged 84% 1 MAT. Control from NB30380 was much better than from the NB20652 and mixed amine 2,4-D formulations which averaged 32 and 45%, respectively. EH1389 is an experimental glyphosate formulation, which provided similar control to the commercial formulation, and averaged 85% 1 MAT. No treatment provided satisfactory purple loosestrife control the following growing season and control declined to 33% or less for all treatments 13 MAT.

Purple loosestrife control with triclopyr, glyphosate, and NB30380 varied by location which was likely due to more uniform coverage at the Valley City compared to the Fargo location. In the first study, herbicides were applied with a back-pack single-nozzle sprayer at approximately 60 gpa compared to a boom sprayer that delivered 8.5 gpa in the second experiment. Glyphosate and 2,4-D acid as the NB30380 formulation but not triclopyr, provided the most consistent purple loosestrife control regardless of application method.

Table 1. Purple loosestrife control with various formuations of 2,4-D compared to glyphosate and triclopyr applied with a single nozzle sprayer at 60 gpa in Valley City, ND.

Treatment	Rate	Control/MAT[a]			
		1	11	13	23
	-----lb/A-----	----------------%----------------			
2,4-D acid (NB20652)[b]	0.94	100	31	26	35
2,4-D acid (NB30380)[c]	2.5	100	98	81	83
Glyphosate	3.6	100	100	92	88
Triclopyr	2.7	100	98	92	78
LSD (0.05)		NS	17	25	41

[a]Months after treatment.
[b]2,4-D acid formulation at 1.88 lb/gal from PBI-Gordon, Kansas City, MO.
[c]2,4-D acid formulation at 5 lb/gal from PBI-Gordon, Kansas City, MO.

Table 2. Purple loosestrife control with various formulations of 2,4-D compared to glyphosate and triclopyr applied with a boom sprayer at 8.5 gpa in Fargo, ND.

Treatment	Rate	Control/MAT[a]		
		1	11	13
	------lb/A------	---------------------%---------------------		
2,4-D acid (NB20652)[b] + NIS[c]	0.95 + 0.25%	32	20	0
2,4-D acid (NB22267)[b] + NIS[c]	0.95 + 0.25%	81	46	33
2,4-D amine[d] + NIS[c]	0.95 + 0.25%	45	46	33
Glyphsate (EH1389)[e]	3.6	83	50	25
Glyphosate + NIS[c]	3.6 + 0.25%	88	72	10
2,4-D acid (NB20652)[b] + glyphosate (EH1389)[e]	0.71 + 1.875	73	30	33
Triclopyr	1	53	28	10
2,4-D acid (NB30380)[f] + NIS[c]	2.5 + 0.25%	84	48	32
LSD (0.05)		26	NS	NS

[a]Months after treatment.
[b]2,4-D acid formulation at 1.88 lb/gal from PBI-Gordon, Kansas City, MO.
[c]NIS was a nonionic surfactant, Aqua Zorb from PBI-Gordon, Kansas City, MO.
[d]2,4-D DMA formulation at 1.88 lb/gal (HiDep) from PBI-Gordon, Kansas City, MO.
[e]Experimental formulation of glyphosate from PBI-Gordon, Kansas City, MO.
[f]2,4-D acid formulation at 5 lb/gal from PBI-Gordon, Kansas City, MO.

Cut stump applications of natural-based products to control French broom along roadsides. Steve L. Young. (Hopland Research and Extension Center, University of California, Hopland, CA 95449). A study was conducted at Jackson Demonstration State Forest on the north coast of California to test mechanical cutting of French broom and cut stump applications of acetic acid, pelargonic acid and glyphosate. French broom, a woody perennial, was the dominant vegetation with a few forbs growing underneath the canopy. Mature plants with a stump diameter of up to ½ inch were cut to approximately one foot September 21, 2001, prior to site establishment. All plots were 10 by 10 feet with treatments replicated three times in a randomized complete block design. The natural-based products and glyphosate were dripped onto the cut surface of the stumps in a 100% and 50% concentrate, respectively, on the same day that the cutting was done. Visual evaluations for control were made March 28 and October 12.

Acetic acid and pelargonic acid controlled French broom re-growth (Table). The percentage of dead stumps was not different between acetic acid or pelargonic acid and was significantly less than glyphosate. Acetic acid had the greatest percentage of stunted stumps, indicating the poorest kill. Percent dead stumps with glyphosate remained significantly higher than the other two treatments after more than one year after application.

Table. Control of French broom after mechanical cutting and cut stump treatments.

Treatment[a]	Timing[b]	French broom stumps[c] Dead	Stunted	Alive
		%		
Acetic acid	189 d	30bc	41a	29b
	386 d	32b	19a	49b
Pelargonic acid	189 d	39b	24ab	37b
	386 d	58b	6b	34b
Glyphosate	189 d	77a	0b	23b
	386 d	91a	1b	8c
Untreated control	189 d	0c	0b	100a
	386 d	3c	0b	97a

[a]Acetic acid and pelargonic acid were drip applied as a 100% concentrate. Glyphosate was drip applied as a 50% concentrate. Acetic acid (BurnOut®) @ 25% solution, pelargonic acid (Scythe®) @ 60% solution (4.2 lbs ai/gal) and glyphosate (Roundup®) 41% (3lbs ae/gal).
[b]Timing of evaluations was 189 and 386 (d) days after cutting and application.
[c]Values for each of the two evaluation dates (189 d and 386 d) followed by a different letter are significantly different at P = < 0.05. Ratings are percent of the total stumps in the plot.

Control of yellow starthistle and other roadside vegetation with natural-based products. Steve L. Young. (Hopland Research and Extension Center, University of California, Hopland, CA 95449). A study was conducted in Lake County along Highway 29 near Lakeport, CA with natural-based products (Table 2) in comparison to glyphosate for control of annual vegetation. Plots were established January 17, 2002 along a highway roadside dominated by a variety of annual weed species. Soil type was a sandy loam (50% sand, 30% silt, 20% clay, pH 6.2, 1.5% organic matter and CEC of 22 meq/100 g soil). The plots were 10 by 30 feet with treatments replicated four times in a randomized complete block design. The treatments were broadcast-applied with a CO_2 pressurized backpack sprayer delivering 100 gpa at 36 psi using three XR 8002 flat-fan nozzles evenly spaced across a five foot boom. Natural-based products were applied up to five times starting on February 25 and ending on June 7. Glyphosate was applied February 25 and May 16. Control of yellow starthistle, slender oat, hairy vetch, foxtail fescue, curly dock and buckhorn plantain was evaluated five times at approximately one week after each application beginning March 5 and ending June 14. Due to emergence and senescence patterns of weed species over the growing season, control of broadleaf filaree, hare barley and soft chess was evaluated early in the season between March 5 and May 1. Control of medusahead and lupine, data not included, were evaluated later in the season between May 1 and June 14.

Table 1. Herbicide application data.

Application date	2/25	3/26	4/25	5/16	6/7
Application timing[b]	POST	28 d	59 d	80 d	102 d
Soil temperature (F)	55	60	69	75	85
Air temperature (F)	73	68	74	80	78
Relative humidity (%)	33	32	54	35	43
Wind speed (m/h)	0	0	4	4	3
Cloud cover (%)	0	0	10	0	20
Growth stage[a]					
Broadleaf filaree	5" to 5 leaves				
Curly dock	8" to 3 leaves				
Foxtail fescue	6" to 6 leaves				
Hairy vetch	6" to 5 leaflets				
Hare barley	6" to 6 leaves				
Medusa head	----		6" to 4 leaves		
Buckhorn plantain	5" to 8 leaves				
Slender oat	8" to 6 leaves				
Soft chess	4" to 6 leaves				
Yellow starthistle	8" to 8 leaves				

[a]Growth stage was evaluated prior to initial application. Additional applications on 3/26, 4/25, 5/16 and 6/7 were made based on percent control from previous applications.
[b]Treatments were applied postemergence (POST), POST 28, 59, 80, 102 (d) days later.

The natural-based products showed phytotoxicity on all vegetation (Table 2). Five applications of acetic acid provided 83% or better control of slender oat, broadleaf filaree, hare barley and medusahead. Control of yellow starthistle after one application was 98%, but after five applications dropped to 36%. This was a similar trend for control of hairy vetch, soft chess, buckhorn plantain, foxtail fescue and curly dock. Plant essentials and pine oil controlled hairy vetch, broadleaf filaree and hare barley at least 83%. They also provided good control (>88%) of yellow starthistle, soft chess, buckhorn plantain and medusahead after one application, but subsequently declined in control (<85%) by the last application on June 7. Pelargonic acid controlled all weed species, except soft chess, buckhorn plantain and medusahead at least 85% or better after five applications. Yellow starthistle was the only weed that one application of glyphosate did not control (>95%) up to 60 days after application. A second application provided 100% control yellow starthistle and any other vegetation on June 14. A consistent level of control with the natural-based products, except for pelargonic acid, compared to the standard treatment of glyphosate was not achieved for 7 (yellow starthistle, slender oat, soft chess, buckhorn plantain, foxtail fescue, curly dock and medusahead) out of the 10 weed species evaluated.

Table 2. Weed control with natural-based products and glyphosate in annual vegetation.

Treatment[a]	Rate	Timing[b]	Weed control[c]									
			CENS	AVEB	VICS	EROB	HORL	BROM	PLAL	FESM	RUMC	ELYC
	gal/A		%									
Acetic acid	20	POST	98a	58b	81b	74b	89a	78b	94a	75ab	74a	NR
Plant essentials	15	POST	100a	80a	93a	96a	94a	98a	98a	75ab	90a	NR
Pine oil	20	POST	100a	73a	91a	91a	98a	94a	99a	60bc	75a	NR
Pelargonic acid	10	POST	98a	83a	96a	98a	85a	84b	98a	86a	93a	NR
Glyphosate	2	POST	80a	39c	45c	44c	88a	25c	50b	40c	66a	NR
Control			0b	0d	0d	0d	0b	0d	0c	0d	0b	NR
Acetic acid	20	28 d	80b	61b	60c	81b	86c	69c	98a	50b	68ab	NR
Plant essentials	15	28 d	96a	68b	97ab	98a	95ab	89b	100a	43b	50b	NR
Pine oil	20	28 d	85ab	66b	89b	96a	91bc	74c	100a	35bc	55b	NR
Pelargonic acid	10	28 d	99a	71b	96ab	99a	93b	70c	99a	73ab	80ab	NR
Glyphosate		28 d	100a	100a	100a	100a	100a	100a	100a	99a	96a	NR
Control			0c	0c	0d	0c	0d	0d	0b	0c	0c	NR
Acetic acid	20	59 d	86a	86b	68b	95a	84a	65c	89b	60ab	88a	88b
Plant essentials	15	59 d	95a	89b	100a	100a	83a	80b	94ab	41bc	88a	93ab
Pine oil	20	59 d	84a	88b	98a	98a	95a	78b	95ab	55ab	66b	88b
Pelargonic acid	10	59 d	95a	90b	100a	100a	85a	76b	89b	64ab	93a	89ab
Glyphosate		59 d	85a	99a	100a	95a	100a	100a	100a	100a	99a	100a
Control			0b	0c	0c	0b	0b	0d	0c	0c	0c	0c
Acetic acid	25	80 d	54c	81ab	59b	NR	NR	NR	49c	65ab	64a	91ab
Plant essentials	20	80 d	90ab	70b	100a	NR	NR	NR	73b	24bc	82a	78c
Pine oil	24	80 d	75b	69b	98a	NR	NR	NR	66bc	60ab	65a	88abc
Pelargonic acid	15	80 d	96a	93a	100a	NR	NR	NR	64bc	81a	93a	86bc
Glyphosate	1.5	80 d	90ab	100a	95a	NR	NR	NR	100a	100a	91a	100a
Control			0d	0c	0c	NR	NR	NR	0d	0c	0b	0d
Acetic acid	30	102 d	36b	83a	60b	NR	NR	NR	49d	65bc	65ab	88ab
Plant essentials	30	102 d	85a	86a	100a	NR	NR	NR	84b	20de	73ab	51c
Pine oil	30	102 d	81a	41b	100a	NR	NR	NR	65c	38dc	41b	36c
Pelargonic acid	25	102 d	96a	94a	100a	NR	NR	NR	78bc	85ab	90a	64bc
Glyphosate		102 d	100a	100a	100a	NR	NR	NR	100a	100a	100a	100a
Control			0c	0c	0c	NR	NR	NR	0e	0e	0c	0d

[a]All treatments were applied in a 100 gal/A total spray volume. Acetic acid (BurnOut®) @ 25% solution, plant essentials (Bioganic®) @ 100% solution, pine oil (Organic Interceptor®) @ 71% solution (5.67lbs ai/gal), pelargonic acid (Scythe®) @ 60% solution (4.2 lbs ai/gal) and glyphosate (Roundup®) 41% (3lbs ae/gal).

[b]Timing of application was postemergence (POST), POST 28, 59, 80 and 102 (d) days later.

[c]Weed species evaluated for control were yellow starthistle (CENS), slender oat (AVEB), hairy vetch (VICS), broadleaf filaree (EROB), hare barley (HORL), soft chess (BROM), buckhorn plantain (PLAL), foxtail fescue (FESM), curly dock (RUMC) and medusahead (ELYC). Values for each of the five evaluation dates (POST, 28 d, 59 d, 80 d and 102 d) followed by a different letter are significantly different at P = < 0.05. NR for species that were not evaluated because plants had either not emerged or had died from natural senescence or complete control.

Natural-based products for control of medusahead and other annual vegetation along roadsides. Steve L. Young. (Hopland Research and Extension Center, University of California, Hopland, CA 95449). A study was conducted at the University of California, Hopland Research and Extension Center near Hopland, CA with natural-based products (Table 2) in comparison to glyphosate for control of annual vegetation along roadsides. Plots were established March 21, 2002 along a roadside right-of-way in formerly grazed rangeland dominated by a variety of annual weed species. Soil type was a Sutherlin sandy loam (48% sand, 37% silt, 15% clay, pH 5.6, 4.1% organic matter and CEC of 18 meq/100 g soil). The plots were 10 by 30 feet with treatments replicated four times in a randomized complete block design. The treatments were broadcast-applied with a CO_2 pressurized backpack sprayer delivering 100 gpa at 36 psi using three XR 8002 flat-fan nozzles evenly spaced across a five foot boom. Initial applications were made April 8. DRA-033, an experimental herbicide, and sulfuric acid were re-applied May 3 and May 28, while coconut oil and fatty acid were re-applied May 15. Evaluations for control of slender oat and ripgut brome were made April 15, May 24 and June 24. Control of subterranean clover, soft chess and lupine was evaluated April 15 and May 24. Control of medusahead was evaluated April 15 and June 4. Control of hedgehog dogtailgrass was evaluated May 24 and June 4. Evaluations for control of broadleaf filaree and barb goatgrass were made once (data not included). New vegetative growth was non-existent after June 4 due to droughty summer conditions and therefore, no further evaluations were recorded.

Table 1. Herbicide application data.

Application date	4/8	5/3	5/15	5/28
Application timing[a]	POST	25 d	37 d	50 d
Air temperature (F)	65	65	74	68
Soil temperature (F)	67	60	80	73
Relative humidity (%)	62	57	34	76
Wind speed (m/h)	2	3	3	4
Cloud cover (%)	0	0	0	20
Growth stage[b]				
Slender oat	< 25 cm to 5 lvs			
Ripgut brome	< 18 cm to 4 lvs			
Clover	< 8 cm to 6 lflts			
Soft chess	< 10 cm to 4 lvs			
Lupine	< 12 cm to 9 lflts			
Medusahead	< 10 cm to 4 lvs			
Hedgehog dogtailgrass			<10 cm to 6 lvs	

[a]Growth stage was evaluated prior to initial application. Additional applications on 5/3, 5/15 and 5/28 were made based on percent control from previous applications. Growth reported in height (cm) and number of leaves (lvs) or leaflets (lflts).
[b]Treatments were applied postemergence (POST), POST 25 d and either 37 or 50 (d) days later.

All natural-based products showed phytotoxicity on vegetation after at least one application (Table 2). Fatty acids or coconut oil provided 91% or greater control of all vegetation after two applications. Due to the warm, dry spring, vegetation in plots treated with these products did not recover after two applications. Three applications of DRA-033 was more effective at controlling broadleaf species (>98%) than grass species (<83%). Control of broadleaf weeds, hedgehog dogtailgrass and soft chess was 88 to 100% with two or three applications of sulfuric acid. One application of glyphosate controlled all vegetation (100%) by May 15.

Table 2. Control of annual vegetation along roadsides with natural-based products.

Treatment[a]	Rate	Timing[b]	Weed control[c]						
			AVEBA	BRODI	TRFPR	BROMO	LUPPU	ELYCM	CYXEC
	gal/A		%						
DRA-033	20	POST	64bc	62b	91a	66b	97a	71c	NR
Fatty acid	20	POST	94a	95a	100a	98a	100a	96a	NR
Coconut oil	20	POST	93a	90a	100a	95a	100a	95a	NR
Sulfuric acid	30	POST	69b	69b	95a	83ab	97a	85b	NR
Glyphosate	2	POST	55c	50c	38b	69b	80b	59d	NR
Control			0d	0d	0c	0c	0c	0e	NR
DRA-033	30	25 d	80c	79b	100a	78c	98a	NR	80c
Sulfuric acid	35	25 d	79c	75b	100a	95b	100a	NR	88b
Fatty acid	20	37 d	99ab	100a	100a	100a	100a	NR	100a
Coconut oil	20	37 d	93b	96a	100a	100a	100a	NR	91b
Glyphosate		37 d	100a	100a	100a	100a	100a	NR	100a
Control			0d	0c	0b	0d	0b	NR	0d
DRA-033	30	50 d	76a	83a	NR	NR	NR	79a	80a
Fatty acid		50 d	NR	NR	NR	NR	NR	NR	NR
Coconut oil		50 d	NR	NR	NR	NR	NR	NR	NR
Sulfuric acid	30	50 d	83a	76a	NR	NR	NR	75a	88a
Glyphosate		50 d	NR	NR	NR	NR	NR	NR	NR
Control			0b	0b	NR	NR	NR	0b	0b

[a]All treatments were applied in a 100 gal/A total spray volume. DRA-033 @ 100% solution, fatty acid (Greenscape®) @ 100% solution, coconut oil (Bio-SAFE®) @ 100% solution (700g/liter), sulfuric acid (CT-311) @ 50% solution and glyphosate (Roundup®) 41% (3lbs ae/gal).
[b]Timing of application was postemergence (POST) and either POST 25 + 50 (DRA-033 and Sulfuric acid) or POST 37 (Fatty acid and Coconut oil) (d) days later.
[c]Weed species evaluated for control were slender oat (AVEBA), ripgut brome (BRODI), clover (TRFPR), soft chess (BROMO), lupine (LUPPU), medusahead (ELYCM) and hedgehog dogtailgrass (CYXEC). Values for each of the three evaluation dates (POST, 25 d and 50 d) followed by a different letter are significantly different at P = < 0.05. NR for species that were not evaluated because plants had either not emerged or had died from natural senescence or complete control.

Control of annual vegetation along roadsides using natural-based products and glyphosate. Steve L. Young. (Hopland Research and Extension Center, University of California, Hopland, CA 95449). A study was conducted at the University of California, Hopland Research and Extension Center (HREC) near Hopland, CA with natural-based products (Table 2) in comparison to glyphosate for control of several annual weeds common along roadsides. Plots were established February 21, 2002 at HREC along a roadside right-of-way. Soil type was a Pleasanton sandy loam (47% sand, 41% silt, 12% clay, pH 5.3, 2.5% organic matter and CEC of 18 meq/100 g soil). The plots were 10 by 30 feet with treatments replicated four times in a randomized complete block design. The treatments were broadcast-applied with a CO_2 pressurized backpack sprayer delivering 100 gpa at 36 psi using three XR 8002 flat-fan nozzles evenly spaced across a five foot boom. Control of slender oat and scarlet pimpernel was evaluated visually four times starting March 8 and ending May 24. Prior to natural moisture induced senescence of early winter annuals, control of soft chess, hare barley and broadleaf filaree was evaluated 3 times, starting on March 8. Control of turkey mullein and medusahead was evaluated April 25 and May 24. Natural-based products were applied four times starting February 26 and ending May 15. Glyphosate was applied twice February 26 and May 15.

Table 1. Herbicide application data.

Application date	2/26	3/27	4/18	5/15
Application timing[a]	POST	30 d	52 d	79 d
Air temperature (F)	78	73	70	79
Soil temperature	66	60	--	89
Relative humidity (%)	31	43	75	32
Wind speed (m/h)	0	0	5	6
Cloud cover (%)	0	0	50	0
Growth stage[b]				
Slender oat	< 6" to 5 leaves			
Pimpernel	< 6" to 4 leaflets			
Soft chess	< 4" to 4 leaves			
Hare barley	< 4" to 4 leaves			
Broadleaf filaree	<4" to 8 leaves			
Turkey mullein			< 5" to 8 leaves	
Medusahead			< 4" to 4 leaves	

[a]Treatments were applied postemergence (POST) and POST 30, 52 and 79 (d) days later.
[b]Growth stage was evaluated prior to initial application and includes height and leaf number. Additional applications on 3/27, 4/18 and 5/15 were made based on percent control from previous applications.

Due to the warm, dry spring, any remaining plants of broadleaf filaree, soft chess and hare barley had senesced following the third application of the natural-based products and were not included in a fourth evaluation. The natural-based products controlled broadleaf weeds better than grass weeds (Table 2). After 3 applications, control of broadleaf filaree, scarlet pimpernel and turkey mullein was 85% or greater. Acetic acid did not adequately control any of the grass weeds, except for one application on medusahead (100%). Plant essentials was the most effective natural-based product for control of soft chess, hare barley and medusahead at 80%, 94% and 100%, respectively. After four applications, pine oil showed the best control of slender oat at 71%, which was still significantly lower than one application of glyphosate (100%). Glyphosate controlled all vegetation, except the later emerging turkey mullein and scarlet pimpernel, at least 100% after one application. After a second application, control of these weeds with glyphosate was also 100% (data not included).

Table 2. Weed control of roadside vegetation with natural-based products and glyphosate.

Treatment[a]	Rate	Timing[b]	Weed control[c]						
			AVEBA	EROBO	BROMO	HORLE	ELYCM	ANGAR	ERMSE
	gal/A		%						
Acetic acid	10	POST	53b	60b	60a	NR	NR	NR	NR
Plant essentials	10	POST	59b	96a	64a	NR	NR	NR	NR
Pine oil	10	POST	53b	71ab	61a	NR	NR	NR	NR
Glyphosate	1.5	POST	75a	64b	60a	NR	NR	NR	NR
Control			0c	0c	0b	NR	NR	NR	NR
Acetic acid	15	30 d	50b	76b	40c	68b	NR	NR	NR
Plant essentials	15	30 d	64b	100a	53b	68b	NR	NR	NR
Pine oil	15	30 d	49b	93a	41c	41b	NR	NR	NR
Glyphosate		30 d	100a	100a	100a	100a	NR	NR	NR
Control			0c	0c	0d	0c	NR	NR	NR
Acetic acid	25	52 d	54c	94b	23d	54b	100a	91a	85b
Plant essentials	25	52 d	86ab	100a	80b	94a	100a	100a	100a
Pine oil	25	52 d	78b	99a	60c	93a	100a	95a	93ab
Glyphosate		52 d	100a	100a	100a	100a	100a	100a	0c
Control			0d	0c	0e	0c	0b	0b	0c
Acetic acid	25	79 d	36c	NR	NR	NR	60c	58ab	70ab
Plant essentials	25	79 d	69b	NR	NR	NR	84b	100a	99a
Pine oil	25	79 d	71b	NR	NR	NR	80b	50b	88a
Glyphosate	1.5	79 d	100a	NR	NR	NR	100a	21bc	53b
Control			0d	NR	NR	NR	0d	0c	0c

[a]All treatments were applied in a 100 gal/A total spray volume. Acetic acid (BurnOut®) @ 25% solution, plant essentials (Bioganic®) @ 100% solution, pine oil (Organic Interceptor®) @ 71% solution (5.67lbs ai/gal) and glyphosate (Roundup®) 41% (3lbs ae/gal).

[b]Timing of application was postemergence (POST) and POST 30, 52 and 79 (d) days later.

[c]Weed species evaluated for control of slender oat (AVEBA), scarlet pimpernel (ANGAR), soft chess (BROMO), hare barley (HORLE), broadleaf filaree (EROBO), turkey mullein (ERMSE) and medusahead (ELYCM). Values for each of the four evaluation dates (POST, 30 d, 52 d and 79 d) followed by a different letter are significantly different at P = < 0.05. NR for species that were not evaluated because plants had either not emerged or had died from natural senescence or complete control.

Mechanical cutting and natural-based products for control of jubata grass along roadsides. Steve L. Young. (Hopland Research and Extension Center, University of California, Hopland, CA 95449). A study was conducted at Jackson Demonstration State Forest on the north coast of California to test mechanical cutting of jubata grass and foliar applications of pelargonic acid, fatty acids and glyphosate on the re-growth. Jubata grass was the dominant vegetation with a few forbs growing between individual plants. The mature plants with an average basal diameter of 12 inches were cut to approximately one foot September 21, 2001, prior to site establishment. All plots were 10 by 25 feet with treatments replicated three times in a randomized complete block design. Herbicides were broadcast-applied May 9 with a CO_2 pressurized backpack sprayer delivering 100 gpa at 36 psi using three XR 8002 flat-fan nozzles evenly spaced across a five foot boom. Spot applications of herbicides were made June 27 to individual jubata grass clumps with the CO_2 pressurized sprayer and a single nozzle. Visual evaluations for jubata grass control were made approximately one month after each treatment with a final evaluation October 12.

Table 1. Herbicide application data.

Application date	5/9	6/27
Application timing[a]	POST	49 d
Air temperature (F)	61	67
Soil temperature (F)	68	60
Relative humidity (%)	64	71
Wind speed (m/h)	4	0
Cloud cover (%)	0	0
Re-growth[b]		
Jubata grass	12" clumps w/ 6-18" re-growth	12" clumps w/ 12-48" re-growth

[a]Treatments were applied postemergence (POST) and POST 49 (d) days later.
[b]Re-growth was evaluated prior to each application. Additional applications were made based on percent control from previous applications. Actual re-growth on June 27 for plants that had been either treated or untreated was 12-36" or 24-48(+)", respectively.

Since jubata grass is a perennial grass with extensive underground roots, control ratings are based on above-ground growth with the realization that one year of treatments and monitoring cannot provide conclusive results in terms of total plant kill. All natural-based products showed phytotoxicity on jubata grass re-growth after at least one application (Table 2). Control for all treatments peaked on July 25, following two applications of natural-based products and one application of glyphosate. Glyphosate maintained a high level of control (98%) through the last evaluation.

Table 2. Control of jubata grass after mechanical cutting and postemergence treatments.

Treatment[a]	Rate		Timing[b]	Evaluation Date	Jubata grass control[c]
	gal/A	Vol/vol			%
Fatty acid	20		POST	6/27/02	52b
Pelargonic acid	10		POST	6/27/02	18c
Glyphosate	2		POST	6/27/02	91a
Control				6/27/02	0d
Fatty acid		50/50	49 d	7/25/02	90b
Pelargonic acid		50/50	49 d	7/25/02	77c
Glyphosate			49 d	7/25/02	98a
Control				7/25/02	0d
Fatty acid			128 d	10/12/02	77b
Pelargonic acid			128 d	10/12/02	15c
Glyphosate			128 d	10/12/02	98a
Control				10/12/02	0c

[a]The first application (POST) was made in a 100 gal/A total spray volume. The second application (49 d) was by spot to individual clumps in a 50:50 mix. Fatty acids (Greenscape®) @ 20% and 50% solution, pelargonic acid (Scythe®) @ 10% and 50% solution (4.2 lbs ai/gal) and glyphosate (Roundup®) 41% (3lbs ae/gal).
[b]Timing of application was postemergence (POST) and POST 49 (d) days later. A final evaluation was conducted 128 d.
[c]Values for each of the three evaluation dates (POST, 49 d and 128 d) followed by a different letter are significantly different at $P = < 0.05$.

Mechanical cutting and natural-based products for control of French broom along roadsides. Steve L. Young. (Hopland Research and Extension Center, University of California, Hopland, CA 95449). A study was conducted at Jackson Demonstration State Forest on the north coast of California to test mechanical cutting of French broom and foliar applications of acetic acid, pelargonic acid, coconut oil and glyphosate on the re-growth. French broom, a woody perennial, was the dominant vegetation with a few forbs growing underneath the canopy. The mature plants with an average stem diameter of ½ inch were cut to approximately one foot in height September 21, 2001, prior to site establishment. All plots were 10 by 25 feet with treatments replicated three times in a randomized complete block design. The herbicides were broadcast-applied with a CO_2 pressurized backpack sprayer delivering 100 gpa at 36 psi using three XR 8002 flat-fan nozzles evenly spaced across a five foot boom. Postemergence applications were made March 29 and June 13. Visual evaluations for French broom control were made May 1 and July 25. A final control evaluation was made October 12.

Table 1. Herbicide application data.

Application date	3/29	6/13
Application timing[a]	POST	76 d
Air temperature (F)	74	62
Soil temperature (F)	52	60
Relative humidity (%)	44	69
Wind speed (m/h)	0	0
Cloud cover (%)	0	0
Re-growth[b]		
French broom	12" stumps w/ 4-10" re-growth	12" stumps w/ 6-30" re-growth

[a]Treatments were applied postemergence (POST) and POST 76 (d) days later.
[b]Re-growth was evaluated prior to each application. Additional applications were made based on percent control from previous applications. Actual re-growth on June 13 for acetic acid:10-18"; coconut oil: 6-8"; pelargonic acid: 6-8"; glyphosate: none; untreated control: 18-30".

Due to the fact that woody plants like French broom have extensive underground roots, control ratings are based on above-ground growth with the realization that one year of treatments and monitoring cannot provide conclusive results in terms of total plant kill. All natural-based products showed phytotoxicity on French broom re-growth after at least one application (Table 2). Coconut oil and pelargonic acid seemed to re-grow less after the first application than acetic acid but more than glyphosate. However, a final evaluation showed a decline in control to less than 80%. Control with acetic acid peaked on July 25 at 78%, but declined to 63% on October 12. Glyphosate maintained 98% or better control of French broom re-growth over the entire length of the experiment. Continued evaluations will be needed to determine the extent to which French broom is controlled by these treatments.

Table 2. Control of French broom after mechanical cutting and postemergence treatments.

	Application			
Treatment[a]	Rate	Timing[b]	Evaluation Date	French broom control[c]
	gal/A			%
Acetic acid	20	POST	5/1/02	57b
Pelargonic acid	10	POST	5/1/02	88a
Coconut oil	20	POST	5/1/02	93a
Glyphosate	2	POST	5/1/02	98a
Control			5/1/02	0c
Acetic acid	25	76 d	7/25/02	78c
Pelargonic acid	15	76 d	7/25/02	87bc
Coconut oil	30	76 d	7/25/02	90b
Glyphosate		76 d	7/25/02	99a
Control			7/25/02	0d
Acetic acid			10/12/02	63c
Pelargonic acid			10/12/02	80b
Coconut oil			10/12/02	78bc
Glyphosate			10/12/02	98a
Control			10/12/02	0d

[a]All treatments were applied in a 100 gal/A total spray volume. Acetic acid (BurnOut®) @ 25% solution, pelargonic acid (Scythe®) @ 60% solution (4.2 lbs ai/gal), coconut oil (Bio-SAFE®) @ 100% solution and glyphosate (Roundup®) 41% (3lbs ae/gal).
[b]Timing of application was postemergence (POST) and POST 76 (d) days later. A final evaluation was conducted 177 d.
[c]Values for each of the three evaluation dates (POST, 76 d and 177 d) followed by a different letter are significantly different at $P = < 0.05$.

Control of gorse and other woody and herbaceous vegetation along roadsides with natural-based products. Steve L. Young. (Hopland Research and Extension Center, University of California, Hopland, CA 95449). A study was established at Jug Handle State Reserve on the northern coast of California near Mendocino, CA to compare the efficacy of natural-based products and glyphosate for control of roadside vegetation. Gorse, a woody perennial, was the dominant vegetation with blackberry, another woody perennial, velvet grass and sweet vernalgrass growing in the open spaces. The most abundant forb was common catsear. Total vegetation control was evaluated with an experimental herbicide (DRA-033), fatty acid, coconut oil, sulfuric acid and glyphosate. The reserve was mowed spring 2002, prior to site establishment May 1, 2002. All plots were 10 by 30 feet with treatments replicated four times in a randomized complete block design. The herbicides were broadcast-applied with a CO_2 pressurized backpack sprayer delivering 100 gpa at 36 psi using three XR 8002 flat-fan nozzles evenly spaced across a five foot boom. Initial applications were made May 2. Re-treatment applications of fatty acid and coconut oil were made twice. Sulfuric acid and DRA-033 re-applications were made only once because of excessive vegetation growth. Visual evaluations for weed control were made prior to re-treatments May 10, June 11 and July 3. After visual evaluations July 3, abundant vegetative growth prohibited re-treatment of the natural-based products. A final evaluation for vegetation control was made September 5.

Table 1. Herbicide application data.

Application date	5/1	5/30	6/27
Application timing[a]	POST	29 d	57 d
Air temperature (F)	56	63	62
Soil temperature (F)	60	68	78
Relative humidity (%)	82	79	84
Wind speed (m/h)	5	7	2
Cloud cover (%)	100	0	0
Growth stage[b]			
Gorse	5-18 cm vines		
Blackberry	8-25 cm vines		
Velvet grass	8-12 cm to 12 leaves		
Sweet vernalgrass	10-30 cm w/ inflor		
Common catsear	rosette, 5-6 cm tall		

[a]Growth stage was evaluated prior to initial application. Additional applications on 5/30 and 6/27 were made based on percent control from previous applications. For initial application, gorse was the re-sprouts from spring 2002 mowing, sweet vernalgrass was starting to show inflorescence (inflor).

[b]Treatments were applied postemergence (POST) and POST 29, 57 (d) days later.

All natural-based products showed phytotoxicity on vegetation after at least one application (Table 2). Fatty acids or coconut oil provided 91% or greater control of all vegetation after three applications. On September 5, efficacy of these two treatments had dropped to less than 75% for all vegetation except the two grasses. Two applications of sulfuric acid were effective for controlling gorse and the berries (>83%), but the remaining vegetation seemed to benefit from the reduced competition. Control had dropped noticeably (<35%) after a final evaluation on September 5. DRA-033 was not an effective weed control treatment. One application of glyphosate provided 95% or better control of catsear and the grasses for the entire season. Gorse and berry control was adequate (86%) and poor (61%), respectively, on September 5. No treatment, except for glyphosate on gorse, controlled the woody perennials for the entire season. One application of glyphosate or three applications of the natural-based products, fatty acid and coconut oil, were the most effective for short-term (57 d) control of all vegetation.

Table 2. Control of gorse and other woody and herbaceous vegetation along roadsides.

Treatment[a]	Rate	Timing[b]	Gorse	Berries	Weed control[c] Vernal	Velvet	Catsear
	gal/A				%		
DRA-033	30	POST	64b	81b	53c	56c	69b
Fatty acids	25	POST	99a	96a	91ab	93a	88a
Coconut oil	25	POST	95a	99a	93a	91a	85a
Sulfuric acid	40	POST	95a	95a	83b	76b	86a
Glyphosate	2	POST	10c	31c	40d	40d	21c
Control			0c	0d	0e	0e	0d
DRA-033	30	29 d	55b	61c	23d	33d	48c
Fatty acids	25	29 d	97a	88ab	91ab	91ab	79b
Coconut oil	25	29 d	88a	83b	79b	78b	66bc
Sulfuric acid	35	29 d	96a	83b	53c	56c	64bc
Glyphosate		29 d	99a	95a	100a	100a	100a
Control			0c	0d	0e	0e	0d
DRA-033		57 d	26c	23d	8c	8c	10c
Fatty acids	30	57 d	97a	96a	94a	94a	95a
Coconut oil	30	57 d	97a	100a	91a	91a	93a
Sulfuric acid		57 d	68b	36c	33b	33b	54b
Glyphosate		57 d	100a	81b	100a	100a	99a
Control			0d	0e	0c	0c	0c
DRA-033		127 d	5c	18b	0c	0c	31dc
Fatty acids		127 d	61b	65a	85ab	85a	74ab
Coconut oil		127 d	50b	50a	65b	65b	59abc
Sulfuric acid		127 d	13c	5b	13c	10c	35bcd
Glyphosate		127 d	86a	61a	100a	100a	95a
Control			0c	0b	0c	0c	0d

[a]All treatments were applied in a 100 gal/A total spray volume. DRA-033 @ 100% solution, fatty acids (Greenscape®) @ 100% solution, coconut oil (Bio-SAFE®) @ 100% solution (700g/liter), sulfuric acid (CT-311) @ 50% solution and glyphosate (Roundup®) 41% (3lbs ae/gal).
[b]Timing of application was postemergence (POST) and POST 29 and 57 (d) days later. A final evaluation was conducted 127 d.
[c]Weed species evaluated for control were gorse (Gorse), Himalaya blackberry and California blackberry (Berries), velvet grass (Velvet) and sweet vernalgrass (Vernal) and common catsear (Catsear). Values for each of the four evaluation dates (POST, 29 d, 57 d and 127 d) followed by a different letter are significantly different at P = < 0.05.

Resistance of spiny sowthistle to thifensulfuron-methyl and imazamox. Kee-Woong Park[1], Carol A. Mallory-Smith[1], Amanda McKinley[2], and Stephen Reinertsen[2]. ([1]Department of Crop and Soil Science, Oregon State University, Corvallis, OR 97331; [2]The McGregor Company, Colfax, WA 99111) Suspected sulfonylurea resistant spiny sowthistle was collected near Colfax, WA, from two fields that had been in winter wheat/lentil rotations since at least 1988. Since 1989, imazethapyr was applied to all lentil crops and thifensulfuron-methyl was applied to about one-half of the wheat crops. Greenhouse studies were conducted to determine if the spiny sowthistle was resistant to thifensulfuron-methyl and imazamox. Spiny sowthistle seeds were placed in 98-cell trays (26 ml/cell). Fourteen days later, plants were transplanted into 6 by 6 cm pots containing a commercial potting mix. Plants were grown in a greenhouse with 16 h supplemental lighting and 25/20C day/night temperature. Experiments were conducted in a completely randomized design with four replications. Herbicide treatments were applied when the plants were in the 6 to 7-lf stage with an overhead compressed air sprayer calibrated to deliver 187 L/ha. A nonionic surfactant at 0.25% (v/v) was added to all treatments. The study was repeated. Aboveground biomass was harvested 3 weeks after treatment, dried at 60 C for 48 hr, and weighed. Biomass data are reported as the percent of the untreated control.

Resistance was confirmed in both collections (R1 and R2). Biomass of the susceptible (S) biotype was reduced by 80% by thifensulfuron-methyl at 30 g ai/ha. However, neither resistant biotype was affected at this rate. The rate of thifensulfuron-methyl required for 50% growth reduction was 1293 g ai/ha and 972 g ai/ha for the resistant biotypes, R1 and R2, respectively, but only 2.3 g ai/ha for the susceptible biotype. The two resistant biotypes also were resistant to imazamox. The rate of imazamox required for 50% growth reduction was 118 g ai/ha for R1 and 80 g ai/ha for R2, and 7 g ai/ha for the susceptible biotype.

Table. Biomass as a percent of the untreated control for thifensulfuron-methyl and imazamox resistant (R) and susceptible (S) spiny sowthistle.

	Thifensulfuron-methyl			Imazamox		
Rate	R1	R2	S	R1	R2	S
g ai/ha			%			
1	99	96	85	120	98	95
10	101	102	31	89	86	51
30	97	99	20	81	72	22
100	90	94	19	66	57	17
300	77	81	-	47	37	-
1000	64	57	-	25	23	-
3000	29	30	-	17	16	-
10000	18	19	-	15	16	-
$LSD_{0.05}$	11	19	8	10	16	7

Estimating a rotation's selection pressure for weeds, based on jointed goatgrass demographics. Randy L. Anderson. (USDA-ARS, Brookings SD 57006). Crop rotations are changing in the Central Great Plains, as producers are adding corn and proso millet to the winter wheat-fallow rotation. Because the sequence of winter and summer annual crops will influence weed communities, we were interested in recognizing population trends with weeds as affected by crop sequencing. Population dynamics of jointed goatgrass, a common weed in winter wheat, have been quantified in this region; these data provide an opportunity to estimate selection pressure of various rotations for the ecological niche occupied by winter annual grasses. Our goal is to gain insight for designing rotations that minimize selection pressure for weeds.

We developed an empirical simulation model to estimate changes in jointed goatgrass seedbank density based on the following parameters. Seed survival is 30, 6, 3, and 2% after 1, 2, 3, and 4 years in the seedbank, respectively; survival % was based on the interval from the last winter wheat crop. Seedling emergence is 20% of the seedbank population in the first two years after seed shed, and 10% in years 3 and 4. Approximately 80% of jointed goatgrass seedlings will emerge after winter wheat planting. Seed production by jointed goatgrass was based on an average emergence time and interference with winter wheat; each plant produces 90 seeds. We assumed 10% seed removal with winter wheat grain during combine harvesting. Also, we assumed that seedlings during intervals between winter wheat crops would be controlled, therefore not producing seeds. Demographic data for jointed goatgrass represented a no-till, direct-seeded production system.

We compared two cultural systems for winter wheat, a conventional system comprised of a semi-dwarf cultivar planted at 45 kg/ha with N fertilizer broadcast before planting, and a competitive canopy comprised of a tall cultivar planted at 67 kg/ha with N fertilizer placed near the seed in a band. The competitive canopy reduces jointed goatgrass seed production per plant 45%.

Starting with one jointed goatgrass plant in winter wheat, we calculated population dynamics among five rotations comprised of winter wheat (W), corn (C), proso millet (M), and fallow (F). We compared W-F, W-C-F, W-C-M-F, W-W-C-M, and W-W-C-C-M-M. Simulations were run for 12 years to compare all rotations after complete cycles. Because winter wheat growth is reduced when grown after winter wheat, we increased jointed goatgrass seed production 10% in the second wheat crop.

After 12 years with W-F, seedbank density increased to 21,163 seeds in conventional winter wheat (Table). Population growth of jointed goatgrass increased approximately four-fold with each cycle of W-F (Figure). Lowest density occurred with W-C-M-F; only 0.02 seeds remained after 12 years. To aid comparisons among rotations, we converted seed densities to selection pressure based on seed density in W-C-M-F with the competitive winter wheat canopy (Table). Selection pressure allows us to quantify the effect rotations have on a selected ecological niche, as occupied by jointed goatgrass and other winter annual grasses.

Rotations varied considerably in selection pressure for jointed goatgrass; note the 1 million-fold difference between W-F and W-C-M-F with the conventional canopy. The three-year interval before the next winter wheat crop favored the natural decline of seed density in the seedbank. The W-C-F rotation also was favorable for seed decline, but its selection pressure was 50-fold greater than W-C-M-F.

Organizing rotations to include at least two years between winter wheat crops reduces the selection pressure drastically compared to W-F. Yet, this 2-year interval is not effective if the rotation includes two winter wheat crops grown consecutively. Selection pressure of W-W-C-M was 1.6 million, a 64,000-fold difference compared to W-C-F. In a second example, seedbank density in W-W-C-C-M-M with the conventional winter wheat canopy was approximately 100-fold less than found in W-W-C-M, reflecting the 4-year interval of summer annual crops impact on seedbank density. But, growing winter wheat two years in a row still minimized the interval effect; W-C-F and W-W-C-C-M-M have equal frequency of winter wheat (1/3 of the rotation is in winter wheat), yet selection pressure was more than 60-fold greater in W-W-C-C-M-M than in W-C-F.

Increasing competitiveness of winter wheat, which reduces seed production of jointed goatgrass plants 45%, can have a striking impact on selection pressure. With W-F and W-W-C-M, selection pressure was reduced at least 35-fold compared to winter wheat with a conventional canopy.

Organizing rotations in a cycle-of-four with only one winter wheat crop, such as W-C-M-F, is most effective in minimizing the winter annual niche for weeds. In rotations with continuous cropping, replacing fallow in W-C-M-F with a cool season crop such as dry pea may achieve the same impact on weed dynamics. Dry pea is planted in early April, enabling producers to control jointed goatgrass seedlings at planting time; thus, selection pressure for winter annual grasses with W-C-M-dry pea may be similar to W-C-M-F.

A competitive canopy with winter wheat also may improve herbicide impact on population dynamics. For example, imazamox controls jointed goatgrass in winter wheat; the label recommends applying imazamox once every four years. Integrating this tactic with our simulation of population dynamics in W-F showed that jointed goatgrass population would remain static across 12 years with the conventional winter wheat canopy if imazamox eliminated 95% of jointed goatgrass seedlings. In contrast, only 80% control efficacy was needed to prevent population growth with the competitive canopy in W-F.

Table. Change in jointed goatgrass seedbank density after 12 years in each rotation. Selection pressure of various rotations was compared to W-C-M-F. Simulation calculations started with one plant in winter wheat in year 1, and were based on population dynamics of jointed goatgrass in the Central Great Plains. Conventional wheat canopy was a semi-dwarf winter wheat planted at 45 kg/ha with N fertilizer broadcast before planting; the competitive canopy was a tall cultivar planted at 67 kg/ha with N fertilizer placed in a band near the seed.

	Winter wheat canopy		Winter wheat canopy	
Rotation	Conventional	Competitive	Conventional	Competitive
	--------- seeds/seedbank ----------		--------- selection pressure ----------	
W[a]-F	21,163	603	5,300,000	150,750
W-C-F	2	0.131	500	33
W-C-M-F	0.02	0.004	5	1
W-W-C-M	6397	166	1,600,000	41,500
W-W-C-C-M-M	63	9	15,750	2,250

[a] W – winter wheat; C – corn; M – proso millet; F – fallow.

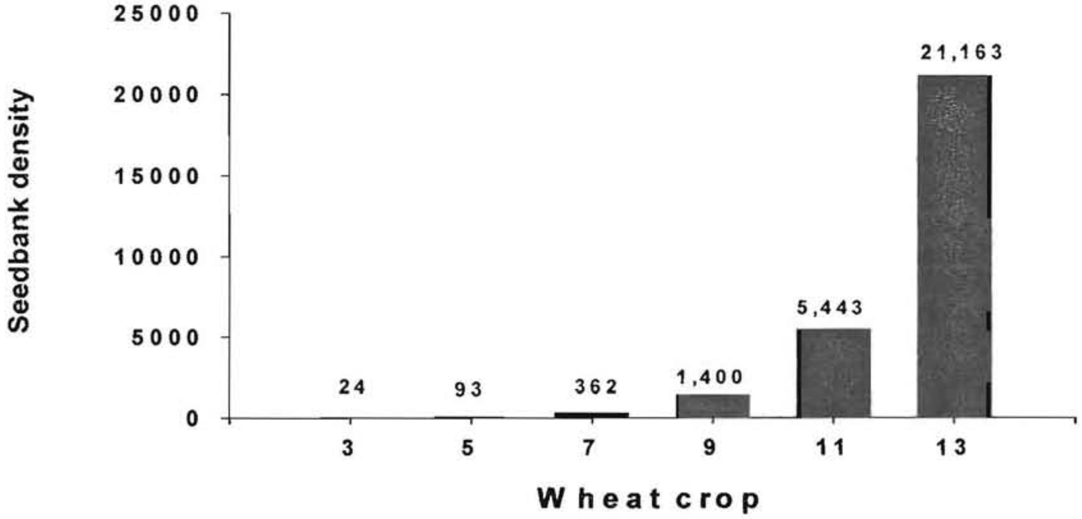

Figure. Seedbank density of jointed goatgrass at planting time of each winter wheat crop in W-F. Simulation started with one plant in winter wheat and estimated population growth across 12 years. The X axis represents wheat crop in years after initial simulation.

Sequencing crops to reduce weed community density. Randy L. Anderson and Dwayne L. Beck. (USDA-ARS, Brookings, SD 57006 and Dakota Lakes Research Farm, Pierre SD 57501). Rotations are rapidly changing in the Great Plains because of no-till systems. In place of winter wheat-fallow, producers are seeking rotations comprised of a diversity of crops. To help producers plan alternative rotations, a cropping systems study was initiated near Pierre SD in 1990. Sixteen rotations comprised of various combinations of crops are being evaluated in a no-till production system.

After 10 years, weed communities among rotations differed considerably. To quantify this difference, we recorded weed densities among four rotations: winter wheat-fallow (W-F), winter wheat-chickpea (W-CP), winter wheat-corn-chickpea (W-C-CP), and winter wheat-corn-soybean-dry pea (W-C-SB-Pea). The rotations include a range of winter and summer annual crops, with winter wheat and dry pea being winter/spring annual (cool season) crops whereas corn, soybean and chickpea are summer annual crops. Experimental design was a randomized complete block with four replications. Plot size was 150 by 300 feet.

Weeds were controlled with herbicides commonly used in the region: bromoxynil + MCPA in winter wheat, nicosulfuron + primsulfuron-methyl in corn, and imazethapyr + metribuzin in the legumes. Glyphosate controlled weeds during non-crop intervals and at planting. Weeds in 10 randomly-placed 0.1 m^2 quadrats were counted in July of 2001 and 2002. Data for each rotation were averaged across crops and years.

Weed density averaged 31 plants/m^2 in W-F, with downy brome and Japanese chess being the main weed species (see Figure). When chickpea was included in the rotation (W-CP), weed density increased to 60 plants/m^2, with summer annual weeds such as green foxtail, witchgrass and redroot pigweed as well as the brome species comprising the weed community. When a second summer annual crop, corn, was added to the rotation (W-C-CP), brome species were eliminated in the weed community, but summer annual weeds remained at a density of 25 plants/m^2. In the four-year rotation of W-C-SB-Pea, with a balance of two winter/spring crops (winter wheat and dry pea) followed by two summer annual crops (corn and soybean), weed density was only 5 plants/m^2, a 12-fold difference compared to weed density in W-CP and a five-fold difference compared to W-C-CP. Two years in warm season crops reduced winter annual weeds whereas the two cool season crops minimized density of warm season species.

The effect of rotations on weed population dynamics can be partially explained by rate of weed seed decline in the soil seed bank. Seed survival in soil is usually short, with the greatest loss in live seeds occurring during the first two years after entering the seed bank. Studies have shown that seed density can decline 90% in two years. Yet, seed decline within one year was not sufficient to reduce weed density, as demonstrated with W-CP. Other studies have shown that seed density of downy brome and green foxtail is four-fold greater after one year in the seed bank compared to two years.

A second factor contributing to the two-year interval effect is rate of population growth by weeds. A study in northeastern Colorado estimated the population growth of green foxtail in continuous corn. If control of green foxtail in corn averaged 90%, a single green foxtail plant in year one led to 18 plants in year two and 324 plants in the third year. Population growth was exponential, leading to high densities of green foxtail in the third year of corn. A similar trend has been observed with downy brome population growth in winter wheat. The change in life cycle among crops enables producers to control seedlings of weeds with different life cycles before seeds are produced.

It has long been noted that rotating crops with different life cycles can disrupt population growth of weeds. Our data suggest rotations that include two-year intervals within each life cycle of winter or summer annual crops will maximize the life cycle effect on weed density. A unique aspect of Great Plains crop production is that both winter and summer annual crops are economically-viable options, providing producers with an opportunity to reduce weed community density by crop sequencing.

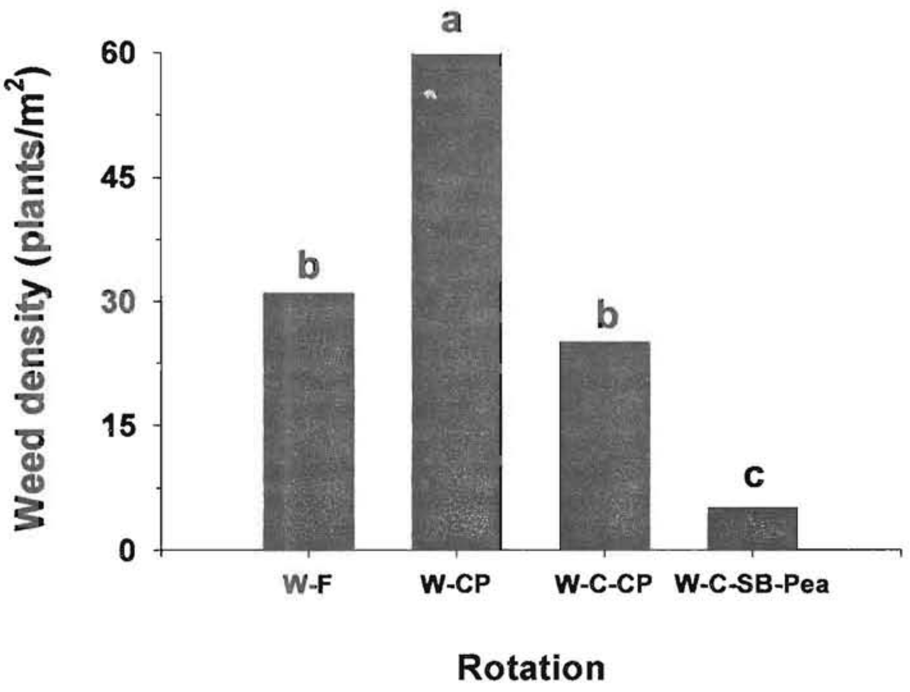

Figure. Weed densities within various rotations; data averaged across crops and years within a rotation. Bars followed by the same letter are not significantly different as determined by Fisher's LSD (0.05). Study conducted near Pierre, SD.

Crop and Persian darnel rooting depth. Johnathon D. Holman, John M. Wraith and Alvin J. Bussan. (Land Resources and Environmental Sciences, Montana State University, Bozeman, MT 59717) Water is a major limiting resource of cropping systems of the northern Great Plains and other arid regions. Weeds compete with crops for the limited water resources. A key component to crop success is the ability to extract water from the soil profile. The goal of this research was to evaluate the soil water profile at the end of the growing season following growth of Persian darnel and three different crops. The final water profile might provide insight into water use patterns of the weed and crops and the mechanisms of competition between Persian darnel and wheat, canola and sunflower.

A study was conducted at Bozeman, MT in 2001 to evaluate rooting depth of Persian darnel compared to spring wheat, canola and sunflower. In 2001, monocultures of spring wheat, canola, sunflower and Persian darnel were seeded in a randomized complete block with four replications and 0.42 by 0.35 m experimental units in an area planted to spring wheat the previous year. Soil moisture readings were taken at harvest from each plot at 20 cm soil depth increments from a soil depth of 10 cm to 170 cm with a soil neutron probe. Neutron probe readings were converted to volumetric soil moisture content using a previously determined conversion factor from soil laboratory analysis (data not shown). Soil volumetric moisture content was then converted to soil matric potential using the Van Genuchten soil moisture retention model (Wraith and Or 1998) (Equation 1):

$$2_{(\Theta)} = 2_r + (2_s - 2_r) * [1 + (\forall * \Theta *)^n]^{-m} \qquad [1]$$

where Θ is the matric potential, 2_r and 2_s are the residual and saturated water contents, respectively, and $\forall$, n and m are parameters fit depending on the shape of the $2_{(\Theta)}$ curve. The soil moisture retention model and corresponding parameter estimates were fit using nonlinear regression (Figure 1). All parameter estimates were significant at $P \leq 0.05$ (data not shown). Effective rooting depth of the four species was estimated from soil matric potential. Based on previous research, soil moisture was assumed ineffectively extracted, or that plant rooting ceased at a given soil depth when matric potential was greater than -1 bar (Gregory 1998).

Soil matric potential was regressed with soil depth for each species using least squares regression. A logarithmic function was unable to be fit to the data set likely due to the lack of observations and stochastic response. Crop and Persian darnel rooting depth was compared using mean separation (alpha = 0.05) at each 20 cm soil depth interval. Persian darnel and canola rooting depth was estimated to be 60 cm, spring wheat rooted to 100 cm and sunflower rooted below 170 cm (Figure 2). Persian darnel rooting depth was not different than spring wheat or canola, but was less than sunflower (Table 1 and Figure 2). The deeper rooting depth of sunflower might enable it to capture soil resources, i.e. nutrients and moisture, in an area unattainable by Persian darnel. These results support previous research which showed Persian darnel reduced the yield of spring wheat and canola more than sunflower (Holman 2002).

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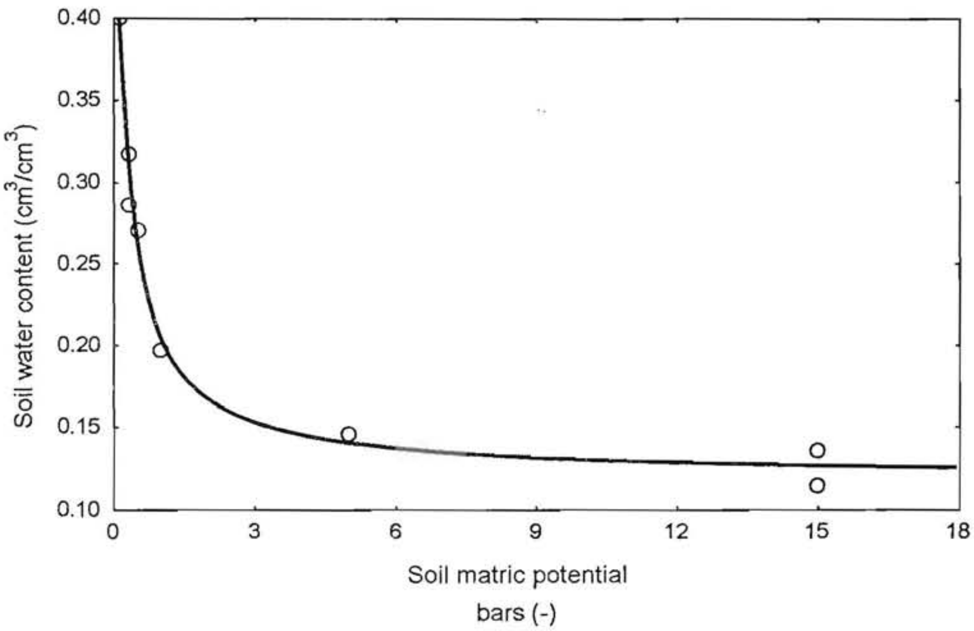

Figure 1. Soil moisture retention curve. Data were fitted to Van Genuchten equation (Equation 1).

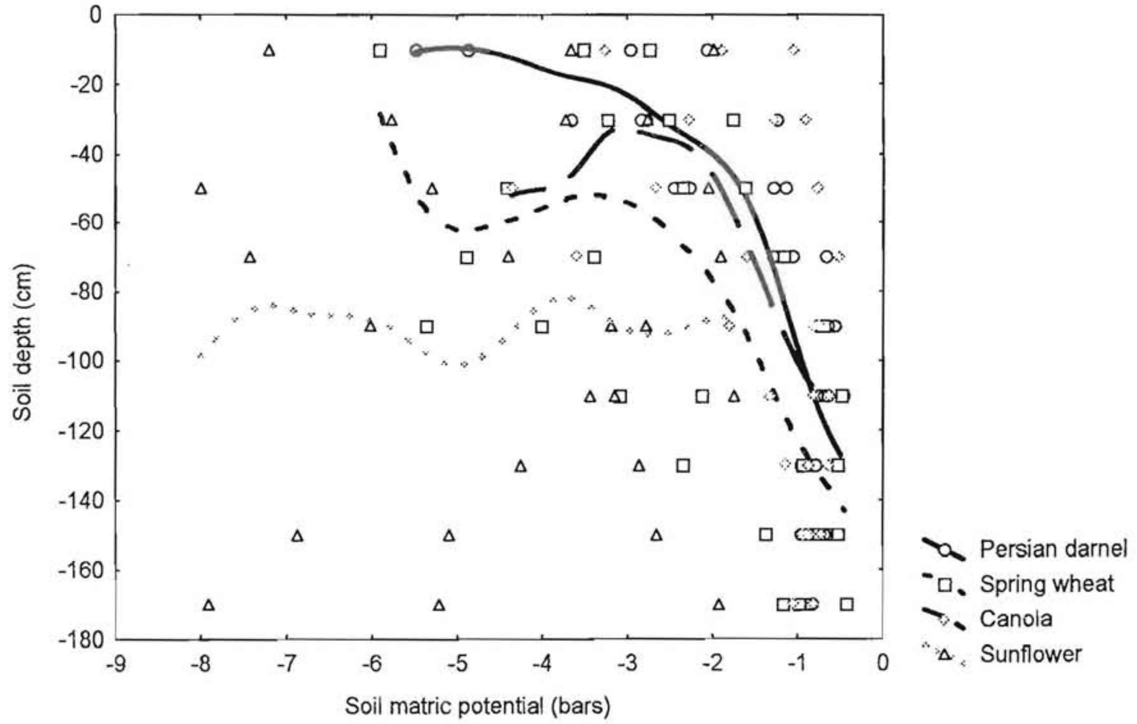

Figure 2. Soil matric potential by soil depth. Soil matric potential measured from spring wheat, canola, sunflower and Persian darnel monoculture plots.

Table 1. Mean soil matric potential at soil depth in Persian darnel, spring wheat, canola and sunflower.

	Soil depth (cm)[1]								
Species	-10	-30	-50	-70	-90	-110	-130	-150	-170
Persian darnel	-3.84 (0.80)	-2.63 (0.50)	-1.78 (0.33)	-1.02 (0.12)	-0.68 (0.04)	-0.64 (0.06)	-0.78 (0.09)	-0.79 (0.07)	-0.86 (0.02)
Spring wheat	-4.04 (0.95)	-2.49 (0.42)	-2.79 (0.83)	-3.14 (1.07)	-3.35 (1.37)	-1.90 (0.75)	-1.27 (0.54)	-0.89 (0.24)	-0.86 (0.22)
Canola	-2.05 (0.63)	-1.49 (0.39)	-2.60 (1.03)	-1.90 (0.89)	-1.12 (0.33)	-0.92 (0.20)	-0.88 (0.13)	-0.84 (0.05)	-0.93 (0.11)
Sunflower	-4.28 (1.52)	-4.07 (0.88)	-5.67 (2.18)	-4.58 (1.58)	-3.99 (1.01)	-2.77 (0.51)	-3.33 (0.45)	-4.87 (1.22)	-5.01 (1.73)

[1] Mean soil matric potential and standard error

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