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FOREWORD

The 2015 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.

Traci Rauch
Research Progress Report Editor
Western Society of Weed Science
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TABLE OF CONTENTS

Project 4: TEACHING AND TECHNOLOGY TRANSFER

Detecting herbicide resistant kochia (*Kochia scoparia*) in Utah. Heather E. Olsen and Corey V. Ransom (Plant, Soils, and Climate Department, Utah State University, Logan, Utah 84322-4820) Currently, the only documented case of herbicide resistance in weeds in Utah is a reported herbicide resistant kochia located around an industrial site in Box Elder County in 1998. In surrounding states, herbicide resistant kochia has been documented on roadsides, railways, in corn, wheat, and other cereal grains. We believe the lack of further herbicide resistant cases in Utah is due to the absence of documentation, rather than the absence of resistance. Seeds from kochia accessions growing in Utah were collected in the fall of 2014 from three geographically distinct cropping regions in Utah (northern, central, and southern). A total of 85 accessions were collected throughout the state, with approximately the same number of accessions from each region, for use in two discriminating dose experiments. One experiment was designed to evaluate resistance to an ALS herbicide (chlorsulfuron) and the other to evaluate resistance to a growth regulator herbicide (dicamba). Seeds from each accession were planted into potting mix and grown under greenhouse conditions in spring 2015. When plants were at the 3 to 4 leaf stage, they were treated with chlorsulfuron at 0.25 oz ai/A, or in the second experiment, treated with dicamba at 4 oz ai/A. All treatments were applied using an enclosed chamber sprayer; for the chlorsulfuron treatment, spray delivery was 20 gpa, for the dicamba treatment spray delivery was 18 gpa. Non-ionic surfactant was added to all treatments at the rate of 0.25% v/v. For each experiment, the number of plants showing injury symptoms (or complete necrosis) versus the number of uninjured plants was counted for each accession at 7, 14, and 21 DAT. These counts were used to calculate a cumulative injury rating for each accession (Table). One accession failed to have any germination. Accessions showing resistance to the discriminating dose will undergo further dose-response experiments in spring 2016.

Table. The number of kochia accessions showing varying levels of resistance to two discriminating dose herbicide applications at 21 DAT.

Treatment[1]	Rate	Very highly resistant (0% injury)	Highly resistant (1-10% injury)	Moderately resistant (11-49% injury)	Moderately susceptible (50-79% injury)	Highly susceptible (80-99% injury)	Very highly susceptible (100% injury/death)
	oz ai/A	——— number of unique kochia accessions (% of total accessions tested[2]) ———					
Chlorsulfuron	0.25	15 (18)	14 (17)	23 (27)	6 (7)	15 (18)	11 (13)
Dicamba	4	0 (0)	3 (4)	38 (45)	32 (38)	10 (12)	1 (1)

[1]All treatments were applied with nonionic surfactant (NIS) at 0.25% v/v.
[2]The accession that failed to germinate was excluded from this calculation; the total number of accessions was therefore 84.

<u>The influence of herbicide application gallonage on medusahead control.</u> Heather Olsen and Corey V. Ransom (Plants, Soils, and Climate Department, Utah State University, Logan, Utah, 84322-4820) A study was conducted in spring 2015 to evaluate the influence of decreasing herbicide application gallonage rates on medusahead control. Medusahead was grown in the greenhouse and treatments were applied when the medusahead had 2 to 4 tillers present. Each pot was considered a plot and were arranged in a randomized design with six replications and repeated. Applications of imazapic, with and without the addition of ammonium sulfate, were made at the following spray volumes: 20 gpa, 15 gpa, 10 gpa, 5 gpa, and 2.5 gpa. All treatments included the addition of MSO at 1.5 pt/A and were applied using an enclosed chamber sprayer. Spray volume was adjusted by changing the speed of the sprayer (Table 1). Water sensitive paper was used to evaluate the differences among treatment coverage (Figure 1). Four water sensitive cards were used per treatment. Each card was scanned using a business card scanner, and then the number of droplets were counted using the DepositScan software (Table 2). Visual injury and control ratings were conducted at one and two weeks after treatment. At the end of each trial, plant tissue was cut at the soil surface and dry weight biomass was measured. Preliminary analysis of injury differences among treatments is shown in Table 3. Significant injury and reduced medusahead biomass was observed in all treatments when compared to the untreated; however, the imazapic treatment without AMS applied at 2.5 gpa showed significantly less injury and less reduction of biomass than the other treatments.

Table 1. The treatment rates, desired gallonage, and sprayer speed used to evaluate the influence of herbicide application gallonage on medusahead control.

Treatment[1]	Rate	Gallonage	Sprayer speed[2]
	lb ai/A	gpa	mph
untreated check	--	--	--
imazapic	0.156	20	0.9
imazapic + AMS[3]	0.156	20	0.9
imazapic	0.156	15	1.21
imazapic +AMS	0.156	15	1.21
imazapic	0.156	10	1.8
imazapic + AMS	0.156	10	1.8
imazapic	0.156	5	3.6
imazapic + AMS	0.156	5	3.6
imazapic	0.156	2.5	4 (7.2)
imazapic + AMS	0.156	2.5	4 (7.2)

[1]All treatments included MSO at 1.5 pt/A.
[2]The chamber sprayer had an upper limit of 4 mph. To achieve the 2.5 gallons per acre at a lower speed than the required 7.2 mph, the boom height was increased.
[3]AMS (Actamaster) at 3.4 lb/gal

Table 2. The means separation values for the number of droplets per card for each treatment.

Treatment[1]	Gallonage	Number of droplets[2]	Coverage
	gpa		%
imazapic	20	1559.75 gh	59.72 b
imazapic+AMS	20	1226.5 h	64 a
imazapic	15	2485.33 ef	48.76 d
imazapic +AMS	15	2015 fg	52.07 c
imazapic	10	3235.58 bc	35.75 f
imazapic + AMS	10	3188.5 bcd	38.18 e
imazapic	5	3814.58 a	22.27 g
imazapic + AMS	5	3504.58 ab	20.19 g
imazapic	2.5	2954.83 cde	12.14 h
imazapic + AMS	2.5	2729.25 de	10.4 h

[1] All treatments were applied at a rate of 0.156 lb ai/A and included MSO at 1.5 pt/A.
[2] Within a column, numbers followed by the same letter are not significantly different

Table 3. Injury ratings and dry weight measurements for medusahead treated with imazapic with and without AMS at varying gallonages.

Treatment[1]	Gallonage	Injury (1WAT)[2]	Injury (2WAT)	Dry Weight
	gpa	%	%	grams
untreated	--	0 d	0 c	2.104 a
imazapic	20	59.58 a	76.92 a	0.306 c
imazapic+AMS	20	39.17 b	70.92 a	0.447 c
imazapic	15	37.5 b	72.58 a	0.402 c
imazapic +AMS	15	40 b	71.67 a	0.465 c
imazapic	10	43.33 b	74.83 a	0.378 c
imazapic + AMS	10	39.17 b	70.5 a	0.362 c
imazapic	5	45.83 b	75.5 a	0.501 c
imazapic + AMS	5	40 b	70.75 a	0.461 c
imazapic	2.5	15.42 c	43.25 b	0.949 b
imazapic + AMS	2.5	39.58 b	70.67 a	0.388 c

[1] All treatments were applied at a rate of 0.156 lb ai/A and included MSO at 1.5 pt/a.

[2] Within a column, numbers followed by the same letter are not significantly different

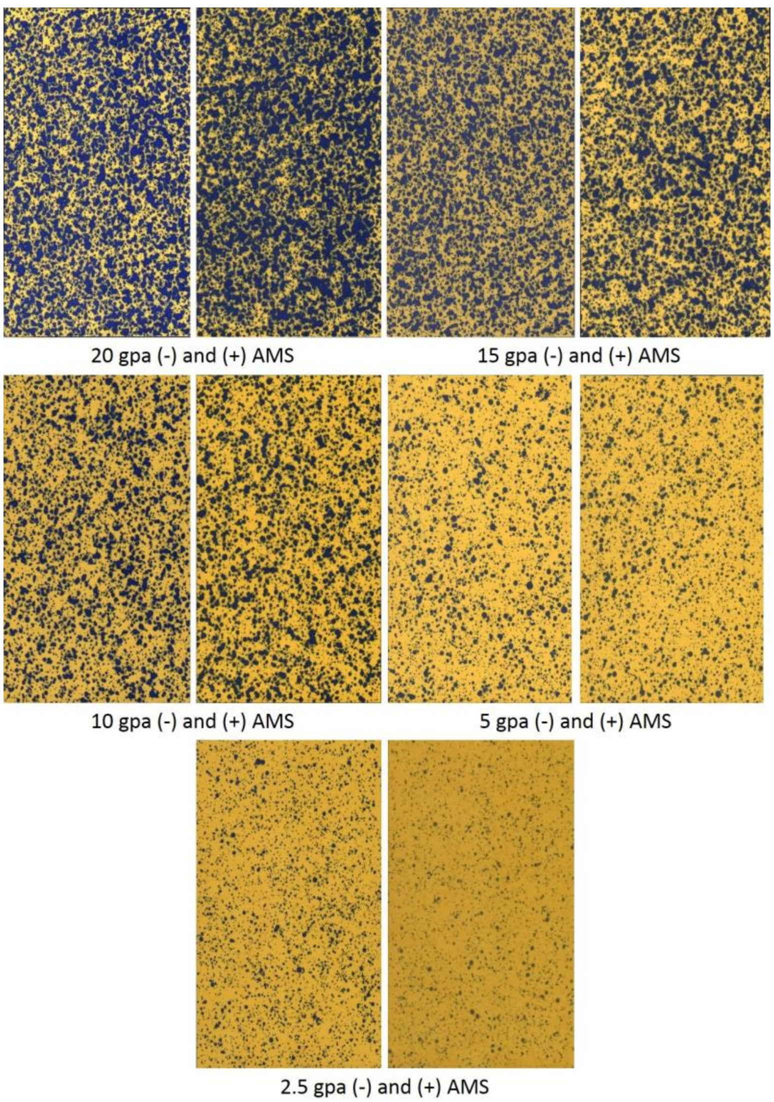

Figure 1. Water sensitive paper showing the differences among coverage of imazapic delivered at each of the decreasing spray volumes, with and without the addition of AMS.

Evaluating the effect of herbicide application timing for rush skeletonweed control in Northern Utah. Heather Olsen and Corey V. Ransom (Plants, Soils, and Climate Department, Utah State University, Logan, Utah, 84322-4820) A study was established in Box Elder County, Utah to evaluate the effect of application timing of six different herbicides on rush skeletonweed control. Plots were 10 by 30 ft arranged in a randomized complete block design with four replications. Six herbicides were evaluated for control efficacy when applied at a spring/rosette stage versus a fall/mature stage application timing (Table 1). All herbicide treatments were applied using a CO_2 pressurized backpack sprayer calibrated to deliver 18 gpa at 30 psi. Non-ionic surfactant was added to all treatments at the rate of 0.25% v/v. Rush skeletonweed injury and control were evaluated visually in summer 2015, at either 14 (for spring application timings) or 9 MAT (for fall application timings), density counts were also conducted to evaluate treatment success (Table 2).

Table 1. Application date and growth stage data.

Location	Howell, Utah	
Application date	May 13, 2014	October 24, 2014
Rush skeletonweed growth stage	rosette to 3" bolt	flowering to senescent

In general, treatments applied in the fall timing controlled rush skeletonweed better than when applied in the spring, with the exception of picloram which performed equally well when applied in either spring or fall. The chlorsulfuron and 2,4-D treatments provided the least amount of control when applied at either timing.

Table 2. Control of rush skeletonweed with spring and fall application timings in Northern Utah in 2014-2015, evaluated 9 MAT (for fall application timings) or 14 MAT (for spring application timings).

			Rush skeletonweed[2]	
Treatment[1]	Rate	Application timing	Control	Density
	lb ae/A	(evaluated 14 MAT)	%	plants/plot
aminopyralid	0.078	spring/rosette	51.8 a-d	27.5 b
aminopyralid	1.09	spring/rosette	74.3 abc	18.8 b
2,4-D	0.95	spring/rosette	17.5 de	155.3 ab
clopyralid	0.375	spring/rosette	76.3 ab	14.5 b
dicamba	3	spring/rosette	66.3 abc	16.8 b
chlorsulfuron	0.047	spring/rosette	33.8 b-e	282.8 a
aminopyralid+AMS[3]	0.078	spring/rosette	74.3 abc	18.8 b
picloram	1	spring/rosette	99.5 a	0 b
untreated check	--	spring/rosette	0 e	201.5 ab
		(evaluated 9 MAT)		
aminopyralid	0.078	fall/mature	99.3 a	0 b
aminopyralid	1.09	fall/mature	99.8 a	0 b
2,4-D	0.95	fall/mature	35 b-e	90.5 b
clopyralid	0.375	fall/mature	100 a	0 b
dicamba	3	fall/mature	100 a	0 b
chlorsulfuron	0.047	fall/mature	27.5 cde	174 ab
aminopyralid+AMS[3]	0.078	fall/mature	97.5 a	0.8 b
picloram	1	fall/mature	100 a	0 b
untreated check	--	fall/mature	0 e	167.8 ab

[1]All treatments were applied with nonionic surfactant (NIS) at 0.25% v/v.
[2]Within a column, numbers followed by the same letter are not significantly different at $P<0.05$ according to Fisher's protected LSD.
[3]Ammonium sulfate (Actamaster) at 17 lb ai/100 gal was included.

Control of leafy spurge in environmetally sensitive areas. Rodney G. Lym. (Department of Plant Sciences, North Dakota State University, Fargo, ND 58108-6050). Leafy spurge control in environmentally sensitive areas such as around trees, near water, and in areas with very sandy soil has been especially difficult. Most auxinic herbicides that control this weed such as picloram and aminocyclopyrachlor can severely injure broadleaf trees and shrubs and have long soil residuals which allow them to move through the soil profile into groundwater. Leafy spurge biological control agents such as *Aphthona* spp. flea beetles have not controlled leafy spurge in these sensitive sites either. 2,4-D can be used in many ecological sensitive areas, but will only control leafy spurge top-growth and must be reapplied annually to prevent spread of the weed. The purpose of this research was to evaluate herbicide mixtures for leafy spurge control in sensitive sites. The herbicides evaluated are labeled for use near trees and open water, but generally will not control leafy spurge when applied alone.

The first study evaluated aminopyralid applied with 2,4-D and/or dicamba plus diflufenzopyr for leafy spurge control. The experiment was established on the Albert Ekre Grassland Perserve near Walcott, ND on June 23, 2014. Leafy spurge was in the true flower growth stage and 7 to 28 inches tall. All treatments in these studies were applied using a hand-held boom sprayer delivering 17 gpa at 35 psi. Experimental plots were 10 by 30 feet and replicated four times in a randomized complete block design. Leafy spurge control was evaluated visually using percent stand reduction compared to the untreated control.

Aminopyralid applied alone at 1.75 or 2.5 oz/A provided 40% or less leafy spurge control (Table 1) one year after treatment. However, when aminopyralid was applied with dicamba plus diflufenzopyr, control increased to 87% 12 months after treatment (MAT) which was similar to control from the long-residual herbicides picloram and aminocyclopyrachlor. Leafy spurge control was 73% 12 MAT when aminopyralid at 1.7 oz/A was applied with 2,4-D at 14 oz/A. Leafy spurge control with dicamba plus diflufenzopyr at 2 + 0.8 oz/A was only 21% 12 MAT, but control increased to 62% when 2,4-D at 14 oz/A was added to the treatment. Aminopyralid plus 2,4-D plus dicamba plus diflufenzopyr provided 97% leafy spurge control 12 MAT. Although expensive, this treatment could be used to control small leafy spurge infestations near trees or water and prevent further spread of the weed. *Aphthona* spp. flea beetles became established at the site and leafy spurge control from herbicides alone could not be further evaluated.

The second and third experiments evaluated leafy spurge control with quinclorac applied alone or with 2,4-D or dicamba plus diflufenzopyr. The second study was established at the Albert Ekre Grassland Preserve and treatments were applied on June 23 or September 8, 2014. Leafy spurge was in the true flower growth stage in June and had fall regrowth and was 22 to 26 inches tall in September. Leafy spurge control with quinclorac applied alone in June at 6 or 12 oz/A provided 67 and 88% leafy spurge control, respectively, 15 MAT. Quinclorac applied with dicamba plus diflufenzopyr or 2,4-D provided similar leafy spurge control to quinclorac applied alone. In contrast to the first study, the addition of 2,4-D to dicamba plus diflufenzopyr did not result in acceptable long-term leafy spurge control.

Quinclorac applied in the fall at 6 and 12 oz/A provided only 42 and 70% leafy spurge control 12 MAT (Table 2). Control increased to 68% when quinclorac at 6 oz/A was applied with dicamba plus diflufenzopyr. No other fall-applied treatment provided satisfactory season-long leafy spurge control.

The third experiment was established on the Sheyenne National Grassland near Anselm, ND and treatments were applied on June 3 or September 8, 2014. Leafy spurge was in the true flower growth stage in June and had 6 inch vegetative regrowth on the main stems in September. Quinclorac applied at 6 or 12 oz/A in June provided an average of 89% leafy spurge control 12 MAT (June 5, 2015) and compared to 83% 12 MAT when applied in the fall (September 8, 2015) (Table 3). Leafy spurge control was similar when quinclorac was applied alone or with 2,4-D.

In summary, aminopyralid applied with 2,4-D and/or dicamba plus diflufenzopyr and quinclorac applied alone provided similar leafy spurge control to picloram or aminocyclopyrachlor treatments and can be used near trees, open water, and in areas with shallow groundwater. These treatments will allow land managers to manage leafy spurge in areas long-term auxinic herbicides cannot be applied without compromising long-term control and are superior to 2,4-D the only other herbicide available for use in these areas.

Table 1. Leafy spurge control with aminopyralid mixed with various herbicides applied in June 2014 near Walcott, ND.

		Evaluation date		
		2014		2015
Treatment[a]	Rate	23 July	4 Sept	4 June
	—— oz/A ——	% injury	— % control —	
Aminopyralid[b]	1.75	30	21	11
Aminopyralid	2.5	40	36	40
Aminopyralid + 2,4-D[c]	1.7 + 14	94	90	73
Aminopyralid + dicamba + diflufenzopyr[d]	1.75 + 2 + 0.8	84	86	87
Aminopyralid + dicamba + diflufenzopyr	2.5 + 2 + 0.8	83	86	87
Aminopyralid + 2,4-D + dicamba + diflufenzopyr	1.7 + 14 + 2 + 0.8	95	95	97
Dicamba + diflufenzopyr	2 + 0.8	23	30	21
2,4-D	14	84	74	62
2,4-D + dicamba + diflufenzopyr	14 + 2 + 0.8	81	95	91
Picloram[e]	8	91	99	99
Picloram + dicamba + diflufenzopyr	8 + 2 + 0.8	96	98	99
Aminocyclopyrachlor + chlorsulfuron[f]	1.9 + 0.75	86	97	99
LSD (0.05)		19	8	27

[a]All treatments appliled with 0.25% NIS Activator 90 by Loveland Products, 3005 Rocky Mountain Ave., Loveland, CO 80538.
Commercial formulations - [b]Milestone, [c]Forefront, [e]Tordon 22k by Dow AgroSciences LLC, 9330 Zionsville Road, Indianapolis, IN 46268-1189.
[d]Commercial formulation - Overdrive by BASF Corporation, 26 Davis Drive, Research Triangle Park, NC 27709.
[f]Commercial formulation - Perspective by E.I. duPont de Nemours and Company, 1007 Market Street, Wilmington, DE 19898.

Table 2. Quinclorac applied in June or September 2014 alone or with various herbicide mixtures for leafy spurge control near Walcott, ND.

		Evaluation date		
		2014	2015	
Treatment[a]	Rate	4 Sept	4 June	26 Aug
	—— oz/A ——		—— % control ——	
Spring application (June 23, 2014)				
Quinclorac[b]	6	98	90	67
Quinclorac	12	99	98	88
Quinclorac + dicamba + diflufenzopyr	6 + 3 + 1.2	98	96	78
Quinclorac + 2,4-D	6 + 16	96	80	60
Dicamba + diflufenzopyr[c]	3 + 1.2	68	54	32
Dicamba + diflufenzopyr + 2,4-D	3 + 1.2 + 16	84	64	38
2,4-D	16	68	42	16
Fall application (Sept. 8, 2014)				
Quinclorac	6		78	42
Quinclorac	12		98	70
Quinclorac + dicamba + diflufenzopyr	6 + 3 + 1.2		99	68
Quinclorac + 2,4-D	6 + 16		52	28
Dicamba + diflufenzopyr	3 + 1.2		75	36
Dicamba + diflufenzopyr + 2,4-D	3 + 1.2 + 16		83	39
2,4-D	16		23	9
LSD (0.05)		13	33	31

[a]All treatments were applied with 1 qt/A of Upland MSO by West Central Inc., 2700 Trott Ave SW, P.O. Box 897, Willmar, MN 56201.
Commercial formulation - [b]Facet L, [c]Overdrive by BASF Corporation, 26 Davis Drive, Research Triangle Park, NC 27709.

Table 3. Quinclorac applied alone or with 2,4-D in June or September for leafy spurge control on the Sheyenne National Grasslands near Anselm, ND.

		Evaluation date			
		2014		2015	
Treatment[a]	Rate	5 Aug	8 Sept	5 June	26 Aug
	—— oz/A ——	—————— % control ——————			
Spring application (June 23, 2014)					
Quinclorac[b]	6	71	82	88	44
Quinclorac	12	94	97	90	71
Quinclorac + 2,4-D	6 +16	83	86	76	58
Quinclorac + 2,4-D	12 + 16	93	91	84	82
2,4-D	16	32	50	20	18
Fall application (Sept 8, 2014)					
Quinclorac	6			95	77
Quinclorac	12			97	88
Quinclorac + 2,4-D	6 + 16			92	63
Quinclorac + 2,4-D	12 + 16			91	75
2,4-D	16			56	42
LSD (0.05)		23	20	19	33

[a]All treatments applied with 1 qt/A of Upland MSO by West Central Inc., 2700 Trott Ave SW, P.O. Box 897, Willmar, MN 56201.
[b]Commercial formulation - Facet L by BASF Corporation, 26 Davis Drive, Research Triangle Park, NC 27709.

Evaluation of quinclorac applied in the spring or fall for optimum leafy spurge control. Rodney G. Lym. (Department of Plant Sciences, North Dakota State University, Fargo, ND 58108-6050). The use of quinclorac to control leafy spurge was largely developed in the 1990s but the herbicide was little used until a full grazing label was obtained in 2010. While control of leafy spurge with quinclorac has been well documented, initial publications indicated optimum leafy spurge control was obtained when quinclorac was applied in the spring compared to fall applications. Observations made since 2010 have indicated quinclorac applied in the fall will provide leafy spurge control similar to spring applications. The purpose of this research was to evaluate quinclorac applied in the spring or fall for leafy spurge control.

The experiment was established at two locations in North Dakota. The first site was located on the Sheyenne National Grassland (SNG) near Anselm, while the second location was on the Albert Ekre Grassland Perserve near Walcott. Both locations were within grazed pastures with a dense stand of leafy spurge. Treatments were applied on June 3, or September 8, 2014 at the SNG and June 23 or September 8, 2014 at the Walcott location. Leafy spurge was in the true-flower growth stage and 6 to 24 inches tall in June and was in the fall regrowth stage with with 4 to 6 inch long branches growing from the main stem in September when treatments were applied. Quinclorac applied at 6, 9, or 12 oz/A was compared to aminocyclopyrachlor plus chlorsulfuron at the Walcott location and 2,4-D on the SNG where aminocyclopyrachlor use is prohibited. Herbicides were applied using a hand-held boom sprayer delivering 17 gpa at 35 psi. All quinclorac treatments were applied with a methylated seed oil at 1 qt/A. Experimental plots were 10 by 30 feet and replicated four times in a randomized complete block design. Leafy spurge control was evaluated visually using percent stand reduction compared to the untreated control.

In general, quinclorac tended to provides slightly better leafy spurge control at the Walcott location than at the SNG and as a spring compared to fall applied treatment (Tables 1 and 2). For instance, leafy spurge control 3 months after treatment (MAT) averaged across all quinclorac application rates was 88 and 97% at the SNG and Walcott locations, respectively and 82 and 95% 12 MAT (June 2015), respectively. Quinclorac applied in September 2014 provided excellent control when evaluated in June 2015 (96% average) but control dropped rapidly at both locations. Leafy spurge control averaged over all quinclorac application rates was 82 and 62% when applied in June or September and evaluated 12 MAT at the SNG. The decrease was even more dramatic at the Walcott location as leafy spurge control averaged 95 and 71% when spring and fall applied treatments were compared 12 MAT.

Leafy spurge control tended to increase as the quinclorac application rate increased with 9 oz/A the most likely cost-effective application rate considering both long-term control and chemical cost (approximately $5 per oz ai) (Tables 1 and 2). Quinclorac applied at 9 to 12 oz/A provided similar control to aminocyclopyrachlor plus chlorsulfuron (Table 2) but is more expensive ($45 to $60/A for quinclorac compared to $11/A for aminocyclopyrachlor). However, quinclorac can be used in areas with high ground water, near trees, or in other environmental sensitive areas which makes the treatment most cost-effective from an environmental standpoint. In summary, this research confirmed previous findings that quinclorac provides better long-term leafy spurge when applied in June compared to September.

Table 1. Leafy spurge control with quinclorac applied in June or September on the Sheyenne National Grasslands near Anselm, ND.

		Evaluation date			
		2014		2015	
Treatment	Rate	25 Aug	8 Sept	5 June	26 Aug
	—— oz/A ——	——— % control ———			
June application					
Quinclorac[a] + MSO[b]	6 + 1 qt	81	78	86	68
Quinclorac + MSO	9 + 1 qt	89	86	81	55
Quinclorac + MSO	12 + 1 qt	95	84	79	87
2,4-D	16	40	35	30	10
September application					
Quinclorac + MSO	6 + 1 qt			87	49
Quinclorac + MSO	9 + 1 qt			98	68
Quinclorac + MSO	12 + 1 qt			98	71
2,4-D	16			24	8
LSD (0.05)		36	11	12	27

[a]Commercial formulation - Facet L by BASF Corporation, 26 Davis Drive, Research Triangle Park, NC 27709.
[b]Upland MSO by West Central Inc., 2700 Trott Ave. SW, P.O. Box 897, Willmar, MN 56201.

Table 2. Leafy spurge control with quinclorac applied in June or September at the Albert Ekre research station near Walcott, ND.

		Evaluation date		
		2014	2015	
Treatment	Rate	4 Sept	4 June	26 Aug
	— oz/A —	—	% control	—
June application				
Quinclorac[a] + MSO[b]	6 + 1 qt	96	92	78
Quinclorac + MSO	9 + 1 qt	96	94	91
Quinclorac + MSO	12 + 1 qt	99	95	93
Aminocyclopyrachlor + chlorsulfuron[c]	1.4 + 0.6	97	97	98
September application				
Quinclorac + MSO	6 + 1 qt		97	56
Quinclorac + MSO	9 + 1 qt		99	68
Quinclorac + MSO	12 + 1 qt		99	89
Aminocyclopyrachlor + chlorsulfuron	1.4 + 0.6		99	93
LSD (0.05)		NS	4	22

[a]Commercial formulation - Facet L by BASF Corporation, 26 Davis Drive, Research Triangle Park, NC 27709.
[b]Upland MSO by West Central Inc., 2700 Trott Ave. SW, P.O. Box 897, Willmar, MN 56201.
[c]Commercial formulation - Perspective by E.I. duPont de Nemours and Company, 1007 Market Street, Wilmington, DE 19898.

Control of yellow toadflax with herbicide mixtures. Rodney G. Lym. (Department of Plant Sciences, North Dakota State University, Fargo, ND 58108-6050). Yellow toadflax (*Linaria vulgaris* P. Mill.) is a perennial forb that was introduced to North America as an ornamental because the flower resembles horticultural snapdragons. Yellow toadflax can decrease the value of invaded rangeland by displacing forage plants and reducing native forb diversity, and is considered mildly poisonous to cattle. Previous research at North Dakota State University found that yellow toadflax is best controlled with aminocyclopyrachlor (AMCP) applied early in the growing season or with picloram applied with dicamba plus diflufenzopyr from June through September. The purpose of this research was to further evaluate yellow toadflax control with herbicide mixtures applied in mid-summer or in the fall.

Two experiments were established on land managed by the Army Corp of Engineers at Pipestem Dam near Jamestown, ND. The first experiment evaluated yellow toadflax control with AMCP applied with chlorsulfuron, 2,4-D, or metsulfuron while the second experiment compared aminopyralid or picloram applied with chlorsulfuron. The mid-summer treatments were applied on July 9, 2014 when yellow toadflax was in the vegetative to early bud growth stage and 6 to 20 inches tall. The fall applications were made on September 16, 2014 when the weed was 14 to 18 inches tall and in the flowering to seed-set growth stage. Experimental plots were 10 by 30 feet and replicated three times in a randomized complete block design. Yellow toadflax control was evaluated visually using percent stand reduction compared to the untreated control.

In general, AMCP provided better yellow toadflax control when applied at 1.8 compared to 1 oz/A which averaged 73 and 52% 12 months after treatment (12 MAT), respectively, for both July and September application dates (Table 1). Control was similar whether AMCP at comparable rates was applied with chlorsulfuron, 2,4-D, or metsulfuron regardless of application date. AMCP plus chlorsulfuron plus dicamba plus diflufenzopyr provided slightly better weed control than AMCP plus chlorsulfuron applied alone. Picloram plus dicamba plus diflufenzopyr tended to provide the best long-term yellow toadflax control which averaged 97 and 93% 12 MAT when applied in July or September, respectively.

Yellow toadflax control increased from an average of 46% 12 MAT when picloram was applied alone at 8 oz/A to 85% with picloram applied with chlorsulfuron averaged over application dates (Table 2). Yellow toadflax control with AMCP plus chlorsulfuron averaged 87 and 94% 12 MAT in July and September, respectively. Yellow toadflax control was superior to that observed in the first study even though the treatments were applied on the same dates and the experiments were located side by side. This inconsistency in yellow toadflax control with identical treatments has been observed in several experiments and by land managers attempting to control the weed in a variety of locations. The reasons for the inconsistency are unclear but could be related to differences in yellow toadflax biotypes which came from multiple introductions of the plant, or variation in grass density between the two experiments. The site where aminopyralid was evaluated tended to have denser smooth brome (*Bromus inermis* Leyss.) and reed canarygrass (*Phalaris arundinacea* L.) cover than the AMCP site.

In summary, picloram applied with chlorsulfuron or dicamba plus diflufenzopyr tended to provide better yellow toadflax control than any AMCP combination treatment. Control was inconsistent between experiments despite identical treatments applied on the same day at the same location.

Table 1. Yellow toadflax control with aminocyclopyrachlor applied with other herbicides in July or September near Jamestown, ND.

		Evaluation date		
		2014	2015	
Treatment[a]	Rate	16 Sept	8 July	2 Sept
	——— oz/A ———	———	% control	———
Summer application (July 9, 2014)				
AMCP + chlorsulfuron[b]	1 + 0.4	52	48	49
AMCP + chlorsulfuron	1.8 + 0.7	57	55	58
AMCP + 2,4-D[c]	1 + 7.6	55	42	51
AMCP + 2,4-D	1.8 + 12.7	75	84	82
AMCP + metsulfuron[d]	1.1 + 0.18	79	62	74
AMCP + metsulfuron	1.8 + 0.24	77	85	81
Picloram[e] + dicamba + diflufenzopyr[f]	16 + 4 + 1.6	99	97	97
AMCP + chlorsulfuron+ dicamba + diflufenzopyr	1 + 0.4 + 4 + 1.6	96	93	88
Fall application (Sept 16, 2014)				
AMCP + chlorsulfuron	1 + 0.4		52	42
AMCP + chlorsulfuron	1.8 + 0.7		84	81
AMCP + 2,4-D	1 + 7.6		57	45
AMCP + 2,4-D	1.8 + 12.7		80	72
AMCP + metsulfuron	1.1 + 0.18		68	70
AMCP + metsulfuron	1.8 + 0.24		72	58
Picloram + dicamba + diflufenzopyr	16 + 4 + 1.6		97	93
AMCP + chlorsulfuron+ dicamba + diflufenzopyr	1 + 0.4 + 4 + 1.6		92	79
LSD (0.05)		16	21	27

[a]All treatments applied at 0.25% with NIS Dyne-Amic by Helena Chemical Co., 225 Schilling Blvd, Collierville, TN 38017.
Formulations - [b]Perspective, [c]Kindra, [d]Rejuvra by E.I. duPont de Nemours and Company, 1007 Market Street, Wilmington, DE 19898.
[e]Commercial formulation - Tordon 22k by Dow AgroSciences LLC, 9330 Zionsville Road, Indianapolis, IN 46268-1189.
[f]Commercial formulation - Overdrive by BASF Corporation, 26 Davis Drive, Research Triangle Park, NC 27709.

Table 2. Yellow toadflax control with herbicide mixtures applied in July or September near Jamestown, ND.

		Evaluation date		
		2014	2015	
Treatment[a]	Rate	16 Sept	8 July	2 Sept.
	—— oz/A ——		—— % control ——	
Summer application (July 9, 2014)				
Picloram[b]	8	85	50	33
Chlorsulfuron[c]	0.75	52	25	18
Picloram + chlorsulfuron	8 + 0.75	95	90	69
Aminopyralid[d] + chlorsulfuron	1.75 + 0.75	55	28	20
Picloram + dicamba + diflufenzopyr[e]	8 + 2 + 0.8	99	83	82
Aminocyclopyrachlor + chlorsulfuron[f]	1.87 + 0.76	79	87	72
Fall application (Sept 16, 2014)				
Picloram	8		50	42
Chlorsulfuron	0.75		80	40
Picloram + chlorsulfuron	8 + 0.75		95	87
Aminopyralid + chlorsulfuron	1.75 + 0.75		95	55
Picloram + dicamba + diflufenzopyr	8 + 2 + 0.8		89	78
Aminocyclopyrachlor + chlorsulfuron	1.87 + 0.76		96	94
LSD (0.05)		14	15	16

[a]All treatments appliled with 0.25% NIS Activator 90 by Loveland Products, 3005 Rocky Mountain Ave., Loveland, CO 80538.
Commercial formulations - [b]Tordon 22K, [d]Milestone by Dow AgroSciences LLC, 9330 Zionsville Road, Indianapolis, IN 46268-1189.
Commercial formulation - [d]Telar, [f]Perspective by E.I. duPont de Nemours and Company, 1007 Market Street, Wilmington, DE 19898.
[e]Commercial formulation - Overdrive by BASF Corporation, 26 Davis Drive, Research Triangle Park, NC 27709.

Aminocyclopyrachlor mixtures applied in the spring or fall for absinth wormwood control. Rodney G. Lym. (Department of Plant Sciences, North Dakota State University, Fargo, ND 58108-6050). Aminocyclopyrachlor (AMCP) has been used to control absinth wormwood in non-grazed or hayed areas. Often combinations of herbicides have provided better long-term control of invasive species than a single herbicide used alone. The purpose of this research was to evaluate AMCP applied in the spring or fall with other herbicides for long-term absinth wormwood control.

The first study was established within a pasture near Spiritwood, ND which was fenced to prevent grazing during the study. Herbicides were applied on June 3, 2013 when absinth wormwood was 4 to 16 inches tall and in the rosette growth stage. Fall treatments were applied on September 13, 2013 to plants that had 12 to 18 inches of regrowth after being mowed in August. The second study was established near the Pipestem Dam on land managed by the Army Corp of Engineers on September 16, 2014. The absinth wormwood had been mowed in August and had vigorous regrowth 12 to 18 inches tall at application.

Herbicides were applied using a hand-held boom sprayer delivering 17 gpa at 35 psi. Experimental plots were 10 by 30 feet and treatments were replicated four times in a randomized complete block design. Absinth wormwood control was evaluated visually using percent stand reduction compared to the untreated control.

Absinth wormwood control was 90% or more the season after treatment regardless of AMCP application rate or whether applied with metsulfuron, chlorsulfuron, or 2,4-D in a grazed pasture near Spiritwood (Table 1). Aminopyralid applied at 1.75 oz/A provided near 100% control one year after treatment. In the second study, absinth wormwood control averaged 79 and 95% when AMCP was applied at 1.1 or 1.8 oz/A, respectively, with metsulfuron or chlorsulfuron (Table 2). Control averaged 95% 12 months after treatment (MAT) when AMCP was applied with 2,4-D regardless of the AMCP application rate. Aminopyralid provided 99% control 12 MAT.

In summary, AMCP applied with 2,4-D provided more consistent absinth wormwood control than when applied with metsulfuron or chlorsulfuron, when the application rate was less than 1.8 oz/A. Control was similar regardless of herbicide mixture or application date when AMCP was applied at 1.8 oz/A. Aminopyralid applied at 1.75 oz/A provided near 100% control regardless of application timing or location.

Table 1. Efficacy of aminocyclopyrachlor applied with various other herbicides on absinth wormwood applied in spring or fall at Spiritwood, ND.

		Evaluation date		
		2013	2014	
Treatment/date[a]	Rate	1 Aug	21 May	11 Sept
	—— oz/A ——		% control	
Spring (June 3, 2013)				
AMCP + metsulfuron[b]	1.1 + 0.2	94	94	95
AMCP + metsulfuron	1.8 + 0.3	98	98	95
AMCP + chlorsulfuron[c]	1 + 0.4	94	96	96
AMCP + chlorsulfuron	1.8 + 0.7	98	98	90
AMCP + 2,4-D[d]	1 + 7.6	95	97	96
AMCP + 2,4-D	1.7 + 12.7	98	99	98
Aminopyralid[e]	1.75	99	99	99
Fall (Sept 13, 2013)				
AMCP + metsulfuron	1.1 + 0.2		93	94
AMCP + metsulfuron	1.8 + 0.3		97	95
AMCP + chlorsulfuron	1 + 0.4		93	90
AMCP + chlorsulfuron	1.8 + 0.7		98	95
AMCP + 2,4-D	1 + 7.6		95	95
AMCP + 2,4-D	1.7 + 12.7		98	95
Aminopyralid[e]	1.75		99	98
LSD (0.05)		NS	5	NS

[a]Surfactant at 0.25% applied with all treatments - Induce by Helena Chemical Co., 225 Schilling Blvd, Collierville, TN 38017.
Formulations -[b]Rejuvra, [c]Persective, [d]Kindra by E.I. duPont de Nemours and Company, 1007 Market Street, Wilmington, DE 19898.
[e]Commercial formulation - Milestone by Dow AgroSciences LLC, 9330 Zionsville Road, Indianapolis, IN 46268-1189.

Table 2. Efficacy of aminocyclopyrachlor applied with other herbicides in September 2014 on absinth wormwood near Jamestown, ND.

Treatment[a]	Rate	Evaluation date 8 July 15	Evaluation date 2 Sept 15
	——— oz/A ———	—— % control ——	
AMCP + metsulfuron[b]	1.1 + 0.18	89	81
AMCP + metsulfuron	1.8 + 0.24	97	95
AMCP + chlorsulfuron[c]	1 + 0.38	88	78
AMCP + chlorsulfuron	1.8 + 0.7	95	96
AMCP + 2,4-D[d]	1 + 7.62	92	92
AMCP + 2,4-D	1.7 + 12.7	98	97
Aminopyralid[e]	1.5	99	99
Untreated check	...	0	0
LSD (0.05)		8	10

[a]Surfactant at 0.25% applied with all treatments - NIS Dyne-Amic by Helena Chemical Co., 225 Schilling Blvd, Collierville, TN 38017.
Formulations - [b]Rejuvra [c]Perspective, [d]Kindra, by E.I. duPont de Nemours and Company, 1007 Market Street, Wilmington, DE 19898.
[e]Commercial formulation - Milestone by Dow AgroSciences LLC, 9330 Zionsville Road, Indianapolis, IN 46268-1189.

Performance of mesotrione tankmixes in orchards. Caio A. C. G. Brunharo and Brad D. Hanson. (Department of Plant Sciences, University of California, Davis) The objective of the present research was to evaluate the efficacy of mesotrione as tankmix partner with commonly used preemergence herbicides in almond orchards in California. A 2-year old almond orchard (Nonpareil + Aldrich) at the UC Davis Pomology Farm was chosen to host the experiment. Treatments were applied on January 15, 2015 using a backpack sprayer, pressurized with CO_2, calibrated to deliver 20 gallons per acre (Table). The plots were 2 by 13 m, and the four replications were organized in a randomized complete block design. Evaluations were carried out at 14, 28, 56, 84 and 112 days after treatment using a 0-100 visual scale, where 0 represents no visible injury in the emerged weeds and 100 represents complete absence of weeds. The dominant weeds in the test orchard were annual sowthistle (*Sonchus oleraceus* L.), prostrate knotweed (*Polygonum aviculare* L.) and field bindweed (*Convolvulus arvensis* L.).

Table. Herbicide treatments and visual weed control ratings for annual sowthistle, prostrate knotweed and field bindweed in an almond orchard near Davis, CA, in 2015.

Treatment #	Treatment name	Rate	Annual Sowthistle	Prostrate Knotweed	Field Bindweed
			Visual control 112 days after treatment[1]		
		g ai ha^{-1}	––––––––––%––––––––––		
i	Untreated	-	0 b	0 b	0 b
ii	Indaziflam	51	100 a	70 ab	66 a
iii	Indaziflam	73	97 a	85 a	77 a
iv	Rimsulfuron	70	100 a	67 ab	65 a
v	Indaziflam + Rimsulfuron	51 + 35	100 a	87 a	66 a
vi	Indaziflam + Rimsulfuron	51 + 70	75 a	72 ab	73 a
vii	Mesotrione	210	57 a	32 ab	55 a
viii	Indaziflam + Mesotrione	51 + 210	100 a	52 ab	71 a
ix	Indaziflam + Mesotrione	73 + 210	95 a	72 ab	71 a
x	Indaziflam + Mesotrione	73 + 105	100 a	85 a	70 a
xi	Mesotrione + Pendimethalin	210 + 4260	92 a	97 a	71 a
xii	Mesotrione + Oryzalin	210 + 4500	100 a	95 a	77 a
xiii	Mesotrione + Oxyfluorfen	210 + 1680	100 a	85 a	72 a
xiv	Mesotrione + Rimsulfuron	210 + 35	100 a	57 ab	60 a
xv	Mesotrione + Rimsulfuron	210 + 70	100 a	70 ab	55 a
xvi	Penoxsulam/Oxyfluorfen	29 + 1380	97 a	92 a	62 a

[1]Weed control is given in a 0-100 scale, where 0 represents poor control and 100 excellent control; Means within a column followed by the same letter are not significantly different at the 5% level as determined by the Tukey HSD test.

Annual sowthistle was controlled by all the treatments up to 112 days after treatment although mesotrione alone tended to provide less consistent control (Table). Although statistically all the treatments were equivalently efficient, prostrate knotweed tended to be more susceptible (control greater than 80%) to the treatments containing indaziflam + mesotrione (73 + 105), mesotrione + pendimethalin, mesotrione + oryzalin, mesotrione + oxyfluorfen and penoxsulam/oxyfluorfen. Field bindweed was not controlled by any treatment due to its late emergence, perennial growth habit, and ability to emerge from deeper soil layers. No crop injury was observed with any treatment at any evaluation date. Mesotrione tankmixes were statistically similar to other PRE herbicide programs on the broadleaf weed spectrum in this orchard. However, in sites with other challenging broadleaf weeds such as hairy fleabane (*Conyza bonariensis*), the addition of an HPPD-inhibitor like mesotrione will bring a new mode of action and a resistance management tool for California orchard crops.

Poa annua control during ryegrass removal and early spring transition of bermudagrass turf. Kai Umeda. (University of Arizona, Maricopa County Cooperative Extension, Phoenix, AZ 85040) A small plot field experiment was conducted on a practice baseball field at the Diablo Stadium complex in Tempe, AZ. The out of play area had hybrid bermudagrass cv. Tifway 419 and overseeded in fall 2014 with perennial ryegrass that was maintained at a height of approximately 0.75 inch. Treated plots measured 5 ft by 10 ft and treatments were replicated four times in a randomized complete block design. Herbicides were applied with a backpack CO_2 sprayer equipped with a hand-held boom with three 8003LP flat fan nozzles spaced 20 inches apart and pressurized to 30 psi. Treatments were applied in 50 gpa water and Latron CS-7 non-ionic surfactant at 0.25% v/v was added to foramsulfuron, trifloxysulfuron, and flazasulfuron. The first sprays were applied on 04 May 2015 when the air temperature was 75°F with a nearly clear sky with few clouds, wind was slight at less than 3 mph, soil temperature was 72°F, and rain occurred during the night before. Sequential applications of penoxsulam treatments were made on 18 May when the air temperature was 76°F, clear sky, wind was slight at less than 2 mph, and soil temperature was 68°F. At 2 weeks after treatment of the first application on 18 May, foramsulfuron, trifloxysulfuron, and flazasulfuron significantly affected and reduced ryegrass quality and then totally eliminated ryegrass by 08 July. Foramsulfuron also provided nearly complete control of *P. annua* while trifloxysulfuron also gave acceptable control at 88%. Bermudagrass cover was not complete with bare ground observed in foramsulfuron, trifloxysulfuron, and flazasulfuron treated plots. Penoxsulam and pronamide treated ryegrass displayed equally slower reduction of quality and ryegrass removal was less than complete on 08 July. Penoxsulam did not control *P. annua*.

Table. Transition-aide herbicides for ryegrass removal and *P. annua* control during bermudagrass spring transition, Tempe, AZ, 2015

Treatment	Rate[1]	Ryegrass quality[2]			Ryegrass removed		Bermudagrass cover	Bare ground	POANN control
		12 May	18 May	29 May	29 May	08 July	08 July	08 July	29 May
	lb ai/A				----- % -------		%	%	%
untreated check		8.0 a	8.5 a	8.0 a	0 c	50 a	50 d	0 b	0 f
penoxsulam	0.06	7.0 ab	7.3 b	6.8 ab	8 c	74 b	74 c	0 b	0 f
penoxsulam	0.06 + 0.03	6.5 bc	7.5 ab	6.5 b	10 c	81 bc	81 abc	0 b	0 f
penoxsulam	0.04 + 0.04	7.0 ab	7.5 ab	6.3 b	14 c	90 bcd	88 abc	2 ab	0 f
pronamide	0.5	6.8 b	7.8 ab	7.0 ab	5 c	77 b	75 bc	3 ab	50 e
pronamide	1.0	7.0 ab	7.8 ab	5.7 bc	17 c	98 cd	90 abc	9 a	63 d
foramsulfuron	0.013	6.3 bc	5.3 c	2.3 d	91 a	100 d	91 ab	9 a	99 a
trifloxysulfuron	0.0047	6.0 bc	6.0 c	4.8 c	65 b	100 d	93 a	8 ab	88 b
flazasulfuron	0.0078	5.5 c	5.5 c	4.5 c	76 ab	100 d	93 a	8 ab	76 c

[1]Single and sequential applications made on 04 and 18 May 2015.

[2]Ryegrass quality on 1-9 scale, 1 is worst and 9 is best.

POANN = *Poa annua*, annual bluegrass

Means followed by the same letter are not significantly different by Tukey's HSD at 0.05%.

Indaziflam, metribuzin, and saflufenacil for preemergence kochia control in an abandoned alfalfa field. Randall S. Currie and Patrick W. Geier. (K-State Southwest Research-Extension Center, 4500 E. Mary Street, Garden City, KS 67846) An experiment was conducted at the Kansas State University Southwest Research-Extension Center near Garden City, KS to examine the efficacy of indaziflam at four rates with metribuzin compared to standards for preemergence kochia control. The site was an abandoned alfalfa field with a dense natural population of kochia. Herbicides were applied March 11, 2015 using a tractor-mounted, CO_2-pressurized sprayer delivering 20 gpa at 30 psi and 3 mph. A few kochia seedlings had emerged by this date, and were in the cotyledon stage and less than 1 inch tall. The majority of the kochia had not emerged prior to application. Soil was a Ulysses silt loam with 1.4% organic matter, pH of 8.0, and cation exchange capacity of 18.4. Plots were 10 by 60 feet, and arranged as a randomized complete block replicated four times. Kochia control was visually determined 6, 14, 21, 30, 61, and 91 days after treatment (DAT). Indaziflam at 2, 3, 4 or 5 oz/A combined with metribuzin at 10.7 oz/A were generally the most effective herbicides for kochia control at 14, 21, 30, and 61 DAT. Saflufenacil alone or with pendimethalin, metribuzin, or indaziflam was less effective at controlling kochia compared to indaziflam plus metribuzin at these dates. By 91 DAT, indaziflam at 3, 4, and 5 oz/A plus metribuzin was more effective than the 2 oz/A rate for kochia control. However, all indaziflam plus metribuzin treatments were better than saflufenacil-containing herbicides at 91 DAT.

Table. Indaziflam, metribuzin, and saflufenacil for preemergence kochia control in an abandoned alfalfa field.

Treatment	Rate[a]	Kochia					
		6 DAT[b]	14 DAT	21 DAT	30 DAT	61 DAT	91 DAT
		% Control					
Indaziflam Metribuzin	2.0 oz 10.7 oz	58	94	97	97	95	75
Indaziflam Metribuzin	3.0 oz 10.7 oz	65	92	96	97	93	80
Indaziflam Metribuzin	4.0 oz 10.7 oz	63	93	99	98	96	83
Indaziflam Metribuzin	5.0 oz 10.7 oz	50	90	95	98	95	80
Flumioxazin Metribuzin	4.0 oz 10.7 oz	48	83	93	94	83	60
Saflufenacil MSO Concentrate AMS	2.0 oz 1% 2%	55	68	68	55	50	43
Saflufenacil Pendimethalin MSO Concentrate AMS	2 oz 48 oz 1% 2%	58	75	83	79	60	48
Saflufenacil Metribuzin MSO Concentrate AMS	2 oz 8 oz 1% 2%	58	88	94	90	75	60
Saflufenacil Indaziflam	2.0 oz 2.0 oz	43	48	58	53	50	53
Untreated	---	0	0	0	0	0	0
LSD (0.05)		8.6	6.1	4.0	4.7	5.3	4.7

[a] Methylated seed oil concentrate (MSO concentrate) rate is % V/V and ammonium sulfate (AMS) rate is % W/V.
[b] DAT is days after treatment.

Time of day application effects on weed control with bentazon in dry bean. Michael L. Thornton and Don W. Morishita. (Kimberly Research and Extension Center, University of Idaho, Kimberly, ID 83341. Weed control with postemergence bentazon applications in Idaho has been inconsistent. It is hypothesized that relative humidity and temperature have the greatest influence. Because it is most humid in early morning and evening hours compared to mid-day, a field experiment was conducted at the University of Idaho Research and Extension Center near Kimberly, Idaho to determine the influence that the time of day has on the effectiveness of bentazon applications in dry bean. 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% sand, 52% silt, and 19% clay) with a pH of 8.1, 1.4% organic matter, and CEC of 19-meq/100 g soil. 'Sequoia' dry bean was planted May 27, 2015 in 22-inch rows at a rate of 105,000 seed/A. Green foxtail, common lambsquarters, hairy nightshade and redroot pigweed were the major weed species present. Herbicides were applied broadcast using a CO_2-pressurized bicycle-wheel sprayer calibrated to deliver 15 gpa using 11001 flat fan nozzles. Additional environmental and application information is given in Table 1. Weed counts were taken 7 days after first application (DAFA), 4 and 20 days after last application (DALA) on June 25, July 6, and July 22, respectively. Crop injury was evaluated visually June 25, July 3, 6, and 23, which was 7 DAFA, 1, 4, and 21 DALA, respectively. Weed control was evaluated visually 21 DALA on July 23 and 56 DALA on August 27. The two center rows of each plot were harvested mechanically with a small-plot combine on September 29.

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

Application date	6/18 (1st trifoliate)						7/2 (3rd trifoliate)					
Time of day	0600	0900	1200	1500	1800	2100	0600	0900	1200	1500	1800	2100
Air temperature (F)	55	77	91	95	91	75	61	76	86	98	97	88
Soil temperature (F)	70	70	79	84	86	82	78	79	82	91	91	87
Relative humidity (%)	68	42	20	15	13	30	79	41	34	21	19	33
Wind velocity (mph)	3	1	-	6	3	2	3	2	5	6	7	3
Cloud cover (%)	10	20	35	80	10	15	10	35	5	5	50	70
Weed species/ft^2												
foxtail, green	<1						2					
lambsquarters, common	<1						2					
nightshade, hairy	<1						<1					
pigweed, redroot	<1						1					

Crop injury 7 DAFA ranged from 1 to 18% (Table 2). The 6 AM and 9 AM applications were the highest at 18 and 13%, respectively. At 1 DALA, crop injury ranged from 0 to 6% with the 9 AM timing the highest. Crop injury 4 DALA ranged from 0 to 12% following a similar trend with more injury with the 6 AM and 9 AM applications. By 21 DALA, there was no injury observed in any treatment. Although not statistically significant, weed control had the lowest rating with the 3 PM application for all weed species compared. Weed counts were comparable among all treatments. Green foxtail had the highest population in the 9 PM application 7 DAFA, but this trend did not continue to the 20 DALA evaluation. Dry bean yield ranged from 3,269 to 3,898 lb/A with the untreated control having the lowest yield. There is no statistical difference between the treatments suggesting there was variability from rep to rep within a treatment. Ultimately, no weed control or yield differences were observed, and timing appears to affect crop injury with the greatest injury occurring in morning applications.

Table 2. Crop tolerance, weed control, and yield in furrow irrigated dry bean, near Kimberly, ID[1]

	Application		Weed counts[2]														
			CHEAL			AMARE			SOLSA			SETVI			MEDSA	MALNE
Treatment[3]	rate	date & time	6/25	7/6	7/22	6/25	7/6	7/22	6/25	7/6	7/22	6/25	7/6	7/22	7/6	7/22
	lb ai/A		plants/183ft[2]													
Untreated control			3 a	229 a	7 a	0 a	114 a	3 a	0 a	76 a	5 a	5 ab	270 a	7 a	0 a	0 a
Bentazon +	0.5 +	6/18, 6AM	0 a	1 b	2 ab	0 a	1 bc	0 a	0 a	0 a	0 b	2 ab	4 b	1 b	1 a	0 a
MSO +	1.5 pt/A +															
AMS fb	1.5 fb															
Bentazon +	0.5 +	7/2, 6AM														
clethodim +	0.156 +															
MSO +	1.5 pt/A +															
AMS	1.5															
Bentazon +	0.5 +	6/18, 9AM	0 a	2 b	2 ab	0 a	1 bc	1 a	0 a	0 a	0 b	3 ab	4 b	0 b	0 a	0 a
MSO +	1.5 pt/A +															
AMS fb	1.5 fb															
Bentazon +	0.5 +	7/2, 9AM														
clethodim +	0.156 +															
MSO +	1.5 pt/A +															
AMS	1.5															
Bentazon +	0.5 +	6/18, 12PM	1 a	2 b	2 ab	1 a	2 b	2 a	0 a	0 a	1 b	3 ab	5 b	1 b	0 a	1 a
MSO +	1.5 pt/A +															
AMS fb	1.5 fb															
Bentazon +	0.5 +	7/2, 12PM														
clethodim +	0.156 +															
MSO +	1.5 pt/A +															
AMS	1.5															
Bentazon +	0.5 +	6/18, 3PM	0 a	0 b	1 b	0 a	1 bc	1 a	0 a	0 a	0 b	0 b	2 b	0 b	0 a	0 a
MSO +	1.5 pt/A +															
AMS fb	1.5 fb															
Bentazon +	0.5 +	7/2, 3PM														
clethodim +	0.156 +															
MSO +	1.5 pt/A +															
AMS	1.5															
Bentazon +	0.5 +	6/18, 6PM	0 a	2 b	2 ab	0 a	1 bc	2 a	0 a	0 a	0 b	2 ab	4 b	0 b	0 a	0 a
MSO +	1.5 pt/A +															
AMS fb	1.5 fb															
Bentazon +	0.5 +	7/2, 6PM														
clethodim +	0.156 +															
MSO +	1.5 pt/A +															
AMS	1.5															
Bentazon	0.5 +	6/18, 9PM	1 a	1 b	2 ab	0 a	1 bc	2 a	0 a	0 a	1 b	6 a	3 b	0 b	0 a	0 a
MSO +	1.5 pt/A +															
AMS fb	1.5 fb															
Bentazon +	0.5 +	7/2, 9PM														
clethodim +	0.156 +															
MSO +	1.5 pt/A +															
AMS	1.5															
Handweeded control			1 a	0 b	1 b	0 a	0 c	0 a	1 a	0 a	1 b	1 ab	0 b	1 b	0 a	0 a

Table 2. continued[1]

							Weed control[2]									Dry
	Application		Crop injury				CHEAL		AMARE		SOLSA		SETVI		MEDSA	bean
Treatment[3]	rate	date & time	6/25	7/3	7/6	7/23	7/23	8/27	7/23	8/27	7/23	8/27	7/23	8/27	7/23	yield
	lb ai/A		%													lb/A
Untreated control			-	-	-	-	-	-	-	-	-	-	-	-	-	3,269 a
Bentazon +	0.5 +	6/18, 6AM	18 a	1 b	12 a	0 a	90 a	84 a	99 a	97 a	100 a	99 a	100 a	99 a	100 a	3,507 a
MSO +	1.5 pt/A +															
AMS fb	1.5 fb															
Bentazon +	0.5 +	7/2, 6AM														
clethodim +	0.156 +															
MSO +	1.5 pt/A +															
AMS	1.5															
Bentazon +	0.5 +	6/18, 9AM	13 b	6 a	4 b	0 a	89 a	79 a	99 a	93 a	100 a	99 a	100 a	99 a	100 a	3,518 a
MSO +	1.5 pt/A +															
AMS fb	1.5 fb															
Bentazon +	0.5 +	7/2, 9AM														
clethodim +	0.156 +															
MSO +	1.5 pt/A +															
AMS	1.5															
Bentazon +	0.5 +	6/18, 12PM	5 c	0 b	2 bc	0 a	81 a	60 a	83 a	54 a	98 a	99 a	97 a	94 a	100 a	3,898 a
MSO +	1.5 pt/A +															
AMS fb	1.5 fb															
Bentazon +	0.5 +	7/2, 12PM														
clethodim +	0.156 +															
MSO +	1.5 pt/A +															
AMS	1.5															
Bentazon +	0.5 +	6/18, 3PM	1 c	0 b	0 c	0 a	28 a	27 a	51 a	50 a	31 a	80 a	31 a	31 a	31 a	3,366 a
MSO +	1.5 pt/A +															
AMS fb	1.5 fb															
Bentazon +	0.5 +	7/2, 3PM														
clethodim +	0.156 +															
MSO +	1.5 pt/A +															
AMS	1.5															
Bentazon +	0.5 +	6/18, 6PM	3 c	0 b	0 c	0 a	89 a	57 a	89 a	78 a	100 a	99 a	100 a	99 a	100 a	3,332 a
MSO +	1.5 pt/A +															
AMS fb	1.5 fb															
Bentazon +	0.5 +	7/2, 6PM														
clethodim +	0.156 +															
MSO +	1.5 pt/A +															
AMS	1.5															
Bentazon	0.5 +	6/18, 9PM	3 c	0 b	0 c	0 a	92 a	80 a	91 a	92 a	100 a	99 a	100 a	99 a	100 a	3,633 a
MSO +	1.5 pt/A +															
AMS fb	1.5 fb															
Bentazon +	0.5 +	7/2, 9PM														
clethodim +	0.156 +															
MSO +	1.5 pt/A +															
AMS	1.5															
Handweeded control			-	-	-	-	100 a	95 a	99 a	93 a	100 a	99 a	100 a	99 a	100 a	3,441 a

[1]Means followed by same letter are not significantly different using Fisher's Protected LSD (P=0.05).
[2]Weeds counted and evaluated for control were common lambsquarters (CHEAL), hairy nightshade (SOLSA), redroot pigweed (AMARE), and green foxtail (SETVI) common mallow (MALNE) and volunteer alfalfa (MEDSA).
[3] Bentazon is sold as Basagran. Clethodim is sold as Shadow. MSO is sold as MSO Super Spread. AMS is an ammonium sulfate sold as BroncMax. Fb=followed by.

Sprayer nozzle and volume effects on weed control in dry bean with bentazon. Michael L. Thornton, Don W. Morishita, Kyle G. Frandsen. (Kimberly Research and Extension Center, University of Idaho, Kimberly, ID 83341. Postemergence bentazon applications for weed control in dry bean grown in Idaho's dry climate are inconsistent. A field experiment was conducted at the University of Idaho Research and Extension Center near Kimberly, Idaho to determine the influence that spray volume and nozzle type had on the effectiveness of bentazon applications in dry beans. Experimental design was a randomized complete block with four replications. Individual plots were four rows by 30 ft. Soil type was a Porteneuf silt loam (29% sand, 52% silt, and 19% clay) with a pH of 8.1, 1.4% organic matter, and CEC of 19-meq/100 g soil. 'Sequoia' dry bean was planted May 27, 2015 in 22-inch rows at a rate of 105,000 seed/A. Green foxtail, common lambsquarters, hairy nightshade and redroot pigweed were the major weed species present. Herbicides were applied broadcast using a CO_2-pressurized bicycle-wheel sprayer. Depending on treatment, the sprayer was calibrated to deliver 10, 15, or 20 gpa using 11001 flat fan nozzles or 11001 air induction flat spray tip nozzles. Additional environmental and application information is given in Table 1. Weed counts were taken 7 days after first application (DAFA), 4 and 20 days after last application (DALA) on June 25, July 6 and 22, respectively. Crop injury was evaluated visually June 25, July 3, 6, 23 which was 7 DAFA, 1, 4 and 21 DALA, respectively. Weed control was evaluated visually 21 and 56 DALA on July 23 and August 27, respectively. The two center rows of each plot were harvested mechanically with a small-plot combine on September 29.

Table 1. Environmental conditions and weed species densities at application

Application date	6/18	7/2
Application timing	1st trifoliate	before 2nd cultivation
Air temperature (F)	83	74
Soil temperature (F)	78	78
Relative humidity (%)	33	38
Wind velocity (mph)	4	3
Cloud cover (%)	25	15
Time of day	1030	730
Weed species/ft^2		
foxtail, green	<1	2
lambsquarters, common	<1	2
nightshade, hairy	<1	<1
pigweed, redroot	<1	1

Crop injury 7 DAFA ranged from 1 to 6% with no statistical differences among treatments (Table 2). At 1 DALA, crop injury ranged from 16 to 33% and at 4 DALA, crop injury ranged from 10 to 31% with the lowest injury observed with the flat fan (FF) 20 gal/A treatment for both dates. By 21 DALA no injury was observed among the herbicide treatments. Crop injury was highest following an application but the dry bean yield was unaffected by injury caused by herbicide. Treatments had comparable overall weed control. Common lambsquarters counts 20 DALA was more abundant than at earlier dates but no statistical difference was observed. Common lambsquarters weed control 56 DALA ranged from 51-97% with the lowest control in treatments with 10, 15, and 20 gal/A in AI nozzles, suggesting that, with regards to common lambsquarters, FF nozzles with 15 or 20 gal/A provided better control due to better spray coverage. Dry bean yield ranged from 3269 to 3631 lb/A with the untreated control having the lowest yield. Although yield differs, there is no statistical difference between treatments suggesting there was variability from plot to plot in a treatment. Ultimately, no yield differences were observed…

Table 2. Crop tolerance, weed control, and yield in furrow irrigated dry beans near Kimberly, ID[1]

	Application		Nozzle	Weed counts[2]												Crop injury				Weed control[2]								Dry bean
				CHEAL			AMARE			SOLSA			SETVI							CHEAL		AMARE		SOLSA		SETVI		
Treatment[3]	rate	date	type[4]	6/25	7/6	7/22	6/25	7/6	7/22	6/25	7/6	7/22	6/25	7/6	7/22	6/25	7/3	7/6	7/23	7/23	8/27	7/23	8/27	7/23	8/27	7/23	8/27	yield
	lb ai/A			plants/183ft[2]												%												lb/A
Untreated control				3 a	229 a	7 a	0 a	114 a	3 a	0 a	76 a	5 a	5 ab	270 a	7 a	-	-	-	-	-	-	-	-	-	-	-	-	3.269 a
Bentazon +	0.5 +	6/18	FF, 10	1 a	1 b	2 ab	0 a	0 b	1 a	0 a	1 a	0 b	4 ab	5 b	0 b	4 a	18 b	21 ab	0 a	82 a	75 abc	100 a	99 a	100 a	99 a	99 a	99 a	3.386 a
MSO +	1.5 pt/A +																											
AMS fb	1.5 fb																											
Bentazon +	0.5 +	7/2	FF, 10																									
clethodim +	0.156 +																											
MVO +	4 fl oz/A +																											
MSO +	1.5 pt/A +																											
AMS	1.5																											
Bentazon +	0.5 +	6/18	FF, 15	0 a	1 b	2 ab	0 a	0b	1 a	0 a	0 a	0 b	1 ab	3 b	1 b	1 a	24 a	18 ab	0 a	95 a	87 ab	93 a	87 a	100 a	99 a	100 a	99 a	3.500 a
MSO +	1.5 pt/A +																											
AMS fb	1.5 fb																											
Bentazon +	0.5 +	7/2	FF, 15																									
clethodim +	0.156 +																											
MVO +	4 fl oz/A +																											
MSO +	1.5 pt/A +																											
AMS	1.5																											
Bentazon +	0.5 +	6/18	FF, 20	0 a	0 b	1 b	0 a	2 b	1 a	0 a	0 a	0 b	5 ab	5 b	2 b	5 a	16 b	10 b	0 a	99 a	94 ab	83 a	74 a	100 a	99 a	100 a	99 a	3.541 a
MSO +	1.5 pt/A +																											
AMS fb	1.5 fb																											
Bentazon +	0.5 +	7/2	FF, 20																									
clethodim +	0.156 +																											
MVO +	4 fl oz/A +																											
MSO +	1.5 pt/A +																											
AMS	1.5																											
Bentazon +	0.5 +	6/18	AI, 10	1 a	2 b	4 ab	0 a	2 b	2 a	0 a	0 a	0 b	4 ab	3 b	0 b	5 a	31 a	31 a	0 a	78 a	51 c	95 a	75 a	99 a	99 a	100 a	99 a	3.436 a
MSO +	1.5 pt/A +																											
AMS fb	1.5 fb																											
Bentazon +	0.5 +	7/2	AI, 10																									
clethodim +	0.156 +																											
MVO +	4 fl oz/A +																											
MSO +	1.5 pt/A +																											
AMS	1.5																											
Bentazon +	0.5 +	6/18	AI, 15	2 a	2 b	3 ab	0 a	0 b	0 a	0 a	0 a	0 b	7 a	5 b	1 b	5 a	28 a	29 a	0 a	77 a	66 bc	91 a	95 a	94 b	99 a	100 a	99 a	3.526 a
MSO +	1.5 pt/A +																											
AMS fb	1.5 fb																											
Bentazon +	0.5 +	7/2	AI, 15																									
clethodim +	0.156 +																											
MVO +	4 fl oz/A +																											
MSO +	1.5 pt/A +																											
AMS	1.5																											

Table 2. Continued

				Weed counts[2]																Weed control[2]								Dry
	Application		Nozzle	CHEAL			AMARE			SOLSA			SETVI			Crop injury				CHEAL		AMARE		SOLSA		SETVI		bean
Treatment[3]	rate	date	type[4]	6/25	7/6	7/22	6/25	7/6	7/22	6/25	7/6	7/22	6/25	7/6	7/22	6/25	7/3	7/6	7/23	7/23	8/27	7/23	8/27	7/23	8/27	7/23	8/27	yield
	lb ai/A			---plants/183ft²---												---%---												lb/A
Bentazon +	0.5 +	6/18	AI, 20	0 a	1 b	4 ab	0 a	1 b	0 a	0 a	0 a	1 b	4 ab	3 b	0 b	3 a	28 a	26 a	0 a	93 a	65 bc	98 a	85 a	100 a	99 a	100 a	99 a	3.631 a
MSO +	1.5 pt/A +																											
AMS fb	1.5 fb																											
Bentazon +	0.5 +	7/2	AI, 20																									
clethodim +	0.156 +																											
MVO +	4 fl oz/A +																											
MSO +	1.5 pt/A +																											
AMS	1.5																											
Bentazon +	0.75 +	6/18	FF, 15	1 a	0 b	2 ab	0 a	2 b	1 a	0 a	0 a	0 b	3 ab	3 b	0 b	6 a	31 a	30 a	0 a	95 a	90 ab	86 a	77 a	100 a	99 a	100 a	99 a	3.389 a
dimethenamid-P +	0.84 +																											
MSO +	1.5 pt/A +																											
AMS fb	1.5 fb																											
Bentazon +	0.75 +	7/2																										
clethodim +	0.156 +																											
MSO +	1.5 pt/A +																											
AMS	1.5																											
Bentazon +	0.75 +	6/18	FF, 15	0 a	1 b	1 ab	1 a	1 b	1 a	0 a	0 a	0 b	3 ab	3 b	0 b	4 a	33 a	23 ab	0 a	98 a	94 ab	92 a	81 a	100 a	99 a	100 a	99 a	3.487 a
ethalfluralin +	1.125 +																											
MSO +	1.5 pt/A +																											
AMS fb	1.5 fb																											
Bentazon +	0.5 +	7/2	FF, 15																									
clethodim +	0.156 +																											
MSO +	1.5 pt/A +																											
AMS	1.5																											
Handweeded control				1 a	0 b	1 b	0 a	0 b	0 a	1 a	0 a	1 b	1 b	0 c	1 b	-	-	-	-	100 a	97 a	99 a	93 a	100 a	99 a	100 a	99 a	3.441 a

[1]Means followed by same letter are not significantly different using Fisher's Protected LSD (P=0.05).

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

[3] Bentazon is Basagran. MSO is sold as MSO Super Spread. AMS an ammonium sulfate sold as BroncMax. Clethodim is sold as Shadow. MVO is a modified vegetable oil sold as the drift retardant In-Place. Dimethenamid-P is Outlook. Ethalfluralin is sold as Sonalan. Handweeded control was the handweeded check. Fb=followed by.

[4]Multiple spray volumes were used (10), (15), (20) GAL/A. Several types of nozzles were compared (FF) = flat fan Nozzles (AI) = Air induction nozzles.

Sequential herbicide applications for weed control in furrow irrigated dry bean. Michael L. Thornton, Don W. Morishita, Kyle G. Frandsen. (Kimberly Research and Extension Center, University of Idaho, Kimberly, ID 83341). A field experiment was conducted at the University of Idaho Research and Extension Center near Kimberly, Idaho to determine the effectiveness of sequential herbicide applications in furrow irrigated dry bean. 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% sand, 52% silt, and 19% clay) with a pH of 8.1, 1.4% organic matter, and CEC of 19-meq/100 g soil. 'Sequoia' dry bean was planted May 25, 2015 in 22-inch rows at a rate of 105,000 seed/A. Common lambsquarters (CHEAL), redroot pigweed (AMARE), hairy nightshade (SOLSA), and green foxtail (SETVI) were the major weed species present. Herbicides were applied broadcast with a CO_2-pressurized bicycle-wheel sprayer calibrated to deliver 15 gpa using 11001 flat fan nozzles. Additional environmental and application information is given in Table 1. All herbicide treatments included a preplant incorporated (PPI) herbicide treatment followed by (fb) a sequential postemergence application prior to the first cultivation, which was June 19. The lone exception was the PPI combination of EPTC 7E + Ethalfluralin 3EC at 3.94 + 0.75 lb ai/A. Crop injury was evaluated visually 8, 19, and 36 days after last application (DALA) on June 25, July 6, and July 23, respectively. Weed control was evaluated visually 36 and 71 DALA on July 23 and August 27, respectively and weed counts were taken 8, 19, and 35 DALA on June 25, July 6, and July 22, respectively. The two center rows of each plot were harvested mechanically September 29.

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

Application date	5/15/2015	6/2/2015	6/17/2015
Application timing	Pre-germination	At planting	1st Trifoliate
Air temperature (F)	58	68	84
Soil temperature (F)	64	65	77
Relative humidity (%)	49	66	18
Wind velocity (mph)	5	6	2
Cloud cover (%)	100	10	10
Time of day	1430	1000	1130
Weed species/ft^2			
foxtail, green	-	1	1
lambsquarters, common	-	<1	<1
nightshade, hairy	-	<1	<1
pigweed, redroot	-	<1	<1

Crop injury was greatest 8 DALA ranging from 0 to 12% with dimethenamid-P + ethalfluralin 3EC fb pyroxasulfone + bentazon + clethodim + MSO + AMS at 12% injury. At 19 DALA the injury ranged from 0 to 7% with pyroxasulfone rated with the highest at 7% injury. By 36 DALA, injury ranged from 0 to 1% with no statistical difference between any treatments. Weed populations in this study were low (Table 2). However, the densities were high enough to reduce the yield of the untreated control compared to all of the herbicide treatments. Visual weed control throughout the study ranged from 97 to 100% and weed count data supports the weed control numbers with no statistical differences between treatments. Dry bean yield ranged from 2,843 to 3,683 lb/A with the untreated control producing the lowest yield. Despite the injury observed in dimethenamid-P + ethalfluralin 3EC fb pyroxasulfone + bentazon + clethodim + MSO + AMS, it had the highest yield of 3,683 lb/A.

*Table 2***.** Crop tolerance, weed control, and yield in furrow irrigated dry beans near Kimberly, ID[1]

	Application		Weed counts[2]												Crop injury			Weed control[2]								Dry bean
			CHEAL			AMARE			SOLSA			SETVI						CHEAL		AMARE		SOLSA		SETVI		
Treatment[3]	rate	date	6/25	7/6	7/22	6/25	7/6	7/22	6/25	7/6	7/22	6/25	7/6	7/22	6/25	7/6	7/23	7/23	8/27	7/23	8/27	7/23	8/27	7/23	8/27	yield
	lb ai/a		plants/183ft[2]												%											lb/A
Untreated control			29 a	46 a	11 a	4 a	31 a	6 a	32 a	27 a	6 a	39 a	80 a	14 a												2,843 b
EPTC 7E +	3.94 +	5/15	0 b	1 b	0 b	0 b	0 b	0 b	1 b	0 b	0 b	1 b	0 b	0 b	0 b	0 b	0 a	100 a	99 a	100 a	99 a	100 a	97 a	100 a	99 a	3,355 a
ethalfluralin 3EC	0.75																									
EPTC 7E +	3.94 +	5/15	0 b	0 b	0 b	0 b	0 b	0 b	0 b	0 b	0 b	0 b	1 b	0 b	0 b	0 b	1 a	100 a	99 a	100 a	98 a	100 a	98 a	100 a	99 a	3,519 a
ethalfluralin 3EC fb	0.75																									
EPTC 20G	4	6/2																								
EPTC 7E +	3.94 +	5/15	0 b	0 b	0 b	0 b	0 b	0 b	0 b	1 b	1 b	0 b	0 b	0 b	7 a	1 b	0 a	100 a	99 a	100 a	99 a	100 a	98 a	100 a	99 a	3,469 a
ethalfluralin 3EC fb	0.75																									
EPTC 7E +	3.94 +	6/17																								
bentazon +	0.5 +																									
clethodim +	0.076 +																									
GWN-10172 +	3.94 +	5/15	0 b	0 b	0 b	0 b	0 b	0 b	0 b	0 b	0 b	0 b	0 b	0 b	4 a	3 ab	0 a	100 a	99 a	100 a	99 a	100 a	99 a	100 a	99 a	3,441 a
ethalfluralin 3EC	0.75																									
GWN-10172 fb	3.94 +	6/17																								
bentazon +	0.5 +																									
clethodim +	0.076 +																									
EPTC 7E +	3.94 +	5/15	0 b	0 b	0 b	0 b	0 b	0 b	0 b	0 b	0 b	0 b	0 b	0 b	7 a	3 ab	0 a	100 a	99 a	100 a	99 a	100 a	99 a	100 a	99 a	3,497 a
ethalfluralin 3EC fb	0.75																									
EPTC 7E +	3.94 +	6/17																								
bentazon +	0.5 +																									
clethodim +	0.076 +																									
EPTC 7E +	2.63 +	5/15	0 b	0 b	0 b	0 b	0 b	0 b	0 b	1 b	0 b	0 b	0 b	0 b	0 b	0 b	0 a	100 a	99 a	100 a	99 a	100 a	99 a	100 a	99 a	3,434 a
ethalfluralin 3EC fb	1.13																									
EPTC 20G	4	6/17																								
EPTC 7E +	2.63 +	5/15	0 b	0 b	0 b	0 b	0 b	0 b	0 b	0 b	1 b	0 b	0 b	0 b	5 a	0 b	0 a	100 a	99 a	100 a	99 a	100 a	99 a	100 a	99 a	3,579 a
ethalfluralin 3EC fb	1.13 +																									
EPTC 20G +	4 +	6/17																								
bentazon +	0.5 +																									
clethodim +	0.076 +																									
EPTC 7E +	2.63 +	5/15	0 b	1 b	0 b	0 b	0 b	0 b	0 b	0 b	0 b	0 b	1 b	0 b	0 b	0 b	0 a	100 a	99 a	100 a	99 a	100 a	99 a	100 a	99 a	3,359 a
dimethenamid-P fb	0.656																									
ethalfluralin 10G	1.1	6/17																								
EPTC 7E +	2.63 +	5/15	0 b	5 b	0 b	0 b	0 b	0 b	0 b	1 b	0 b	0 b	3 b	0 b	5 a	0 b	0 a	100 a	99 a	100 a	99 a	100 a	99 a	100 a	99 a	3,342 a
dimethenamid-P fb	0.656																									
Fomesafen +	0.25 +	6/17																								
bentazon +	0.5 +																									
clethodim +	0.076 +																									

Table 2. Continued[1]

	Application		Weed counts[2]															Weed control[2]							Dry
			CHEAL			AMARE			SOLSA			SETVI			Crop injury			CHEAL		AMARE		SOLSA		SETVI		bean
Treatment[3]	rate	date	6/25	7/6	7/22	6/25	7/6	7/22	6/25	7/6	7/22	6/25	7/6	7/22	6/25	7/6	7/23	7/23	8/27	7/23	8/27	7/23	8/27	7/23	8/27	yield
	lb ai/a		plants/183ft^2												%											lb/A
EPTC 7E +	2.63 +	5/15	0 b	0 b	0 b	0 b	0 b	0 b	0 b	1 b	0 b	0 b	0 b	0 b	1 b	0 b	0 a	100 a	99 a	100 a	99 a	100 a	99 a	100 a	99 a	3,450 a
dimethenamid-P fb	0.656																									
ethalfluralin 3EC	1.13 +	6/17																								
bentazon +	0.5 +																									
clethodim +	0.076 +																									
EPTC 7E +	2.63 +	5/15	0 b	2 b	0 b	0 b	3 b	0 b	0 b	1 b	0 b	0 b	3 b	0 b	3 ab	1 b	0 a	100 a	99 a	100 a	99 a	100 a	99 a	100 a	99 a	3,516 a
dimethenamid-P fb	0.656																									
s-metolachlor	1.43 +	6/17																								
bentazon +	0.5 +																									
clethodim +	0.076 +																									
EPTC 7E +	2.63 +	5/15	0 b	1 b	0 b	0 b	0 b	0 b	0 b	0 b	0 b	0 b	1 b	0 b	0 b	0 b	0 a	100 a	99 a	100 a	99 a	100 a	99 a	100 a	99 a	3,412 a
dimethenamid-P fb	0.656																									
acetochlor +	1.13 +	6/17																								
bentazon +	0.5 +																									
clethodim +	0.076 +																									
Dimethenamid-P +	0.656 +	5/15	0 b	0 b	0 b	0 b	0 b	0 b	0 b	0 b	0 b	0 b	0 b	0 b	1 b	0 b	0 a	100 a	99 a	100 a	99 a	100 a	99 a	100 a	99 a	3,533 a
pendimethalin +	0.95																									
bentazon +	0.5 +	6/17																								
clethodim +	0.076 +																									
Dimethenamid-P +	0.84 +	5/15	0 b	0 b	0 b	0 b	0 b	0 b	0 b	0 b	0 b	0 b	1 b	0 b	0 b	0 b	0 a	100 a	99 a	100 a	99 a	100 a	99 a	100 a	99 a	3,188 a
ethalfluralin 3EC fb	1.13																									
bentazon +	0.5 +	6/17																								
clethodim +	0.076 +																									
Dimethenamid-P +	0.656 +	5/15	0 b	1 b	0 b	0 b	0 b	0 b	0 b	0 b	0 b	0 b	0 b	0 b	12 a	7 a	0 a	100 a	99 a	100 a	99 a	100 a	99 a	100 a	99 a	3,683 a
ethalfluralin 3EC fb	1.13																									
pyroxasulfone +	0.16 +	6/17																								
bentazon +	0.5 +																									
clethodim +	0.076 +																									

[1]Means followed by same letter are not significantly different using Fisher's Protected LSD (P=0.05).
[2]Weeds counted and evaluated for control were common lambsquarters (CHEAL), redroot pigweed (AMARE), hairy nightshade (SOLSA), and green foxtail (SETVI).
[3]EPTC 7E is Eptam 7E. Ethalfluralin 3EC is sold as Sonalan HFP. EPTC 20G is a granular formulation sold as Eptam 20G. Bentazon is sold as Basagran. Clethodim is sold as Select Max. MSO and AMS at 1.2 and 1.5 pt/A, respectively were added to all treatments containing bentazon + clethodim. MSO is sold as MSO Super Spread. AMS is ammonium sulfate sold as Bronc Max. GWN-10172 is an unregistered EPTC formulation. Dimethenamid-P is sold as Outlook. Ethalfluralin 10G is a granular formulation sold as Sonalan 10G. Fomesafen is sold as Reflex. S-metolachlor is sold as Dual Magnum. Acetochlor is sold as Warrant. Pendimethalin is sold as Prowl H_2O. Pyroxasulfone is sold as Zidua. Fb=followed by.

Comparison of adjuvants used with bentazon for postemergence weed control in dry bean. Samara L. Arthur, Don W. Morishita, and Kyle G. Frandsen. (Kimberly Research and Extension Center, University of Idaho, Kimberly, ID 83341). Response of postemergence bentazon applications for weed control in dry bean has been variable due primarily to the low humidity environment of south central Idaho. A field experiment was conducted at the University of Idaho Research and Extension Center near Kimberly, Idaho to compare several adjuvants with bentazon for postemergence weed control and crop injury potential in dry bean. Experimental design was a randomized complete block with four replications. Individual plots were 7.33 by 30 ft. Soil type was a Portneuf silt loam (16% sand, 64.1% silt, and 19.9% clay) with a pH of 8.1, 1.87% organic matter, and CEC of 18.3-meq/100 g soil. 'Othello' dry bean was planted May 27, 2015 in 22-inch rows at a rate of 105,000 seed/A. Green foxtail (SETVI), common lambsquarters (CHEAL), and redroot pigweed (AMARE) were the major weed species present. Herbicides were applied broadcast with a CO_2-pressurized bicycle-wheel sprayer calibrated to deliver 15 gpa using 11001 flat fan nozzles. Additional environmental and application information is given in Table 1. Crop injury was evaluated 8 days after the first application (DAFA) on June 25, and 2 and 7 days after the last herbicide application (DALA) on July 3 and 8. Weed control was evaluated visually 7 and 13 DALA on July 8 and 14. However, only the 13 DALA evaluation data are presented. The two center rows of each plot were harvested mechanically with a small-plot harvester on September 10.

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

Application date	6/17/15	7/1/15
Application timing	1 to 2 trifoliate	before 1st cultivation
Air temperature (F)	78	81
Soil temperature (F)	71	80
Relative humidity (%)	42	39
Wind speed (mph)	2.3	5
Cloud cover (%)	5	-
Time of day	0940	0920
Weed species/ft^2		
foxtail, green	6	6
lambsquarters, common	5	5
nightshade, hairy	1	1
pigweed, redroot	2	2

One of the primary objectives of this study was to monitor crop injury from these treatments. At 8 DAFA, crop injury ranged from 1 to 17%. Two adjuvant treatments applied with bentazon + clethodim, MSO + AMS and micronutrient solution + MSO + AMS, and MSO + AMS applied with bentazon and the Select Max formulation of clethodim had injury ratings of 11, 13 and 17%, respectively (Table 2). Injury symptoms primarily were bronzed or chlorotic leaves. Crop injury ratings 2 DALA ranged from 2 to 16%. Several treatments had injury ratings >10%. These treatments included MSO + AMS (16%), micronutrient solution at 2 and 4 pt/A with MSO + AMS (13 and 10%, respectively), WE1569-1 (12%), and MSO + AMS used with bentazon and the Select Max formulation of clethodim (16%). At 7 DALA, the injury ratings were very similar to 2 DALA and ranged from 3 to 13%. Common lambsquarters control 13 DALA ranged from 78 to 99%. However, due to variability in the weed population, there were no significant differences in control. Redroot pigweed control ranged from 5 to 68%. Control of this species was unacceptable for all herbicide treatments because bentazon does not adequately control redroot pigweed. Hairy nightshade control was excellent with all herbicide treatments. However, there were Colorado potato beetles in the study site that may have influenced this. Green foxtail control 13 DALA ranged from 79 to 100%. Using WC214 + AMS with bentazon + clethodim reduced green foxtail control to 79%. There were no differences in green foxtail control among the other herbicide treatments. Dry bean yield ranged from 2,620 to 3,349 lb/A with the untreated control having the lowest yield. The addition of WC221 + AMS and WC226 + AMS to bentazon + clethodim resulted in the only yields that were significantly higher than the untreated control.

Table 2. Crop injury, weed control, and dry bean yield, near Kimberly, ID[1]

	Application		Crop injury			Weed control[2]				Dry bean yield
						CHEAL	AMARE	SOLSA	SETVI	
Treatment[3]	rate	date	6/25	7/3	7/8	7/14	7/14	7/14	7/14	
	lb ai/A		-----------------%						-----------------%	lb/A
Untreated Control			-	-	-	-	-	-	-	2,620 b
Bentazon +	0.75 +	6/17 & 7/1	7 bcd	6 ab	8 abc	91 a	41 a	99 a	100 a	3,079 ab
clethodim-1 +	0.156 +									
COC +	1 % v/v +									
AMS	1.5 fb									
Bentazon +	0.75 +	6/17 & 7/1	1 e	4 ab	5 bc	99 a	58 a	100 a	98 a	3,150 ab
clethodim-1 +	0.156 +									
WC051	0.25 % v/v +									
AMS	1.5 fb									
Bentazon +	0.5 +	6/17 & 7/1	3 cde	2 b	6 abc	99 a	25 a	100 a	100 a	3,122 ab
clethodim-1 +	0.156 +									
WC051 +	0.25 % v/v +									
AMS	1.5 fb									
Bentazon +	0.75 +	6/17 & 7/1	3 cde	5 ab	5 bc	96 a	48 a	100 a	100 a	3,167 ab
clethodim-1 +	0.156 +									
WC199 +	0.5 % v/v =									
AMS	1.5 fb									
Bentazon +	0.5 +	6/17 & 7/1	1 e	5 ab	6 abc	78 a	36 a	100 a	98 a	3,024 ab
clethodim-1 +	0.156 +									
WC211	0.5 % v/v +									
AMS	1.5 fb									
Bentazon +	0.75 +	6/17 & 7/1	4 cde	3 ab	5 bc	96 a	9 a	100 a	79 c	3,070 ab
clethodim-1 +	0.156 +									
WC214 +	0.25 % v/v +									
AMS	1.5 fb									
Bentazon +	0.5 +	6/17 & 7/1	1 e	3 ab	5 bc	94 a	30 a	100 a	93bc	3,349 a
clethodim-1 +	0.156 +									
WC221 +	0.5 % v/v +									
AMS	1.5 fb									
Bentazon +	0.75 +	6/17 & 7/1	5 b-e	5 ab	5 bc	92 a	68 a	100 a	95 abc	3,339 a
clethodim-1 +	0.156 +									
WC226+	0.5 % v/v +									
AMS	1.5 fb									
Bentazon +	0.5 +	6/17 & 7/1	13 ab	13 a	10 ab	93 a	5 a	100 a	100 a	2,840 ab
clethodim-1 +	0.156 +									
micronutrient solution +	2 pt/a +									
MSO+	1.5 pt/a +									
AMS	1.5 fb									

Table 2. (continued)

Treatment[3]	Application rate	Application date	Crop injury 6/25	Crop injury 7/3	Crop injury 7/8	Weed control[2] CHEAL 7/14	Weed control[2] AMARE 7/14	Weed control[2] SOLSA 7/14	Weed control[2] SETVI 7/14	Dry bean yield
	lb ai/A		---%						---%	lb/A
Bentazon +	0.75 +	6/17 & 7/1	6 b-e	10 ab	9 abc	96 a	42 a	100 a	92 bc	3,012 ab
clethodim-1 +	0.156 +									
micronutrient solution +	4 pt/a +									
AMS	1.5 fb									
Bentazon +	0.5 +	6/17 & 7/1	11 abc	16 a	13 a	85 a	27 a	100 a	100 a	3,170 ab
clethodim-1 +	0.156 +									
MSO +	1.5 pt/a +									
AMS	1.5 fb									
Bentazon +	0.5 +	6/17 & 7/1	9 a-d	8 ab	10 ab	93 a	8 a	100 a	100 a	2,904 ab
clethodim-1 +	0.156 +									
WE1442-1 +	1.5 % v/v +									
AMS	1.5 fb									
Bentazon +	0.5 +	6/17 & 7/1	2 de	12 ab	13 a	87 a	23 a	100 a	100 a	2,809 ab
clethodim-1 +	0.156 +									
WE1569-1 +	0.5 % v/v +									
AMS	1.5 fb									
Bentazon +	0.75 +	6/17 &/1	1 e	2 b	3 c	91 a	36 a	100 a	97 a	3,204 ab
clethodim-2 +	0.076 +									
NIS	0.25 % v/v fb									
Bentazon +	0.75 +	6/17 & 7/1	17 a	16 a	10 ab	91 a	56 a	100 a	99 a	3,059 ab
clethodim-2 +	0.076 +									
MSO +	1.5 pt/a +									
AMS	1.5 fb									

[1] Means followed by same letter are not significantly different (P=0.05, LSD).

[2] Weed species evaluated for control were: common lambsquarters (CHEAL), redroot pigweed (AMARE), hairy nightshade (SOLSA) and green foxtail (SETVI).

[3] Bentazon is sold as Basagran 5L. Clethodim-1 is sold as Shadow. COC is a crop oil concentrate sold as Mor-Act. AMS is ammonium sulfate sold as Bronc Max. WC051, WC199, WC211, WC214, WC221, and WC226 are proprietary adjuvants. Micronutient solution is an adjuvant sold as Quatro. MSO is a methylated seed oil sold as MSO Super Spread. WE1442-1 and WE1569-1 are proprietary adjuvants. NIS is a nonionic surfactant sold as R-11. Clethodim-2 is sold as Select Max.

Weed control with pre and postemergence herbicides in sugar beet. Samara L. Arthur, Don W. Morishita, and Kyle G. Frandsen. (Kimberly Research and Extension Center, University of Idaho, Kimberly, ID 83341). A field experiment was conducted at the University of Idaho Research and Extension Center near Kimberly, Idaho to evaluate the efficacy of various herbicide combinations and timings 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 (19% sand, 60% silt, and 21% clay) with a pH of 8.3, 1.3% organic matter, and CEC of 28.4-meq/100 g soil. 'Holly hybrid SX1534RR' sugar beet was planted May 6, 2015 in 22-inch rows at a rate of 60,589 seed/A. Common lambsquarters (CHEAL) and redroot pigweed (AMARE) were the major weed species present. Herbicides were applied broadcast with a CO_2-pressurized bicycle-wheel sprayer calibrated to deliver 15 gpa using 11001 flat fan nozzles. Additional environmental and application information is given in Table 1. Crop injury and weed control were evaluated visually 12 days after the last herbicide application (DALA) on June 18. The two center rows of each plot were harvested mechanically October 7.

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

Application date	4/20/2015	6/4/2015	6/18/2015
Application timing	pre-emergence	2 leaf	4-6 leaf
Air temperature (F)	63	58	73
Soil temperature (F)	59	60	66
Relative humidity (%)	21	59	39
Wind speed (mph)	2.7	7	0
Cloud cover (%)	5	95	5
Time of day	1055	0841	0800
Weed species/ft^2			
lambsquarters, common	0	7	8
pigweed, redroot	0	6	11

Crop injury ranged from 0 to 3% at 12 and 25 DALA with no significant difference among herbicide treatments (Table 2). Common lambsquarters control ranged from 70 to 96% 12 DALA. Those treatments that included ethofumesate applied postemergence twice averaged 96% common lambsquarters control compared to 80% for those treatments that had one postemergence ethofumesate application. A similar pattern of common lambsquarters control was observed at 25 DALA. Redroot pigweed control 12 DALA ranged from 97 to 100% control for all herbicide treatments. By 25 DALA, control ranged from 88 to 100% control. Ethofumesate followed by acetochlor + glyphosate + ethofumesate at 1.5 + 1.12 + 0.125 lb ai/A applied one time postemergence had the poorest redroot pigweed control at 88%. There were no differences in sugar content, nitrates, or conductivity among all of the treatments. This is consistent with previous research. The root and estimated recoverable sucrose (ERS) yield of the untreated control was less than all of the herbicide treatments. Although slight differences in common lambsquarters control were observed among the herbicide treatments, there were no differences in root or ERS yield among the herbicide treatments. As seen before, increased weed control drastically lowers competition and results in greater crop yield.

Table 2. Crop tolerance, common lambsquarters and redroot pigweed control, sugar content, nitrate, conductivity, yield and estimated recoverable sucrose (ERS) in sugar beet, near Kimberly, ID[1]

	Application		Crop injury		Weed control[2]				Sugar beet				
					CHEAL		AMARE						
Treatment[3]	rate	date	6/30	7/13	6/30	7/13	6/30	7/13	sugar	nitrate	conductivity	yield	ERS
	lb ai/A		--------------------------------%--------------------------------						%	ppm	mmho/cm	ton/A	lb/A
Untreated control			-	-	-	-	-	-	17 a	143 a	0.54 a	6 b	1,810 b
Ethofumesate fb	1.25 fb	4/20	0 a	3 a	70 c	65 f	99 a	88 c	18 a	158 a	0.60 a	41 a	12,935 a
Acetochlor +	1.5lb +	6/4											
glyphosate-1 +	1.12lb ae/A +												
ethofumesate +	0.125 +												
AMS	2.55												
Ethofumesate fb	1.25 fb	4/20	3 a	1 a	79 bc	87 de	100 a	100 a	18 a	154 a	0.57 a	44 a	14,078 a
Acetochlor +	1.5 +	6/18											
glyphosate-1 +	1.12lb ae/A +												
ethofumesate +	0.125 +												
AMS	2.55												
Ethofumesate fb	1.25 fb	4/20	0 a	1 a	83 b	81 e	97 a	95 b	18 a	160 a	0.56 a	42 a	13,924 a
S-metolachlor +	1.52 +	6/4											
glyphosate-1 +	1.12lb ae/A +												
ethofumesate +	0.125+												
AMS	2.55												
Ethofumesate fb	1.25 fb	4/20	0 a	1 a	89 ab	92 cde	100 a	99 ab	18 a	148 a	0.63 a	43 a	13,642 a
S-metolachlor +	1.52 +	6/18											
glyphosate-1 +	1.12lb ae/A +												
ethofumesate +	0.125 +												
AMS	2.55												
Ethofumesate fb	1.25 fb	4/20	0 a	2 a	79 bc	82 e	100 a	100 a	18 a	162 A	0.55 a	42 a	13,865 a
Dimethenamid-P +	0.975 +	6/4											
glyphosate +	1.12lb ae/A +												
ethofumesate +	0.125 +												
AMS	2.55												
Ethofumesate fb	1.25 fb	4/20	3 a	1 a	79 bc	88 de	100 a	99 ab	18 a	164 a	0.52 a	39 a	12,860 a
Dimethenamid-P +	0.975 +	6/18											
glyphosate-1 +	1.12lb ae/A +												
ethofumesate +	0.125+												
AMS	2.55												

Table 2 (continued)

Treatment[3]	Application Rate	Application date	Crop injury 6/30	Crop injury 7/13	Weed control[2] CHEAL 6/30	CHEAL 7/13	AMARE 6/30	AMARE 7/13	Sugar beet sugar	nitrate	conductivity	yield	ERS
	lb ai/A		---------------------------------%---------------------------------						%	ppm	mmho/cm	ton/A	lb/A
Ethofumesate fb	1.25 fb	4/20	1 a	1 a	95 a	100 ab	100 a	100 a	18 a	152 a	0.58 a	42 a	13,930 a
Acetochlor +	1.13 +	6/4											
glyphosate-1 +	1.12lb ae/A +												
ethofumesate +	0.125 +												
AMS fb	2.55 fb												
Acetochlor +	1.13 +	6/18											
glyphosate-1 +	1.12lb ae/A +												
ethofumesate +	0.125 +												
AMS	2.55												
Ethofumesate fb	1.25 fb	4/20	3 a	1 a	96 a	97 bc	100 a	100 a	18 a	153 a	0.60 a	43 a	13,924 a
Dimethenamid-P +	0.56 +	6/4											
glyphosate-1 +	1.12lb ae/A +												
ethofumesate +	0.125 +												
AMS fb	2.55 fb												
Dimethenamid-P +	0.56 +	6/18											
glyphosate-1 +	1.12lb ae/A +												
ethofumesate +	0.125 +												
AMS	2.55												
Ethofumesate fb	1.25 fb	4/20	0 a	0 a	96 a	100 a	100 a	100 a	18 a	157 a	0.52 a	45 a	14,485 a
S-metolachlor +	0.56 +	6/4											
glyphosate-1 +	1.12lb ae/A +												
ethofumesate +	0.125 +												
AMS fb	2.55 fb												
S-metolachlor +	0.56 +	6/18											
glyphosate-1 +	1.12lb ae/A +												
ethofumesate +	0.125 +												
AMS	2.55												
Glyphosate-2 +	0.78lb ae/A +	6/18	3 a	1 a	88 ab	95 cd	100 a	99 ab	18 a	151 a	0.59 a	44 a	14,275 a
AMS	1.275												
Glyphosate/S-metolachlor +	1.64lb ae/A +	6/4											
AMS	1.275												

[1]Means followed by the same letter are not significantly different (p=0.05, LSD)

[2]Weed species evaluated for control were: common lambsquarters (CHEAL) and redroot pigweed (AMARE).

[3] Ethofumesate is sold as Nortron. Acetochlor is sold as Warrant. Glyphosate-1 is sold as Roundup PowerMax. Glyphosate-2 is sold as Touchdown Total. AMS is ammonium sulfate sold as Bronc Max. S-metolachlor is sold as Dual Magnum, dimethenamid-P is sold as Outlook. Glyphosate/S-metolachlor is a premixture sold as Sequence.

Broadleaf weed control in Kentucky bluegrass with bicyclopyrone and saflufenacil. Traci A. Rauch and Joan M. Campbell. (Crop and Weed Science Division, University of Idaho, Moscow, ID 83844-2339) A study was conducted in seedling "Pennington' Kentucky bluegrass near Moscow, Idaho to evaluate broadleaf weed control with bicyclopyrone and saflufenacil. The study was arranged in a randomized complete block design with four replications and included an untreated check. All herbicide treatments were applied using a CO_2 pressurized backpack sprayer calibrated to deliver 10 gpa at 32 psi and 3 mph. Broadleaf weed control was evaluated visually.

Table 1. Application data for grass weed sites.

Bluegrass planting date	5/1/2015
Application date	6/9/2015
Growth stage	
Kentucky bluegrass	1 tiller
Mayweed chamomile	2 inch
Common lambsquarters	10 inch
Air temperature (F)	80
Relative humidity (%)	45
Wind (mph, direction)	2, SW
Cloud cover (%)	30
Next moisture occurred	9/5/2015
Soil moisture	dry
Soil temperature at 2 inch (F)	59
pH	5.2
OM (%)	4.1
CEC (meq/100g)	19.5
Texture	silt loam

Kentucky bluegrass injury did not differ among treatments and ranged from 2 to 7% on June 17 (Table 2). Both rates of saflufenacil controlled mayweed chamomile 96% 8 days after treatment (DAT). At 23 DAT, all treatments, except bicyclopyrone at 0.045 lb ai/A, controlled mayweed chamomile 70 to 84%. Saflufenacil alone controlled common lambsquarters 99% at 8 DAT but by 23 DAT control was reduced to 75 to 82%. Common lambsquarters control with saflufenacil plus mesotrione increased to 94% at 23 DAT compared to 69% at 8 DAT. Bicyclopyrone did not control common lambsquarters.

Table 2. Broadleaf weed control in Kentucky bluegrass near Moscow, ID in 2015.

Treatment[1]	Rate	Kentucky bluegrass injury[2]	Mayweed chamomile 8 DAT	Mayweed chamomile 23 DAT	Common lambsquarters 8 DAT	Common lambsquarters 23 DAT
	lb ai/A	%	%	%	%	%
Bicyclopyrone +	0.04					
NIS	0.25% v/v	2	48	26	18	10
Bicyclopyrone +	0.09					
NIS	0.25% v/v	2	52	84	32	44
Saflufenacil +	0.02					
MSO	1% v/v	5	96	80	99	82
Saflufenacil +	0.04					
MSO	1% v/v	7	96	83	99	75
Saflufenacil +	0.02					
mesotrione +	0.09					
COC	1% v/v	6	79	70	69	94
LSD (0.05)		NS	13	30	16	38

[1]NIS = nonionic surfactant, MSO is methylated seed oil, and COC = crop oil concentrate.
[2]Evaluation date June 17, 2015.

Pulse crop tolerance to fluthiacet. Joan M. Campbell and Traci A. Rauch. (Crop and Weed Science Division, University of Idaho, Moscow, ID 83844-2339) Studies were established in pulse crops to evaluate fluthiacet tolerance and weed control near Moscow, ID in 2016. Fluthiacet was applied at three growth stages. The plots were arranged in a randomized complete block design with four replications and included an untreated check. All herbicide treatments were applied using a CO_2 pressurized backpack sprayer calibrated to deliver 20 gpa at 38 psi and 3 mph (Table 1). All crops were harvested at maturity.

Table 1. Application and soil data.

Crop	Pea			Lentil			Chickpea		
Variety	Banner			Pardina			Billy bean		
Application date	5/11	5/18	5/26	5/11	5/18	5/26	5/11	5/18	5/26
Crop growth stage (nodes)	Crack-1	2-3	3-5	1	2-3	5-7	Crack-3	2-5	6-8
Air temperature (F)	72	70	73	72	70	73	72	70	70
Relative humidity (%)	37	71	58	37	71	58	37	71	58
Wind (mph, direction)	0-4, N	2, S	2-3, E	0	2, S	2-3, E	3-6, NW	2, S	7, NNW
Cloud cover (%)	100	30	75	100	30	75	100	30	90
Soil moisture	dry	wet	wet	dry	wet	wet	dry	wet	wet
Soil temperature at 2 inch (F)	67	67	74	67	67	74	68	67	72
Next rain occurred	5/13	5/21	5/29	5/13	5/21	5/29	5/13	5/21	5/29
pH	6.1			5.5			4.9		
OM (%)	3.5			3.4			4.9		
CEC (meq/100g)	18.3			17.7			24.9		
Texture	silt loam			silt loam			silty, clay loam		

Heavy rain, wind and hail on May 13 and additional rain the next two weeks impacted crop vigor due to physical plant injury, standing water, and disease which resulted in low crop seed yield. All crops were visibly chlorotic within 3 days after application (data not shown). The plants quickly recovered their green color, but all treatments applied on May 26 and fluthiacet + metribuzin + NIS applied May 18 reduced pea seed yield compared to the untreated check (Table 2). Injury was highest with fluthiacet + MSO and reduced pea seed yield over 97%. Lentil and chickpea tolerated fluthiacet better than pea and seed yield was not reduced compared to the untreated check (Table 3). Common lambsquarters was controlled to some extent with all treatments in the chickpea experiment which resulted in lower yield in the untreated compared to treated plots. No weeds were present in the pea experiment. Seed weight was not affected by any treatment.

Table 2. Pea tolerance to fluthiacet.

Treatment[1]	Application time	Pea seed yield	Pea seed weight
		lb/a	g/1000 seed
Fluthiacet + NIS	May 11	692 a[2]	139 a
Fluthiacet + metribuzin + NIS	May 11	789 a	135 a
Fluthiacet + NIS	May 18	730 a	147 a
Fluthiacet + metribuzin + NIS	May 18	348 c	147 a
Fluthiacet + NIS	May 26	530 b	142 a
Fluthiacet + metribuzin + NIS	May 26	170 d	152 a
Fluthiacet + MSO	May 26	23 e	160 a
Untreated	-	832 a	141 a

[1]Application rates were fluthiacet 0.007 lb ai/a, metribuzin at 0.15 lb ai/a, NIS (nonionic surfactant, R11) 0.25% v/v, and MSO (methylated seed oil) 1% v/v.
[2]Means followed by the same letter within a column are not different from one another at $P \leq 0.05$.

Table 3. Lentil and chickpea tolerance to fluthiacet.

Treatment[1]	Application time	Chickpea		Lentil	
		Seed yield	Seed weight	Seed yield	Seed weight
		lb/a	g/1000 seed	lb/a	g/1000 seed
Fluthiacet + NIS	May 11	377 a[2]	490 a	340 a	33 a
Fluthiacet + NIS	May 18	372 a	490 a	324 a	33 a
Fluthiacet + NIS	May 26	418 a	496 a	298 a	33 a
Fluthiacet + MSO	May 26	398 a	495 a	226 a	34 a
Untreated	-	261 b	467 a	327 a	33 a

[1]Application rates were fluthiacet 0.007 lb ai/a, NIS (nonionic surfactant, R11) 0.25% v/v, and MSO (methylated seed oil) 1% v/v.

[2]Means followed by the same letter within a column are not different from one another at $P \leq 0.05$.

Broadleaf weed control in ‘Frontier’ chickpeas. Drew Lyon and Henry Wetzel. (Dept. of Crop & Soil Sciences, Washington State Univ., Pullman, WA 99164-6420) A study was conducted at the WSU Cook Agronomy Farm near Pullman, WA to evaluate herbicides for the control of broadleaf weeds in chickpeas. In addition, we evaluated if soil disturbance after treatments were applied affected product efficacy. On May 7, 2015, the entire trial area was sprayed preplant with glyphosate (1.125 lb ae/A) to control germinated weeds, primarily Italian ryegrass. On May 11th, ‘Frontier’ chickpeas were planted at 175 lb/A at a depth of 1.5 inches using a Monosem vacuum planter with a 10-inch row spacing. Plots were 10 ft by 66 ft arranged in a randomized complete block design with four replications. Post-plant, pre-emerge applications were made on May 12th using a CO_2 backpack sprayer set to deliver 10 gpa at 2.3 mph and 40 psi (Table 1). Each herbicide treatment was applied to a 10 ft by 66 ft area. Immediately after the herbicides were applied, half of the treated area (10 ft by 33 ft), within each block, received a roller packer treatment by driving perpendicular to the treated area. The other half of the plot remained undisturbed. The experimental design was a split-block (roller packer) with subplots (herbicide treatments) in a randomized complete block. Visual ratings of common lambsquarters (CHEAL) and mayweed chamomile (ANTCO) control were taken on June 24th. CHEAL and ANTCO plant counts were taken on June 26th by counting the number of plants within a square meter at two locations within the plot and the values presented are an average. The trial area was harvested with a small plot combine on September 4th.

Table 1. Application and soil data.

Location	Cook Agronomy Farm, Pullman, Washington
Application date	May 12, 2015
Chickpea growth stage	Beginning of imbibition
Air temperature (F)	51
Relative humidity (%)	82
Wind (mph, direction)	3,W
Cloud cover (%)	100
Soil temperature at 6 in (F)	57
pH	4.8
OM (%)	3.0
Texture	Silt loam

On May 12th, approximately 14 hours after herbicides were applied, plots received approximately 0.38 inches of rain. Between May 12th and June 2nd, the crop received the majority of its precipitation in the amount of 2.47 inches. CHEAL and ANTCO were the predominate weeds in the study area. Rolling in combination with the linuron + flumioxazin and linuron + imazethapyr treatments reduced CHEAL control (Table 2). Rolling in combination with the linuron + imazethapyr treatment reduced ANTCO control. Rolling did not affect herbicide performance in regards to the density of CHEAL. This was generally the case for ANTCO as well, except the linuron + imazethapyr treatment that was rolled. Rolling did not have a significant effect on yield or 100-seed-weight, thus means are composed of eight replications (Table 3). All herbicide treatments increased yield when compared to the nontreated check. The linuron + imazethapyr-treated plots had the lowest yield among the herbicides evaluated and its 100-seed-weight was comparable to the nontreated check. This is probably due to the fact that this treatment’s efficacy was compromised by rolling.

Table 2. The effect of herbicides and rolling on the control and incidence of CHEAL and ANTCO in 'Frontier' chickpeas near Pullman, Washington in 2015.

Treatment	Rate	Mechanical treatment	CHEAL	ANTCO	CHEAL	ANTCO
			Control (0 to 100)		plants per sq. meter	
	lb ai/A		---------------6/24---------------		----------------6/26--------------	
Nontreated check	--	Not-Rolled	--	--	20 a	30 a
Nontreated check	--	Rolled	--	--	40 a	40 a
Saflufenacil + metribuzin	0.044 + 0.375	Not-Rolled	98 a[1]	100 a	0 a	0 c
Saflufenacil + metribuzin	0.044 + 0.375	Rolled	99 a	98 a	0 a	0 c
Linuron + sulfentrazone	0.625 + 0.25	Not-Rolled	98 a	100 a	0 a	0 c
Linuron + sulfentrazone	0.625 + 0.25	Rolled	96 a	91 a	0 a	1 bc
Linuron + flumioxazin	0.625 + 0.064	Not-Rolled	95 a	100 a	0 a	0 c
Linuron + flumioxazin	0.625 + 0.064	Rolled	86 b	92 a	0 a	0 c
Linuron + imazethapyr	0.625 + 0.031	Not-Rolled	96 a	98 a	1 a	0 c
Linuron + imazethapyr	0.625 + 0.031	Rolled	87 b	69 b	0 a	6 b
Dimethenamid + sulfentrazone	0.984 + 0.25	Not-Rolled	100 a	100 a	0 a	0 c
Dimethenamid + sulfentrazone	0.984 + 0.25	Rolled	99 a	100 a	0 a	0 c

[1]Means, based on four replicates, within a column, followed by the same letter are not significantly different at P = 0.05.

Table 3. The effect of herbicides on yield and 100-seed-weight in 'Frontier' chickpeas near Pullman, Washington in 2015.

Treatment	Rate	Yield	100-seed-weight
	lb ai/A	lb/A	grams
Nontreated check	--	801	38.0
Saflufenacil + metribuzin	0.044 + 0.375	2030	40.3
Linuron + sulfentrazone	0.625 + 0.25	2040	39.6
Linuron + flumioxazin	0.625 + 0.064	1880	39.6
Linuron + imazethapyr	0.625 + 0.031	1730	38.6
Dimethenamid + sulfentrazone	0.984 + 0.25	2050	39.8
LSD (0.05)		174	1.3

Evaluation of asulam and 2,4-DB in red clover grown for seed for crop safety and dock control . Kyle C. Roerig, Andrew G. Hulting, Daniel W. Curtis, and Carol A. Mallory-Smith. (Department of Crop and Soil Science, Oregon State University, Corvallis OR 97331) Dock continues to be a problematic weed in clover grown for seed. A trial was conducted in an established red clover field in Yamhill County, OR, with a substantial dock population to assess the best timing and rates for dock control and crop safety (Table). Applications were made January 27 and March 6, 2015. Prior to harvest, dock seed heads were removed and counted giving a quantitative measure of control and preventing contamination in harvested seed, which distorts yield data.

Split application did not improve control with either asulam or 2,4-DB. Some leaf cupping was observed with the 2,4-DB application, but in this trial and in previous trials this symptom has not resulted in a decrease in clover vigor or yield. 2,4-DB labels caution against NIS use in legumes due to increased risk of crop injury. In this trial, no additional injury was noted when NIS was added. Additionally, there were no differences in clover injury or yield and dock control between the 1.0 and 1.5 lb ai/a rate of 2,4-DB. In previous studies, asulam efficacy was reduced when applied too early while injury has been unacceptable when applied too late. In this trial, the late January and early March timings seem to be within the optimal window of good dock control and acceptable crop injury. Fluthiacet was included in this trial. Fluthiacet is considered a possibility for being labeled in clover grown for seed because it is registered for broadleaf weed control in soybeans. In this trial fluthiacet safety in red clover was excellent. Fluthiacet provided no control of dock. However, it may control other important broadleaf weeds and evaluation of this product will continue. No treatments in this trial caused a reduction in clover seed yield or seed quality as measured by germination.

Table. Herbicide tolerance and dock control in established red clover, Yamhill County, Oregon.

	Rate	Applied	Dock[1] control	Dock[2] heads/plot	Red clover[2] injury	Red clover[3] seed yield
	lb ai/a		%	#	%	lb/a
Untreated			0	70	0	284
Oxyfluorfen	0.094	27-Jan	41	56	0	265
+ diuron	1.5	27-Jan				
+ paraquat	0.75	27-Jan				
Asulam	1.5	27-Jan	74	25	15	289
+ NIS	0.418	27-Jan				
2,4-DB	1	27-Jan	61	32	5	263
2,4-DB	1.5	27-Jan	38	88	5	313
2,4-DB	0.75	27-Jan	85	11	5	254
+ 2,4-DB	0.75	6-Mar				
Asulam	0.835	27-Jan	88	3	25	281
+ NIS	0.418	27-Jan				
+ asulam	0.835	6-Mar				
+ NIS	0.418	6-Mar				
Asulam	1.5	6-Mar	100	1	38	314
+ NIS	0.418	6-Mar				
2,4-DB	1	6-Mar	95	9	0	306
2,4-DB	1.5	6-Mar	94	11	0	286
2,4-DB	1.5	6-Mar	86	2	0	297
+ NIS	0.418	6-Mar				
Fluthiacet	0.00427	6-Mar	13	83	5	330
+ NIS	0.418	6-Mar				
Fluthiacet	0.0064	6-Mar	31	59	0	351
+ NIS	0.418	6-Mar				
LSD P=0.05			32	78	19	104

[1]Evaluated 6/25/15
[2]Evaluated 7/27/15
[3]Harvested 8/17/15

Evaluation of carfentrazone, flumioxazin and saflufenacil for crop safety and weed control in clovers grown for seed. Kyle C. Roerig, Andrew G. Hulting, Daniel W. Curtis, and Carol A. Mallory-Smith. (Department of Crop and Soil Science, Oregon State University, Corvallis, OR 97331) Carfentrazone and flumioxazin have recently received registration and saflufenacil is being evaluated for use in clover grown for seed. Protoporphyrinogen oxidase (PPO) inhibitors have potential for use in dormant, established clover for the burn down of small annual weeds. PPO inhibitors cause necrosis and desiccation of exposed tissues in susceptible plant species, including clover. Defoliated, established clover recovers due to stored resources available in the roots, while small annual weeds do not. This use is similar to the current practice of applying paraquat to established clover. PPO inhibitors offer the advantage of much lower mammalian toxicity than paraquat. These products were evaluated in two locations; established white clover in Linn County, Oregon (Table 1) and in established red clover in Yamhill County, Oregon (Table 2).

At the white clover location, saflufenacil and flumioxazin were applied alone and flumioxazin was applied as tank mixes with carfentrazone, paraquat and saflufenacil. Applications of saflufenacil alone or with flumioxazin resulted in the removal of all stems and leaves resulting in bare ground. In the spring, the clover regrew from the roots and by harvest no difference was visible from the untreated plots. Application of these herbicides to white clover may eliminate the need for sheep or mowing to maximize seed yield. Flumioxazin applied with carfentrazone removed foliage and most stems, but the plants regrew in the spring. Flumioxazin with or without paraquat caused the least initial injury. Flumioxazin with paraquat controlled 96-98% of volunteer annual ryegrass (data not shown). No other treatments controlled annual ryegrass. There was no injury in any of the plots by harvest.

Carfentrazone and saflufenacil were applied in an established red clover field and while clover fully recovered from the application; reduced competition caused by removal of clover foliage increased dock fecundity. Red clover had no signs of injury at seed harvest and yield was equivalent to the check. However, forage which is normally harvested in the spring and may be an important component of economic return would be eliminated.

Table 1. Herbicide tolerance of established white clover, Linn County, Oregon.

			White clover	
Name	Rate	Applied	injury[1]	injury[2]
	lb ai/a		----------%----------	
Untreated			0	0
Saflufenacil	0.0445	26-Jan	100	0
Flumioxazin	0.128	26-Jan	43	0
Flumioxazin	0.064	26-Jan	88	0
+ carfentrazone	0.039	26-Jan		
Flumioxazin	0.128	26-Jan	91	0
+ carfentrazone	0.039	26-Jan		
Flumioxazin	0.064	26-Jan	45	0
+ paraquat	0.75	26-Jan		
Flumioxazin	0.128	26-Jan	43	0
+ paraquat	0.75	26-Jan		
Flumioxazin	0.064	26-Jan	100	0
+ saflufenacil	0.0445	26-Jan		
Flumioxazin	0.128	26-Jan	100	0
+ saflufenacil	0.0445	26-Jan		
LSD P=0.05			7	0

[1]Evaluated 2/16/15

[2]Evaluated 6/1/15

Table 2. Herbicide tolerance of established red clover, Yamhill County, Oregon.

	Rate	Applied	Dock[1] Control	Dock[2] Heads/plot	Red clover[2] Injury	Red clover[3] Seed yield
	lb ai/a		%	#	%	lb/a
Untreated			0	70	0	284
Oxyfluorfen	0.094	27-Jan	41	56	0	265
+ diuron	1.5	27-Jan				
+ paraquat	0.75	27-Jan				
Carfentrazone	0.039	27-Jan	0	163	15	302
Saflufenacil	0.0445	27-Jan	0	148	10	296
LSD P=.05			32	78	19	104

[1]Evaluated 6/25/15
[2]Evaluated 7/27/15
[3]Harvested 8/17/15

Evaluation of flumetsulam for crop safety and weed control in clover grown for seed. Kyle C. Roerig, Andrew G. Hulting, Daniel W. Curtis, and Carol A. Mallory-Smith. (Department of Crop and Soil Science, Oregon State University, Corvallis, OR 97331) Flumetsulam is commonly used for broadleaf weed management in clover grown for seed, alfalfa and pastures in New Zealand. There are no labels for flumetsulam use in clover grown for seed in the U.S., though it is commonly used for broadleaf weed management in field corn and soybean production in the Midwest. Flumetsulam was applied to seedling red and white clover and to established white clover. In the seedling red clover, flumetsulam was applied at three timings in the late winter to early spring at two rates (Table 1). Flumetsulam injury in clover appeared as yellowing, or occasionally stunting of plants. Flumetsulam injured clover following each application (data not shown), but injury symptoms diminished within a month or two of application and were no longer visible at harvest. An important discovery at this location was flumetsulam activity on wild carrot. Control ranged from 68-100%, with the latest timing and highest rate providing the best control. Wild carrot can be a difficult weed to control in clover seed production and an additional tool for use in this crop would be valuable for growers. Flumetsulam provided no control of spiny sowthistle.

Flumetsulam was applied to seedling white clover grown at the Hyslop Research Farm (Table 2). Injury was observed following the application of each treatment. These symptoms disappeared by mid-June except in the plots treated in April and the higher rate in March. Weed control varied by species, rate and timing. Pineappleweed control was 100% with both rates applied March 4. Earlier and later timings provided less control, 83-87% and 30-33%, respectively. Shepherd's-purse control was 100% when applied January 23. March application controlled 88-93% and late April application did not provide any control of shepherd's-purse. Mayweed chamomile control was 100% with late April applications at both rates. In January and March, the higher rates provided better control. Neither prickly lettuce nor wild garlic was affected by flumetsulam.

Flumetsulam was applied to established white clover in a grower field (Table 3). The plots were in a vigorous, healthy stand and the only weed present was volunteer annual ryegrass. Flumetsulam does not have any grass activity. Following each application some injury was noted initially, but was no longer visible a month or two following application and no injury was visible shortly before harvest.

Table 1. Crop safety and weed control with flumetsulam on seedling red clover, Yamhill County, Oregon.

			Sowthistle	Wild carrot	Red clover	
	Rate	Applied	control[1]		Injury[2]	Yield[3]
	lb ai/a		----------------------	%----------------------		lb/a
Untreated			0	0	0	109
Flumetsulam	0.0665	27-Jan	0	68	0	93
Flumetsulam	0.133	27-Jan	0	73	0	75
Flumetsulam	0.0665	6-Mar	0	73	0	75
Flumetsulam	0.133	6-Mar	0	80	0	72
Flumetsulam	0.0665	16-Apr	0	73	0	66
Flumetsulam	0.133	16-Apr	0	100	0	82
LSD P=0.05			0	25	0	26

[1]Evaluated 6/3/15
[2]Evaluated 6/25/15
[3]Harvested 8/17/15

Table 2. Crop safety and weed control of flumetsulam on seedling white clover, Benton County, Oregon.

	Rate		Pineapple-weed	Shepherd's-purse	Prickly lettuce	Mayweed chamomile	White clover Injury[2]
			control[1]				
	lb ai/a		------------------------------------	------------------------------------	%	------------------------------------	------------------------------------
Untreated			0	0	0	0	0
Flumetsulam	0.0665	23-Jan	83	100	0	63	0
Flumetsulam	0.133	23-Jan	87	100	0	88	3
Flumetsulam	0.0665	4-Mar	100	93	0	25	0
Flumetsulam	0.133	4-Mar	100	88	0	94	10
Flumetsulam	0.0665	28-Apr	33	0	0	100	20
Flumetsulam	0.133	28-Apr	30	0	0	100	20
LSD P=0.05			16	7	0	43	7

[1]Evaluated 5/13/15, excepting mayweed chamomile which was evaluated 6/23/15

[2]Evaluated 6/23/2015

Table 3. Flumetsulam tolerance on established white clover, Linn County, Oregon.

			White clover	
Name	Rate	Applied	injury[1]	injury[2]
	lb ai/a		----------%	----------
Untreated			0	0
Flumetsulam	0.0665	26-Jan	1	0
Flumetsulam	0.133	26-Jan	14	0
Flumetsulam	0.0665	3-Mar	-	0
Flumetsulam	0.133	3-Mar	-	0
Flumetsulam	0.0665	20-Apr	-	0
Flumetsulam	0.133	20-Apr	-	0
LSD P=0.05			7	0

[1]Evaluated 2/16/15

[2]Evaluated 6/1/15

Efficacy of preemergence or early postemergence herbicides in irrigated corn. Randall S. Currie and Patrick W. Geier. (K-State Southwest Research-Extension Center, 4500 E. Mary Street, Garden City, KS 67846) An experiment at the Kansas State University Southwest Research-Extension Center near Garden City, KS determined the efficacy of preemergence and early postemergence herbicides in irrigated corn. Preemergence herbicides were applied June 2, 2015, with early postemergence treatments applied June 16, 2015. Corn was 5 to 7 inches tall when early postemergence treatments were made, and weeds were 1 to 2 inches tall. Herbicides were applied using a CO_2-compressed tractor-mounted or backpack sprayer delivering 20 gpa at 3 mph and 27 or 30 psi. Soil was a Ulysses silt loam with 1.4% organic matter, pH of 8.0, and cation exchange capacity of 18.4. Plots were 10 by 35 feet and arranged in a randomized complete block with four replications. Visual weed control was determined July 28, 2015, which was 42 days after early postemergence application (42 DA-B). Grain yields were determined October 14, 2015 by mechanically harvesting the center two rows of each plot and adjusting weights to 15.5% moisture. Control of buffalobur was complete regardless of herbicide at 42 DA-B. Velvetleaf and puncturevine control was 99 to 100 and 95 to 99%, respectively, at the same date by all herbicides. The premix of acetochlor\flumetsulam with clopyralid, atrazine and glyphosate applied early postemergence and the preemergence herbicides GF-3471 with atrazine and *S*-metolachlor/atrazine/mesotrione controlled Palmer amaranth 96 to 99%. The early postemergence treatment of acetochlor/flumetsulam/clopyralid plus atrazine and glyphosate was the only treatment to control green foxtail more than 95% at 42 DA-B. Grain yields did not differ between herbicide treatments or the untreated controls.

Table. Efficacy of preemergence or early postemergence herbicides in irrigated corn.

Treatment[a]	Rate	Timing[b]	42 days after early postemergence application: Palmer amaranth	Velvetleaf	Puncturevine	Buffalobur	Green foxtail	Yield
			% Visual					bu/A
Acetochlor/ Atrazine	2.4 qt	PRE	95	100	95	100	91	134.0
Clopyralid Flumetsulam	4.0 oz	PRE						
Acetochlor/ Flumetsulam/ Clopyralid	2.0 pt	PRE	90	100	98	100	84	122.1
Atrazine	1.0 qt	PRE						
Acetochlor/ Flumetsulam/ Clopyralid	2.0 pt	EPOST	99	100	99	100	97	141.9
Atrazine	1.0 qt	EPOST						
Glyphosate	32 oz	EPOST						
AMS	2.5 %	EPOST						
GF-3471	2.5 qt	PRE	99	99	96	100	89	124.1
Atrazine	1.0 qt	PRE						
GF-3471	1.5 qt	PRE	96	100	96	100	85	135.6
Atrazine	1.0 qt	PRE						
S-metolachlor/ Atrazine/ Mesotrione	2.7 qt	PRE	99	100	98	100	85	148.7
Untreated			0	0	0	0	0	130.2
LSD (0.05)			4.1	1.4	5.5	NS	4.6	NS

[a] AMS is ammonium sulfate.

[b] PRE is preemergence, EPOST is early postemergence.

Efficacy of preemergence and sequential herbicides in irrigated corn. Randall S. Currie and Patrick W. Geier. (K-State Southwest Research-Extension Center, 4500 E. Mary Street, Garden City, KS 67846) An experiment conducted at the Kansas State University Southwest Research-Extension Center near Garden City, KS evaluated the efficacy of preemergence and sequential herbicides in irrigated corn. Herbicides were applied preemergence alone (PRE) or preemergence followed by early postemergence (EPOST) or postemergence (POST) (Table 1). Herbicides were applied using a tractor-mounted, compressed CO_2 plot sprayer delivering 20 gpa at 3 mph and 30 psi. Soil was a Ulysses silt loam with 1.4% organic matter, pH of 8.0, and cation exchange capacity of 18.4. Plots were 10 by 35 feet and arranged in a completely randomized block with four replications. Visual weed control was determined July 31, 2015 which was 48 days after POST applications (DA-C). Corn yields were determined October 8, 2015 by mechanically harvesting the center two rows of each plot and adjusting the weights to 15.5% moisture. The PRE treatment of fluroxypyr plus nonionic surfactant alone provided no residual control of any weed species at 48 DA-C. Control of kochia and quinoa was 98 to 100% regardless of herbicide treatment at 48 DA-C, and 95% or more with all herbicides for Russian thistle (Table 2). Palmer amaranth control was slightly less (94%) with PRE treatments alone compared to sequential treatments (98 to 100%). Thiencarbazone\isoxaflutole plus atrazine, fluroxypyr, and Nonionic surfactant PRE controlled crabgrass 88%, whereas all other treatments provided 91% or more crabgrass control. Corn receiving most herbicide treatments yielded 33 to 66 bu/A more than untreated corn; corn treated with fluroxypyr plus nonionic surfactant PRE did not.

Table 1. Application information.

Application timing	Preemergence	Early postemergence	Postemergence
Application date	May 18, 2015	June 8, 2015	June 15, 2015
Air temperature (F)	63	87	77
Relative humidity (%)	43	26	68
Soil temperature (F)	58	76	70
Wind speed (mph)	8 to 10	4 to 6	4 to 6
Wind direction	North-northeast	North	Northwest
Soil moisture	Good	Good	Fair

Table 2. Efficacy of preemergence and sequential herbicides in irrigated corn.

Treatment[a]	Rate	Timing	48 days after POST application					Yield
			SASKR[b]	AMAPA[b]	KCHSC[b]	CHEQU[b]	DIGSS[b]	
			% control					bu/A
Thiencarbazone/	5.6 oz	PRE	100	94	100	100	88	201.9
Isoxaflutole		PRE						
Atrazine	32 oz	PRE						
Fluroxypyr	18.3 oz	PRE						
NIS	0.25 %	PRE						
Isoxaflutole	4.0 oz	PRE	98	94	100	100	91	211.7
Acetochlor/	77 oz	PRE						
Atrazine		PRE						
Fluroxypyr	18.3 oz	PRE						
NIS	0.25 %	PRE						
Isoxaflutole	4.0 oz	PRE	95	94	98	100	91	179.3
Atrazine/	32 oz	PRE						
Pyroxasulfone/		PRE						
Fluthiacet		PRE						
Fluroxypyr	18.3 oz	PRE						
NIS	0.25 %	PRE						
Fluroxypyr	18.3 oz	PRE	100	100	100	100	94	210.1
NIS	0.25 %	PRE						
Glyphosate	32 oz	EPOST						
Thiencarbazone/	3.0 oz	EPOST						
Tembotrione								
Atrazine	32 oz	EPOST						
Dicamba	8 oz	EPOST						
Superb HC	1.0 %	EPOST						
AMS	1.5 lb	EPOST						
Fluroxypyr	18.3 oz	PRE	100	98	99	100	96	210.2
NIS	0.25 %	PRE						
S-metolachlor/	58 oz	EPOST						
Glyphosate/								
Mesotrione								
Dicamba	8 oz	EPOST						
NIS	0.25 %	EPOST						
AMS	1.5 lb	EPOST						
Thiencarbazone/	3.3 oz	PRE	100	100	99	100	95	194.6
Isoxaflutole								
Atrazine	32 oz	PRE						

Fluroxypyr	18.3 oz	PRE						
NIS	0.25%	PRE						
Glyphosate	32 oz	POST						
Thiencarbazone/ Tembotrione	3.0 oz	POST						
Atrazine	16 oz	POST						
Dicamba	8 oz	POST						
Superb HC	1.0 %	POST						
AMS	1.5 lb	POST						
Thiencarbazone/ Isoxaflutole	3.3 oz	PRE	100	98	100	100	91	205.1
Atrazine	32 oz	PRE						
Fluroxypyr	18.3 oz	PRE						
NIS	0.25%	PRE						
Glyphosate	32 oz	POST						
Tembotrione/ Dicamba	32 oz	POST						
Atrazine	16 oz	POST						
Destiny HC	1 %	POST						
AMS	1.5 lb	POST						
Thiencarbazone/ Isoxaflutole	3.3 oz	PRE	100	100	100	100	95	204.1
Atrazine	32 oz	PRE						
Fluroxypyr	18.3 oz	PRE						
NIS	0.25%	PRE						
Glyphosate	32 oz	POST						
Dicamba	10 oz	POST						
Atrazine	16 oz	POST						
Destiny HC	1 %	POST						
AMS	1.5 lb	POST						
Fluroxypyr	18.3 oz	PRE	0	0	0	0	0	154.2
NIS	0.25 %	PRE						
Untreated	---	---	0	0	0	0	0	145.7
LSD (0.05)			4.9	5.6	2.9	NS	5.8	23.7

[a] NIS is nonionic surfactant, AMS is ammonium sulfate.

[b] SASKR is Russian thistle. AMAPA is Palmer amaranth. KCHSC is kochia. CHEQU is quinoa. DIGSS is crabgrass.

Weed control with nicosulfuron, mesotrione, isoxadifen and atrazine in irrigated corn. Randall S. Currie and Patrick W. Geier. (K-State Southwest Research-Extension Center, 4500 E. Mary Street, Garden City, KS 67846) An experiment conducted at the Kansas State University Southwest Research-Extension Center near Garden City, KS investigated the efficacy of nicosulfuron, mesotrione, and isoxadifen along with several tank mix partners postemergence in corn. The experimental area was overseeded with a mixture of kochia, green foxtail, crabgrass, and quinoa seed prior to corn planting. Quinoa seed was used as a surrogate for lambsquarters. All other weed populations were naturally occurring. Preemergence herbicides were applied May 18, 2015, and postemergence applications occurred on June 16, 2015. Corn was 6 to 9 inches tall at the time of postemergence treatment, and weeds were 1 to 5 inches tall. All herbicides were applied with a tractor-mounted, compressed-CO_2 sprayer delivering 20 gpa at 30 psi and 3.0 mph. Soil was a Ulysses silt loam with 1.4% organic matter, pH of 8.0, and cation exchange capacity of 18.4. Plots were 10 by 35 feet, and arraigned in a randomized complete block with four replications. Weed control was visually rated on August 6, 2015, which was 51 days after postemergence application (DA-B). Corn yields were determined October 10, 2015 by harvesting the center two rows of each plot with a plot combine and adjusting the weights to 15.5% moisture. All herbicides controlled quinoa 100%, Russian thistle 95 to 100%, and green foxtail 96% or more at 51 DA-B. Palmer amaranth control was 95% or more when nicosulfuron plus mesotrione and isoxadifen were applied postemergence with atrazine or when these herbicides were applied following a preemergence herbicide treatment. Nicosulfuron plus mesotrione and isoxadifen alone postemergence provided 88% palmer amaranth control at 51 DA-B. Similarly, nicosulfuron plus mesotrione and isoxadifen alone postemergence controlled kochia 95% at 51 DA-B. Kochia control was 92 and 90% when nicosulfuron plus mesotrione and isoxadifen alone or with atrazine and dicamba were applied postemergence following *S*-metolachlor preemergence. Crabgrass control with preemergence followed by postemergence treatments exceeded 90% except when *S*-metolachlor preemergence was followed by nicosulfuron plus mesotrione, isoxadifen, atrazine, and dicamba (89%). Crabgrass control was 83 and 88% when no preemergence herbicide was applied prior to postemergence herbicides. No herbicide treatment increased corn yield relative to the untreated controls.

Table. Weed control with nicosulfuron, mesotrione, isoxadifen and atrazine in irrigated corn.

Treatment[a]	Rate	Timing	51 days after POST application						Yield
			Palmer amaranth	Kochia	Russian thistle	Quinoa	Crabgrass	Green foxtail	
	oz/A		% Visual						bu/A
S-metolachlor	16 oz	PRE	95	92	95	100	93	100	197.7
Nicosulfuron	0.65 oz	POST							
Mesotrione	2.5 oz	POST							
Isoxadifen	0.25 oz	POST							
COC	1 %	POST							
AMS	2.0 lb	POST							
S-metolachlor	16 oz	PRE	100	97	99	100	98	100	183.8
Nicosulfuron	0.65 oz	POST							
Mesotrione	2.5 oz	POST							
Isoxadifen	0.25 oz	POST							
Atrazine	16 oz	POST							
COC	1 %	POST							
AMS	2.0 lb	POST							
S-metolachlor	16 oz	PRE	95	90	96	100	89	97	166.8
Nicosulfuron	0.65 oz	POST							
Mesotrione	2.5 oz	POST							
Isoxadifen	0.25 oz	POST							
Atrazine	16 oz	POST							
Dicamba	4.0 oz	POST							
COC	1 %	POST							
AMS	2.0 lb	POST							
S-metolachlor	16 oz	PRE	98	98	100	100	98	100	185.1
Nicosulfuron	0.65 oz	POST							
Mesotrione	2.5 oz	POST							
Isoxadifen	0.25 oz	POST							
Atrazine	16 oz	POST							
Tembotrione	0.75 oz	POST							
COC	1 %	POST							
AMS	2.0 lb	POST							
Atrazine/ *S*-metolachlor	2.0 qt	PRE	100	100	99	100	96	100	185.3
Nicosulfuron	0.65	POST							
Mesotrione	2.5 oz	POST							
Isoxadifen	0.25 oz	POST							
COC	1 %	POST							
AMS	2.0 lb	POST							

Atrazine/ *S*-metolachlor	1.5 qt	PRE	99	100	100	100	99	100	190.2
Nicosulfuron	0.65 oz	POST							
Mesotrione	2.5 oz	POST							
Isoxadifen	0.25 oz	POST							
Atrazine/ *S*-metolachlor	1.0 qt	POST							
COC	1 %	POST							
AMS	2.0 lb	POST							
Atrazine/ *S*-metolachlor	2.0 qt	PRE	99	100	100	100	97	99	191.9
Tembotrione	3.0 oz	POST							
MSO	1 %	POST							
AMS	2.0 lb	POST							
Nicosulfuron	0.65 oz	POST	88	95	99	100	83	96	178.6
Mesotrione	2.5 oz	POST							
Isoxadifen	0.25 oz	POST							
COC	1 %	POST							
AMS	2.0 lb	POST							
Nicosulfuron	0.65 oz	POST	96	100	100	100	88	96	185.0
Mesotrione	2.5 oz	POST							
Isoxadifen	0.25 oz	POST							
Atrazine	16 oz	POST							
COC	1 %	POST							
AMS	2.0 lb	POST							
Untreated	---	---	0	0	0	0	0	0	185.4
LSD (0.05)			4.5	3.6	3.9	NS	6.0	4.0	NS

[a] All plots received fluroxypyr at 18.3 oz/A plus nonionic surfactant at 0.25% v/v preemergence. COC is crop oil concentrate, AMS is ammonium sulfate, MSO is methylated seed oil.

Broadleaf and green foxtail control in field corn. Kyle G. Frandsen, Don W. Morishita, and Samara L. Arthur. (Kimberly Research and Extension Center, University of Idaho, Kimberly, ID 83341). Alternative herbicides to glyphosate are critical for reducing the selection pressure for glyphosate resistant weeds. A field experiment was conducted at the University of Idaho Research and Extension Center near Kimberly, Idaho to compare several herbicide mechanisms of action other than glyphosate for weed control in field corn. A Mycogen short season variety corn was planted May 29, 2015 at 35,000 seeds/A. Experimental design was a randomized complete block with four replications and individual plots were 10 by 30 ft. Soil type was a Portneuf silt loam (39% sand, 42% silt, and 19% clay) with a pH of 8.2, 1.4% organic matter, and CEC of 24-meq/100 g soil. Herbicides were applied with a CO_2-pressurized bicycle-wheel sprayer using 11001 flat fan nozzles calibrated to deliver 10 GPA at 21 PSI and 3 MPH. Additional environmental and application information is given in Table 1. Crop injury was visually evaluated 20 days DALA on June 30. Weed control was visually evaluated 6 and 20 DALA on June 16 and June 30. Grain was harvested November 17 with a small-plot combine.

Table 1. Environmental conditions and weed species densities at application

Application date	5/14/2015	6/10/2015
Application timing	pre-emergence	weeds <3”
Air temperature (F)	50	70
Soil temperature (F)	54	70
Relative humidity (%)	58	57
Wind velocity (mph)	1	1
Cloud cover (%)	100	90
Time of day	0850	0845

Crop injury ratings 20 DALA ranged from 0% to 15% (Table 2). Three treatments had an increase in observed injury over the other treatments. These treatments injury ratings ranged from 8 to 15% and included those containing topramezone, *s*-metolachlor/glyphosate, and *s*-metolachlor/glyphosate/mesotrione. All other treatments had minimal to no injury (0 to 1%). Treatments containing pyroxasulfone alone or dimethenamid-P + pendimethalin followed by (fb) glyphosate provided excellent control (>94%) for all weed species on all evaluation dates. Dimethenamid-P + pendimethalin provided very good control of all weeds except for kochia suggesting that another mechanism of action may be necessary to obtain adequate kochia control without glyphosate. All rated treatments 6 DALA provided excellent control (>95%) of common lambsquarters. At 20 DALA, topramezone + diflufenzopyr + glyphosate, s-metolachlor/glyphosate, s-metolachlor/glyphosate/mesotrione did not satisfactorily control common lambsquarters or redroot pigweed. All treatments provided good control of green foxtail on all evaluation dates with the exception of topramezone + diflufenzopyr + glyphosate, which was only 50% at 20 DALA. Yields ranged from 200 bu/A to 255 bu/A with the untreated control yielding 0 bu/A due to heavy weed competition. All treatments yielded higher than the untreated control and while there were substantial numerical differences between treatments none were statistically significant. The lack of yield differences noted between treatments is likely due to variation in the field throughout the study.

Table 2. Crop tolerance and weed control of various herbicides in field corn near Kimberly, ID[1]

	Application		Crop injury	Weed Control[2]							Grain
				KCHSC		CHEAL		AMARE	SETVI		
Treatment[3]	Rate	date	6/30	6/16	6/30	6/16	6/30	6/30	6/16	6/30	yield
	lb ai/A		-----%							-----	bu/A
Untreated control			-	-	-	-	-	-	-	-	0 b
Pyroxasulfone	0.133	5/14	0 b	94 a	95 a	95 a	95 a	99 a	99 ab	100 a	249 a
Pyroxasulfone	0.266	5/14	1 b	96 a	98 a	98 a	98 a	99 a	100 a	98 a	240 a
Pyroxasulfone +	0.106 +	5/14	0 b	96 a	77 bc	99 a	91 a	100 a	97 b	95 a	250 a
pendimethalin	0.95										
Dimethenamid-P +	0.075 +	5/14	0 b	-	63 c	-	100 a	100 a	-	100 a	253 a
pendimethalin	0.095										
Topramezone +	0.0109 lb ae/A +	6/10	15 a	-	68 c	-	58 b	55 b	-	50 b	200 a
diflufenzopyr +	0.057 +										
glyphosate +	0.77 lb ae/A +										
MSO +	1.0 % v/v +										
AMS	1.7										
Dimethenamid-P +	0.075 +	5/14	1 b	99 a	100 a	100 a	100 a	100 a	100 ab	100 a	241 a
pendimethalin fb	0.095										
Glyphosate +	0.77 lb ae/A +	6/10									
MSO +	1 % v/v +										
AMS	1.7										
A20540	1.63	5/14	0 b	84 b	88 ab	99 a	94 a	99 a	100 ab	100 a	255 a
S-metolachlor/glyphosate +	2.3 lb ae/A +	6/10	10 a	-	45 d	-	38 b	47 b	-	94 a	209 a
AMS	0.85										
S-metol/glyphst/mesotrne +	1.98 lb ae/A +	6/10	8 a	-	72 bc	-	66 b	64 b	-	87 a	203 a
AMS	0.85	6/10									

[1]Means followed by same letter do not significantly differ (P=0.05, LSD).
[2]Weed species evaluated for control were: kochia (KCHSC), common lambsquarters (CHEAL), redroot pigweed (AMARE), and green foxtail (SETVI).
[3]Pyroxasulfone is a sold as Zidua. Pendimethalin is Prowl H_20. Dimethenamid-P is sold as Outlook. Topramezone is sold as Armezon. Diflufenzopyr is sold as Status. Glyphosate is sold as Roundup PowerMax. MSO is methylated seed oil sold as MSO Super Spread. AMS is an ammonium sulfate sold as BroncMax. A2054 is unregistered compound. S-metolachlor/glyphosate is a formulation sold as Sequence. S-metol/glyphst/mesotrne is s-metolachlor/glyphosate/mesotrione is a formulation sold as Halex GT.

Efficacy of pyroxasulfone, fluthiacet, and mesotrione timings in irrigated corn. Randall S. Currie and Patrick W. Geier. (K-State Southwest Research-Extension Center, 4500 E. Mary Street, Garden City, KS 67846) An experiment conducted at the Kansas State University Southwest Research-Extension Center near Garden City, KS evaluated the effects of pyroxasulfone, fluthiacet, and mesotrione application timings compared to standard treatments for efficacy in irrigated corn. Herbicides were applied as sequential treatments of preemergence (PRE) followed by late postemergence (LPOST) or as single applications of early postemergence (EPOST) or postemergence (POST) (Table 1). All herbicides were applied using a tractor-mounted, CO_2-compressed sprayer delivering 20 gpa at 3.0 mph and 30 psi. Soil was a Ulysses silt loam with 1.4% organic matter, pH of 8.0, and cation exchange capacity of 18.4. Plots were 10 by 35 feet and arranged in a randomized complete block with 4 replications. Control of Palmer amaranth was 90% or more when any herbicides were applied PRE followed by LPOST or as POST treatments alone at 29 days after POST applications (Table 2). When most herbicides were applied EPOST alone, Palmer amaranth control was 83 to 88%. The exception was diflufenzopyr/dicamba plus glyphosate EPOST (90%). Thiencarbazone/isoxaflutole applied PRE followed by glyphosate LPOST completely controlled puncturevine, and control was similar to most other herbicides. The exceptions were fluthiacet plus dicamba and glyphosate or *S*-metolachlor\glyphosate\mesotrione plus nonionic surfactant, each applied alone EPOST. Velvetleaf control was 95% or more regardless of herbicide treatment. The best green foxtail control was obtained when herbicides were applied PRE followed by LPOST or by POST alone. However, diflufenzopyr\dicamba plus glyphosate EPOST and *S*-metolachlor\glyphosate\mesotrione and nonionic surfactant EPOST also provided good green foxtail control. Corn receiving herbicide treatments yielded 111.6 to 141.2 bu/A, and all out-yielded the untreated check (69.2 bu/A). No yield differences occurred between herbicide treatments.

Table 1. Application information.

Application timing	Preemergence	Early postemergence	Postemergence	Late postemergence
Application date	June 2, 2015	June 11, 2015	June 23, 2015	June 29, 2015
Air temperature (F)	75	75	72	77
Relative humidity (%)	62	64	64	37
Soil temperature (F)	67	74	77	77
Wind speed (mph)	6 to 9	6 to 8	4 to 6	8 to 10
Wind direction	South	North-northwest	East-northeast	East-southeast
Soil moisture	Good	Fair	Fair	Fair

Table 2. Efficacy of pyroxasulfone, fluthiacet, and mesotrione timings in irrigated corn.

Treatment[a]	Rate	Timing[b]	29 days after postemergence application				Yield
			Palmer amaranth	Puncturevine	Velvetleaf	Green foxtail	
			% control				bu/A
Pyroxasulfone/ Fluthiacet	4.0 oz	PRE	93	98	100	98	113.0
Glyphosate	32 oz	LPOST					
AMS	1.0 %	LPOST					
Pyroxasulfone/ Fluthiacet	4.0 oz	PRE	98	93	100	98	119.6
Atrazine	32 oz	PRE					
Glyphosate	32 oz	LPOST					
AMS	1.0 %	LPOST					
Pyroxasulfone/ Fluthiacet	4.0 oz	PRE	90	96	100	97	121.8
Atrazine	32 oz	PRE					
Isoxaflutole	2 oz	PRE					
Glyphosate	32 oz	LPOST					
AMS	1.0 %	LPOST					
Pyroxasulfone/ Fluthiacet	4.0 oz	PRE	91	98	100	93	130.6
Atrazine	32 oz	PRE					
Fluthiacet/ Mesotrione	3.0 oz	LPOST					
Glyphosate	32 oz	LPOST					
AMS	1.0 %	LPOST					
Pyroxasulfone/ Fluthiacet	4.0 oz	PRE	90	93	100	93	142.2
Fluthiacet/ Mesotrione	2.5 oz	LPOST					
Atrazine	16 oz	LPOST					
Glyphosate	32 oz	LPOST					
AMS	1.0 %	LPOST					
S-metolachlor	1.3 pt	PRE	94	95	98	96	119.8
Glyphosate	32 oz	LPOST					
AMS	1.0 %	LPOST					
Acetochlor/ Flumetsulam/ Clopyralid	32 oz	PRE	94	99	100	95	123.2
Glyphosate	32 oz	LPOST					

AMS	1 %	LPOST					
S-metolachlor/ Atrazine/ Mesotrione/ Bicyclopyrone	2.5 qt	PRE	97	97	100	97	119.0
Glyphosate	32 oz	LPOST					
AMS	1.0 %	LPOST					
Thiencarbazone/ Isoxaflutole	4.0 oz	PRE	93	100	100	99	133.0
Glyphosate	32 oz	LPOST					
AMS	1.0 %	LPOST					
Fluthiacet/ Mesotrione	2.5 oz	EPOST	84	94	100	86	134.0
Atrazine	16 oz	EPOST					
Glyphosate	32 oz	EPOST					
AMS	1.0 %	EPOST					
Fluthiacet/ Mesotrione	2.5 oz	EPOST	83	94	95	84	111.5
Pyroxasulfone/ Fluthiacet	2.0 oz	EPOST					
Glyphosate	32 oz	EPOST					
AMS	1.0 %	EPOST					
Fluthiacet/ Mesotrione	2.5 oz	EPOST	86	95	100	89	130.1
Pyroxasulfone/ Fluthiacet	2.0 oz	EPOST					
Atrazine	16 oz	EPOST					
Glyphosate	32 oz	EPOST					
AMS	1.0 %	EPOST					
Fluthiacet	0.7 oz	EPOST	83	90	100	81	125.4
Dicamba	12 oz	EPOST					
Glyphosate	32 oz	EPOST					
AMS	1 %	EPOST					
Diflufenzopyr/ Dicamba	3.0 oz	EPOST	90	95	100	93	138.7
Glyphosate	32 oz	EPOST					
AMS	1.0 %	EPOST					
S-metolachlor/ Glyphosate/ Mesotrione	3.6 pt	EPOST	88	91	100	93	129.0

NIS	0.25 %	EPOST					
AMS	1.0 %	EPOST					
Pyroxasulfone/ Fluthiacet	4.0 oz	POST	95	100	100	98	133.5
Atrazine	32 oz	POST					
Glyphosate	32 oz	POST					
AMS	1.0 %	POST					
Pyroxasulfone/ Fluthiacet	4.0 oz	POST	98	100	100	100	128.2
Glyphosate	32 oz	POST					
AMS	1.0 %	POST					
Pyroxasulfone/ Fluthiacet	4.0 oz	POST	98	99	100	100	141.6
Dicamba	12 oz	POST					
Glyphosate	32 oz	POST					
AMS	1.0 %	POST					
Untreated	---	---	0	0	0	0	69.2
LSD (0.05)			7.3	7.0	2.9	7.4	33.0

[a] AMS is ammonium sulfate, NIS is nonionic surfactant.

[b] PRE is preemergence, EPOST is early postemergence, POST is postemergence, LPOST is late postemergence.

Weed control with postemergence applications of diflufenzopyr, dicamba, topramezone, atrazine, and glyphosate in irrigated corn. Randall S. Currie and Patrick W. Geier. (K-State Southwest Research-Extension Center, 4500 E. Mary Street, Garden City, KS 67846) An experiment conducted at the Kansas State University Southwest Research-Extension Center near Garden City, KS investigated the efficacy of postemergence diflufenzopyr, dicamba, topramezone, atrazine and glyphosate in corn. The experimental area was overseeded with a mixture of kochia, green foxtail, crabgrass, common sunflower, and quinoa seed prior to corn planting. Quinoa seed was used as a surrogate for lambsquarters. All other weed populations were naturally occurring. All herbicide plots received a preemergence application of saflufenacil/dimethenamid at 10 oz/A or thiencarbazone/isoxaflutole at 3.0 oz/A on April 23, 2015. Postemergence herbicides were applied June 4, 2015 when corn was 6 to 9 inches tall and weeds were 2 to 8 inches tall. All herbicides were applied using a tractor-mounted, CO_2-pressurized sprayer delivering 20 gpa at 30 psi and 3 mph. Soil was a Ulysses silt loam with 1.4% organic matter, pH of 8.0, and cation exchange capacity of 18.4. Plots were 10 by 35 feet, and arranged as a randomized complete block replicated four times. Weed control was visually determined July 31, 2015 which was 57 days after postemergence treatment (DA-B). Grain yields were determined by mechanically harvesting the center two rows of each plot on October 10, 2015 and adjusting the weights to 15.5% moisture. All postemergence herbicides provided 98 to 100% control of quinoa, common sunflower, Palmer amaranth, and green foxtail at 57 DA-B. All postemergence herbicides except glyphosate alone controlled Russian thistle and crabgrass 89% or more at 57 DA-B. Dicamba plus glyphosate was slightly more efficacious on kochia than diflufenzopyr\dicamba plus topramezone with atrazine and glyphosate (99 compared 91% control), and all other herbicides were intermediate for kochia control. Corn yields did not differ between herbicide treatments, but all herbicides increased grain yields 200% or more compared to the untreated checks.

Table. Weed control with postemergence applications of diflufenzopyr, dicamba, topramezone, atrazine, and glyphosate in irrigated corn.

Treatment	Rate	Timing	57 days after POST application							Yield
			SASKR[b]	KCHSC[c]	CHEQU[d]	HELAN[e]	AMAPA[f]	DIGSS[g]	SETVI[h]	
	oz/A									bu/A
Saflufenacil/ Dimethenamid	10	PRE	78	95	100	100	98	83	98	195.3
Glyphosate	22	POST								
NIS	0.25%	POST								
Saflufenacil/ Dimethenamid	10	PRE	99	97	100	100	100	91	100	194.1
Diflufenzopyr/ Dicamba	3.75	POST								
Topramezone	0.75	POST								
Atrazine	16	POST								
Glyphosate	22	POST								
MSO	0.25%	POST								
Saflufenacil/ Dimethenamid	10	PRE	93	91	100	100	100	89	100	200.3
Diflufenzopyr/ Dicamba	2.5	POST								
Topramezone	0.5	POST								
Atrazine	16	POST								
Glyphosate	22	POST								
MSO	0.25%	POST								
Saflufenacil/ Dimethenamid	10	PRE	91	94	100	100	100	93	100	196.7
Topramezone	0.75	POST								
Atrazine	16	POST								
Glyphosate	22	POST								
MSO	0.25%	POST								
Saflufenacil/ Dimethenamid	10	PRE	94	93	100	100	100	90	100	183.4
Diflufenzopyr/ Dicamba	3.75	POST								
Glyphosate	22	POST								
MSO	0.25%	POST								
Thiencarbazone/ Isoxaflutole	3.0	PRE	99	99	100	100	100	90	100	199.8
Dicamba	10	POST								
Glyphosate	22	POST								

MSO	0.25%	POST								
Untreated	---	---	0	0	0	0	0	0	0	92.5
LSD (0.05)			6.8	6.6	NS	NS	3.0	5.6	1.7	44.7

[a] NIS is nonionic surfactant, MSO is methylated seed oil.
[b] SASKR is Russian thistle.
[c] KCHSC is kochia.
[d] CHEQU is quinoa.
[e] HELAN is common sunflower
[f] AMAPA is Palmer amaranth.
[g] DIGSS is crabgrass.
[h] SETVI is green foxtail.

Fallow weed control with postemergence applications of AGH15004, AG14039, glyphosate, and atrazine. Randall S. Currie and Patrick W. Geier. (K-State Southwest Research-Extension Center, 4500 E. Mary Street, Garden City, KS 67846) An experiment conducted at the Kansas State University Southwest Research-Extension Center near Garden City, KS evaluated the postemergence efficacy of AGH15004 and AG14039 on kochia and Russian thistle in fallow. All treatments were applied on May 7, 2015 when kochia was 3 to 4 inches tall and Russian thistle was 1 to 2 inches tall. Treatments were applied using a CO2-pressurized backpack sprayer delivering 20 gpa at 3.0 mph and 27 psi. Soil was a Ulysses silt loam with 1.4% organic matter, pH of 8.0, and cation exchange capacity of 18.4. Plots were 10 by 35 feet and arranged as a randomized complete block with four replications. Visual weed control was determined May 21, June 4, and June 18, 2015, which was 14, 28, and 42 days after treatment (DAT). All treatments except AGH15004 at 1.5 pt/a plus glyphosate and nonionic surfactant provided more than 95% kochia control at 14 DAT. By 28 DAT, only those treatments containing atrazine provided as much as 95% kochia control. However, kochia control at 42 DAT was greater than 90% with all treatments except glyphosate plus nonionic surfactant (80%). Only slight differences in Russian thistle control occurred at 14 and 42 DAT, but all treatments provided at least 95% Russian thistle control regardless of rating date.

Table. Fallow weed control with postemergence applications of AGH15004, AG14039, glyphosate, and atrazine.

Herbicide	Rate	14 days after treatment Kochia	14 days after treatment Russian thistle	28 days after treatment Kochia	28 days after treatment Russian thistle	42 days after treatment Kochia	42 days after treatment Russian thistle
		% Control		% Control		% Control	
AGH15004	1.5 pt	93	95	96	100	91	96
Glyphosate	32 oz						
Nonionic surfactant	2.5%						
AGH15004	1.5 pt	97	97	98	100	98	100
Atrazine	16 oz						
Glyphosate	32 oz						
Nonionic surfactant	2.5%						
AGH15004	2.5 pt	96	96	96	100	94	97
Glyphosate	32 oz						
Nonionic surfactant	2.5%						
AGH15004	1.5 pt	96	96	96	100	93	96
Glyphosate	32 oz						
Nonionic surfactant	2.5%						
AG14039	1.0 pt						
AGH15004	1.5 pt	98	99	100	100	97	100
Atrazine	16 oz						
Glyphosate	32 oz						
Nonionic surfactant	2.5%						
AG14039	1.0 pt						
AGH15004	2.5 pt	97	97	96	100	94	99
Glyphosate	32 oz						
Nonionic surfactant	2.5%						
AG14039	1.0 pt						
Glyphosate	32 oz	96	96	90	100	80	95
Nonionic surfactant	2.5%						
Untreated	------	0	0	0	0	0	0
LSD (0.05)		2.7	1.9	1.5	NS	5.1	4.1

Fallow weed control with preemergence applications of dicamba, atrazine, sulfentrazone, saflufenacil, pyrasulfone, and isoxaflutole. Randall S. Currie and Patrick W. Geier. (K-State Southwest Research-Extension Center, 4500 E. Mary Street, Garden City, KS 67846) An experiment was conducted at the Kansas State University Southwest Research-Extension Center near Garden City, KS to examine the efficacy of fall and spring preemergence herbicides in fallow. Fall treatments were applied December 4, 2014 and spring applications were made March 10, 2015. All herbicides were applied using a CO_2-pressurized, backpack sprayer delivering 20 gpa at 27 psi and 3 mph. Soil was a Ulysses silt loam with 1.4% organic matter, pH of 8.0, and cation exchange capacity of 18.4. Plots were 10 by 35 feet, and arranged as a randomized complete block replicated four times. Visual weed control was determined May 8, June 4, and July 21, 2015, which were 8, 13 and 20 weeks after spring herbicide application (WA-B). Kochia control at 8 WA-B was greatest when dicamba was included in the spring applications or when thiencarbazone\isoxaflutole was applied with atrazine and dicamba in the fall. Russian thistle control at the same date was generally best with spring applications except when pendimethalin plus sulfentrazone was applied in the fall or saflufenacil plus atrazine was spring-applied. The best kochia control at 13 WA-B occurred with spring applications containing dicamba, and Russian thistle control at 13 WA-B was best when dicamba was included in the spring applications with saflufenacil, pyroxasulfone, pendimethalin, or thiencarbazone\isoxaflutole. Only dicamba plus atrazine, saflufenacil, pyroxasulfone, sulfentrazone, or thiencarbazone\isoxaflutole applied in the spring provided as much as 90 kochia at 20 WA-B. Only the spring application of pendimethalin/sulfentrazone and dicamba controlled Russian thistle 90% at 20 WA-B.

Table. Fallow weed control with preemergence applications of dicamba, atrazine, sulfentrazone, saflufenacil, pyrasulfone, and isoxaflutole.

Herbicide	Rate	Timing	8 WA-B[a] Kochia	8 WA-B[a] Russian thistle	13 WA-B[a] Kochia	13 WA-B[a] Russian thistle	20 WA-B[a] Kochia	20 WA-B[a] Russian thistle
	(oz/A)		% Control		% Control		% Control	
Dicamba	16	Fall	88	80	84	74	73	58
Atrazine	24							
Saflufenacil	2	Fall	89	90	83	84	65	68
Atrazine	24							
Saflufenacil	2	Fall	88	86	85	85	65	68
Atrazine	42							
Dicamba	8							
Pyroxasulfone	2.5	Fall	96	86	94	84	83	63
Atrazine	24							
Dicamba	8							
Saflufenacil\	2	Fall	90	95	89	91	70	78
Imazethapyr								
Pyroxasulfone	2							
Dicamba	8							
Pendimethalin\	58	Fall	95	100	86	93	73	88
Sulfentrazone								
Dicamba	8							
Thiencarbazone\	3.3	Fall	97	95	91	93	79	73
Isoxaflutole								
Atrazine	24							
Dicamba	8							
Dicamba	16	Spring	100	100	95	89	91	58
Atrazine	24							
Saflufenacil	2	Spring	91	94	91	86	81	70
Atrazine	24							
Saflufenacil	2	Spring	100	100	96	94	93	68
Atrazine	42							
Dicamba	8							
Pyroxasulfone	2.5	Spring	99	100	98	94	95	68
Atrazine	24							
Dicamba	8							
Saflufenacil\	2	Spring	97	99	96	96	79	85
Imazethapyr								
Pyroxasulfone	2							
Dicamba	8							

Pendimethalin\ Sulfentrazone	58	Spring	100	100	98	99	91	90
Dicamba	8							
Thiencarbazone\ Isoxaflutole	3.3	Spring	100	100	100	98	91	80
Atrazine	24							
Dicamba	8							
Untreated	------	------	0	0	0	0	0	0
LSD (0.05)			3.5	3.7	5.2	6.4	22.1	10.6

[a] WA-B is weeks after spring application.

Fallow weed control with preemergence applications of isoxaflutole, thiencarbazone, iodosulfuron, dicamba, atrazine, sulfentrazone, and metribuzin. Randall S. Currie and Patrick W. Geier. (K-State Southwest Research-Extension Center, 4500 E. Mary Street, Garden City, KS 67846) An experiment was conducted at the Kansas State University Southwest Research-Extension Center near Garden City, KS to examine the efficacy of fall and spring preemergence herbicides in fallow. Fall treatments were applied November 20, 2014 and spring applications were made March 9, 2015. All herbicides were applied using a CO_2-pressurized, backpack sprayer delivering 20 gpa at 27 psi and 3 mph. Soil was a Ulysses silt loam with 1.4% organic matter, pH of 8.0, and cation exchange capacity of 18.4. Plots were 10 by 35 feet, and arranged as a randomized complete block replicated four times. Weed control was visually evaluated on May 7, June 6, and July 21, 2015 which was 8, 13, and 20 weeks after spring application (WA-B), respectively. Generally, atrazine alone applied in the fall was less effective for kochia and Russian thistle control than other fall or spring-applied herbicides at 8 and 13 WA-B. By 20 WA-B, control of kochia and Russian thistle was 85% or less with all fall-applied herbicides. Dicamba increased kochia control 16 to 17% when added to isoxaflutole plus iodosulfuron/thiencarbazone plus atrazine applied in the spring at 20 WA-B. All other spring-herbicides were similar for kochia control at 20 DA-B. Russian thistle control was similar among all spring-applied herbicides except atrazine plus dicamba (76%) at 20 WA-B.

Table. Fallow weed control with preemergence applications of isoxaflutole, thiencarbazone, iodosulfuron, dicamba, atrazine, sulfentrazone, and metribuzin.

Herbicide	Rate	Timing	8 WA-B[a] Kochia	8 WA-B[a] Russian thistle	13 WA-B[a] Kochia	13 WA-B[a] Russian thistle	20 WA-B[a] Kochia	20 WA-B[a] Russian thistle
	(oz/A)		% Control		% Control		% Control	
Isoxaflutole Iodosulfuron/ Thiencarbazone Atrazine	2 0.5 32	Fall	98	100	93	95	73	73
Thiencarbazone/ Isoxaflutole Atrazine	4 32	Fall	99	99	95	97	71	75
Sulfentrazone/ Metribuzin	12	Fall	93	100	93	96	76	85
Atrazine	32	Fall	89	86	84	84	68	68
Isoxaflutole Iodosulfuron/ Thiencarbazone Atrazine	1.5 0.5 16	Spring	93	93	91	94	78	95
Isoxaflutole Iodosulfuron/ Thiencarbazone Atrazine Dicamba	1.5 0.5 16 12	Spring	100	100	99	99	95	91
Isoxaflutole Iodosulfuron/ Thiencarbazone Atrazine	2 0.5 16	Spring	91	94	86	90	78	96
Isoxaflutole Iodosulfuron/ Thiencarbazone Atrazine Dicamba	2 0.5 16 12	Spring	100	100	100	98	94	86
Thiencarbazone/ Isoxaflutole Atrazine	3.5 16	Spring	94	91	94	91	89	90
Thiencarbazone/ Isoxaflutole Atrazine Dicamba	3.5 16 12	Spring	100	100	98	100	93	91
Atrazine	16	Spring	100	100	95	91	89	76

Dicamba	12							
Sulfentrazone/ Metribuzin	12	Spring	93	100	90	99	85	95
Untreated	------	------	0	0	0	0	0	0
LSD (0.05)			3.6	3.6	4.5	4.7	11.4	10.5

[a] WA-B is weeks after spring application.

<u>Grass weed control in established tall fescue grown for seed</u>. Daniel W. Curtis, Nicole P. Anderson, Kyle C. Roerig, Andrew G. Hulting and Carol A. Mallory-Smith. (Department of Crop and Soil Science, Oregon State University, Corvallis, OR 97331) A study was established in a five year old field of 'Grande III' tall fescue in Washington County, Oregon. The objectives of this study were to assess control of Italian ryegrass (*Lolium multiflorum*) and volunteer tall fescue and quantify potential crop injury from sequential applications of industry standard treatments of flufenacet/metribuzin, diuron, oxyfluorfen, glufosinate and ethofumesate as well as potential herbicides for grasses grown for seed including pyroxasulfone/flumioxazin and saflufenacil. Twelve treatments replicated 4 times were arranged in a randomized complete block design with plots 8 ft by 25 ft. Initial treatments were applied October 9, 2014, and were followed by rainfall on October 11. A second set of treatments was applied on November 20, 2014. Application data are presented in Table 1. Treatments were applied with a compressed air pressurized boom mounted on a unicycle frame and calibrated to deliver 20 gpa at 20 psi. Injury to the tall fescue was visually evaluated January 26, 2015 and March 25, 2015. Volunteer tall fescue seedling and Italian ryegrass control were visually evaluated March 25, 2015. Plots were swathed on June 25, 2015 and seed was harvested with a small plot combine on July 6, 2015. Seed was cleaned and yields quantified (Table 2).

Table 1. Application and soil data

Application date	October 9, 2014		November 20, 2014
Crop growth stage	dormant		dormant
Volunteer tall fescue growth stage	0 – 1 leaf		2lf – 1 tiller
Italian ryegrass growth stage	0 – 1 leaf		2lf – 1 tiller
Air temperature (ºF)	60		45
Soil temperature (ºF)	60		42
Relative humidity	90		90
Wind	0		0
Cloud cover	100		100
First moisture	October 11, 2014		November 21, 2014
Soil type		Woodburn silt loam	
Soil pH		5.5	
% OM		3.2	

None of the treatments resulted in yield reduction compared to the untreated control. Volunteer tall fescue control was improved in the flufenacet/metribuzin treatments with the addition of diuron or oxyfluorfen or with a sequential application. The addition of oxyfluorfen to pyroxasulfone/flumioxazin did not increase the volunteer tall fescue control. The addition of diuron to pyroxasulfone/flumioxazin or a sequential application increased the volunteer tall fescue control. Italian ryegrass control was improved with sequential applications compared to single applications. Results from this study suggest that sequential applications can be used to manage problematic Italian ryegrass populations in established tall fescue seed production fields.

Table 2. Tall fescue injury and control of volunteer tall fescue and *Lolium multiflorum* in tall fescue, 2014-2015

Treatment	Rate	Crop injury Jan 26	Crop injury Mar 25	Volunteer tall fescue control Mar 25	*Lolium multiflorum* control Mar 25	Yield clean seed Jul 6
	lb ai/A	- % -	- % -	- % -	- % -	lb/A
untreated	0	0	0	0	0	736
flufenacet/metribuzin	0.55	0	0	53	50	671
flufenacet/metribuzin	0.55					
+ diuron	1	0	0	73	48	840
flufenacet/metribuzin	0.55					
+ oxyfluorfen	0.06	3	0	78	69	620
flufenacet/metribuzin	0.55					
+ oxyfluorfen	0.06					
fb pyroxasulfone/flumioxazin	0.14	5	4	91	85	758
pyroxasulfone/flumioxazin	0.14	0	0	80	73	722
pyroxasulfone/flumioxazin	0.14					
+ diuron	1	0	0	93	78	653
pyroxasulfone/flumioxazin	0.14					
+ oxyfluorfen	0.06	0	0	65	70	764
pyroxasulfone/flumioxazin	0.14					
+ oxyfluorfen	0.06					
fb flufenacet/metribuzin	0.43	3	0	93	79	746
flufenacet/metribuzin	0.55					
+ oxyfluorfen	0.06					
fb dimethenamid-P	0.98					
+ glufosinate	0.3	15	5	98	89	915
pyroxasulfone/flumioxazin	0.14					
+ oxyfluorfen	0.06					
fb dimethenamid-P	0.98					
+ glufosinate	0.3	20	4	100	91	783
flufenacet/metribuzin	0.55					
fb pyroxasulfone/flumioxazin	0.14					
+ glufosinate	0.3					
+ ethofumesate	1					
+ saflufenacil	0.04	26	13	100	93	783
LSD (P = 0.05)		9	6	15	13	ns
CV		109	187	14	13	37

Preemergence herbicides for grass weed control in carbon-seeded tall fescue grown for seed. Daniel W. Curtis, Kyle C. Roerig, Andrew G. Hulting and Carol A. Mallory-Smith. (Department of Crop and Soil Science, Oregon State University, Corvallis, OR 97331) A study was established in carbon-seeded tall fescue to assess control of diuron resistant annual bluegrass (*Poa annua*) and roughstalk bluegrass (*Poa trivialis*) and to quantify crop injury from preemergence applications of indaziflam, pyroxasulfone/flumioxazin, rimsulfuron, rimsulfuron plus pronamide compared to industry standards of diuron followed by ethofumesate or diuron plus pronamide. Plots were 8 by 35 ft arranged in a randomized complete block design with four replications. Three rows of *Poa trivialis* seed and three rows of diuron resistant *Poa annua* seed obtained from crop cleaning operations of Willamette Valley grass seed growers were planted on 12 inch row spacings in the front portion of the plots. Fifteen rows of 'Rebel XLR' turf type tall fescue on 18 inch row spacings were planted in the rear portion of the plots. The tall fescue was planted 0.25 inches deep with a 1 inch wide band of activated carbon applied over the rows at 300 lbs per acre. Planting was completed on September 16, 2014. Herbicide application and soil data are presented in Table 1. Herbicide treatments were applied on September 17 and November 24 with a compressed air pressurized boom mounted on a unicycle frame and calibrated to deliver 20 gpa at 20 psi. The planting was irrigated with 0.25 inches following the preemergence application. Irrigation was continued through crop emergence. Injury to the tall fescue and percent control of planted *Poa* species were evaluated visually on April 6, 2015. The tall fescue was swathed on June 25 and harvested with a small plot combine on July 7. Seed was cleaned and yields quantified (Table 2).

Table 1. Application and soil data

Application date	Sept.17, 2014	Nov. 24, 2014
Crop growth stage	preemergence	5 tiller
Poa trivialis growth stage	preemergence	5 tiller
Poa annua growth stage	preemergence	5 tiller
Air temperature (F)	69	53
Relative humidity (%)	70	85
Wind (mph, direction)	1, NE	2, SW
Cloud cover (%)	90	60
First irrigation (inches)	September 17, 0.25	
Soil temperature at 2 inches (F)	70^{o}	47^{o}
pH	5.3	
OM (%)	2.82	
CEC (meq/100g)	13.3	
Texture	silty clay loam	

Competition from a background population of diuron susceptible *Poa annua* reduced yields in the untreated check treatment. This *Poa annua* population was controlled in the herbicide treated plots and yields were greater than the untreated check. Diuron resistant *Poa annua* control was greater than 97% in herbicide treatments with the exceptions of the rimsulfuron and the diuron followed by ethofumesate treatments. *Poa trivialis* was controlled greater than 95% with the exception of the rimsulfuron and the diuron followed by ethofumesate treatments. The addition of pronamide to rimsulfuron improved control of both species. These diuron resistant *Poa annua* and the *Poa trivialis* populations are not controlled by preemergence applications of rimsulfuron, but can be controlled by preemergence applications of indaziflam, pyroxasulfone/flumioxazin and pronamide + diuron.

Table 2. Control of *Poa* species and crop injury with herbicide treatments in carbon-seeded tall fescue, 2014-2015.

Treatment	Rate	*Poa annua*	*Poa trivialis*	Crop injury	Clean seed yield
	lb ai/A	----- % control[1] -----		- % -	lb/A
untreated check	0	0	0	0	928
indaziflam	0.02	99	99	19	973
pyroxasulfone/flumioxazin	0.1	100	95	4	997
pyroxasulfone/flumioxazin	0.14	100	99	23	1252
pyroxasulfone/flumioxazin + pronamide	0.13	100	100	6	1049
rimsulfuron	0.05	13	38	0	1020
rimsulfuron	0.06	15	63	0	1033
rimsulfuron + pronamide	0.05 + 0.13	75	88	0	1079
diuron fb	2.3				
ethofumesate	1	13	63	0	1015
pronamide + diuron	0.25 + 1	97	98	0	1080
LSD (P = 0.05)		23	25	5	305
CV		26	24	68	20

[1]% control and crop injury evaluated April 6, 2014.

[2]Abbreviations: fb, followed by.

Pyroxasulfone use in dormant peppermint. Kyle C. Roerig, Andrew G. Hulting, Daniel W. Curtis, and Carol A. Mallory-Smith. (Department of Crop and Soil Science, Oregon State University, Corvallis, OR 97331) A trial was conducted in an established peppermint field south of Monroe, Oregon, in Lane County. The objective of the trial was to assess the crop safety of pyroxasulfone. Pyroxasulfone provides pre-emergent control of many annual broadleaf and grass weeds impacting mint production in western Oregon. The trial site was free of weeds, including in the untreated check plots. Pyroxasulfone treatments were applied at three different timings, in combination with other herbicides and in two premixes (flumioxazin and carfentrazone). None of the treatments, including the 2x rate and sequential application of pyroxasulfone, injured the peppermint with the exception of the pyroxasulfone-flumioxazin premix. Injury from pyroxasulfone-flumioxazin was no longer visible by harvest and did not affect yield.

Table. Peppermint injury ratings and oil yield at Monroe, OR, in 2015.

	Rate	Application	Injury[a]	Injury[b]	Injury[c]	Injury[d]	Oil Yield[d]
	lb ai/a	date	-------------------------	-------------%------------	-------------	-------------------------	lb/a
Untreated			0	0	0	0	76
Pyroxasulfone	0.19	2/12	0	0	0	0	70
+ terbacil	0.5	2/24					
+ paraquat	0.5	2/24					
+ NIS	0.418	2/24					
Pyroxasulfone	0.19	2/12	0	0	0	0	79
+ pyroxasulfone	0.19	2/24					
+ terbacil	0.5	2/24					
+ paraquat	0.5	2/24					
+ NIS	0.418	2/24					
Pyroxasulfone	0.19	2/24		0	0	0	73
+ terbacil	0.5	2/24					
+ paraquat	0.5	2/24					
+ NIS	0.418	2/24					
Terbacil	0.5	2/24		0	9	0	81
+ paraquat	0.5	2/24					
+ NIS	0.418	2/24					
+ pyroxasulfone	0.19	3/27					
Pyroxasulfone	0.38	2/24		0	0	0	74
+ terbacil	0.5	2/24					
+ paraquat	0.5	2/24					
+ NIS	0.418	2/24					
Terbacil	0.5	2/24		0	0	0	75
+ paraquat	0.5	2/24					
+ NIS	0.418	2/24					
Pyroxasulfone-flumioxazin	0.339	2/24		53	8	0	82
+ paraquat	0.5	2/24					
+ COC	1.67	2/24					
Pyroxasulfone	0.19	2/24		0	0	0	79
+ paraquat	0.5	2/24					
+ COC	1.67	2/24					
Pyroxasulfone-carfentrazone	0.2035	2/24		0	0	0	81
+ COC	1.67	2/24					
LSD P=0.05			0.0	2.3	5.5	0.0	11.4
Standard Deviation			0.0	1.6	3.8	0.0	7.9

[a]Evaluated 2/24/15
[b]Evaluated 3/27/15
[c]Evaluated 5/6/15
[d]Evaluated 7/30/15

Preemergence herbicides for grass weed control in carbon-seeded perennial ryegrass grown for seed. Daniel W. Curtis, Kyle C. Roerig, Andrew G. Hulting and Carol A. Mallory-Smith. (Department of Crop and Soil Science, Oregon State University, Corvallis, OR 97331) A study was established in carbon-seeded perennial ryegrass to assess control of diuron resistant annual bluegrass (*Poa annua*) and roughstalk bluegrass (*Poa trivialis*) and to quantify crop injury from preemergence applications of indaziflam, pyroxasulfone/flumioxazin, rimsulfuron, rimsulfuron plus pronamide compared to industry standards of diuron followed by ethofumesate or diuron plus pronamide. Plots were 8 by 35 ft arranged in a randomized complete block design with four replications. Three rows of *Poa trivialis* seed and 3 rows of diuron resistant *Poa annua* seed obtained from crop cleaning operations of Willamette Valley grass seed growers were planted on 12 inch row spacings in the front portion of the plots. Twenty-four rows of 'APR 2105' perennial ryegrass on 12 inch row spacings were planted in the rear portion of the plots. The perennial ryegrass was planted 0.25 inches deep with a 1 inch wide band of activated carbon applied over the rows at 300 lbs per acre. Planting was completed on October 8, 2014. Herbicide application and soil data are presented in Table 1. Herbicide treatments were applied on October 8 and November 24 with a compressed air pressurized boom mounted on a unicycle frame and calibrated to deliver 20 gpa at 20 psi. Rainfall of 0.23 inches occurred on October 10. Injury to the perennial ryegrass and percent control of planted *Poa* species were evaluated visually on April 6, 2015. The perennial ryegrass was swathed on June 29 and harvested with a small plot combine on July 8. Seed was cleaned and yields quantified (Table 2).

Table 1. Application and soil data

Application date	Oct. 8, 2014		Nov. 24, 2014
Crop growth stage	preemergence		1 tiller
Poa trivialis growth stage	preemergence		1 tiller
Poa annua growth stage	preemergence		1 tiller
Air temperature (F)	78		53
Relative humidity (%)	55		85
Wind (mph, direction)	3, E		2, SW
Cloud cover (%)	0		60
First rainfall (inches)	Oct 10, 0.23		
Soil temperature at 2 inches (F)	70		47
pH		5.3	
OM (%)		2.82	
CEC (meq/100g)		13.3	
Texture		silty clay loam	

Diuron resistant *Poa annua* control was greater than 96% in all herbicide treatments with the exception of the rimsulfuron treatments and the diuron followed by ethofumesate treatment which did not provide adequate control. *Poa trivialis* was controlled greater than 95% in all herbicide treatments with the exception of the rimsulfuron and the diuron followed by ethofumesate treatments. The addition of pronamide to rimsulfuron improved control of the *Poa* species. Rimsulfuron with the addition of pronamide provided 85% control of the diuron resistant *Poa annua* and good control (95%) of the *Poa trivialis*. The diuron resistant *Poa annua* can be controlled by preemergence applications of indaziflam, pyroxasulfone/flumioxazin and pronamide + diuron.

Table 2. Control of *Poa* species and crop injury with herbicide treatments in carbon-seeded perennial ryegrass, 2014-2015.

Treatment	Rate	*Poa annua*	*Poa trivialis*	Crop injury	Clean seed yield
	lb ai/A	----- % control[1] -----		- % -	lb/A
untreated check	0	0	0	0	1520
indaziflam	0.02	96	96	9	1596
pyroxasulfone/flumioxazin	0.1	100	100	1	1492
pyroxasulfone/flumioxazin	0.14	100	100	19	1535
pyroxasulfone/flumioxazin + pronamide	0.13	100	100	9	1727
rimsulfuron	0.05	60	78	0	1751
rimsulfuron	0.06	73	85	0	1686
rimsulfuron + pronamide	0.05 + 0.13	74	95	0	1690
diuron fb	2.3				
ethofumesate	1	76	80	0	1719
pronamide + diuron	0.25 + 1	100	100	0	1642
LSD (P = 0.05)		24	10	2	306
CV		21	8	37	13

[1]% control and crop injury evaluated April 6, 2014.
[2]Abbreviations: fb, followed by.

Evaluation of pyroxasulfone efficacy and crop safety in safflower Mariano F Galla and Kassim Al-Khatib (Department of Plant Science, UC Davis, Davis, CA, 95616). A field trial was conducted in northern California for the evaluation of pyroxasulfone for residual weed control and crop safety in safflower. The trial was conducted at the UC Davis research station, in a yolo silty clay loam soil. The trial was established as a randomized complete block. Individual plots were 10 by 25 ft and included two beds. Treatment application was made one day after safflower planting and the field was irrigated immediately after. Treatments were applied in a total volume of 20 gallons per acre using a hand held, CO2-pressurized, three-nozzle boom sprayer. Application data are presented in the following table:

Application date	April, 17 2015
Crop Stage	Pre-emergence
Application time	09:00 am –10:00 am
Air temperature	62°F
Relative humidity	51%
Soil temperature	62°F
Cloud cover	0%
Wind speed and direction	4 MPH South East

Weed control and crop safety were evaluated 28, 38 and 47 days after treatment. At crop maturity, the central two rows of each plot were harvested using a small plot harvester. Yield data are presented as pounds of safflower per acre. Weed pressure was observed to be fairly heavy and uniform over the trial site. Populations of tumble pigweed (*Amaranthus albus* L.), prostate pigweed (*Amaranthus blitoides* S. Wats.), common lambsquarters (*Chenopodium album* L.), common purslane (*Portulaca oleracea* L.), yellow nutsedge (*Cyperus esculentus* L.) and field bindweed (*Convolvulus arvensis* L.) were recorded.

All treatments applied provided excellent weed control. Pyroxasulfone, with the exception of the low (30 g ai/a) rate, resulted in nearly 100% control of all the weeds present (Tables 1,2 and 3). Generally, pyroxasulfone provided significantly higher level of weed control when applied at rates higher than 60 g ai/a. The addition of either Treflan (trifluralin) (0.75 and 1.5 pt/a) or Dual (s-metolachlor) (0.84 and 1.67 pt/a) to pyroxasulfone did not improve the results obtained by pyroxasulfone applied alone. Finally, pyroxasulfone provided similar weed control to 1.5 pt of Treflan and 1.67 pt of Dual.

All treatments resulted in significantly higher yield than the untreated plots (table 4).

Pyroxasulfone was safe to safflower, no phytotoxicity symptoms were observed in the plots at any rating dates.

Table 1. Common lambsquarters control in safflower at UC Davis research station

Treatment	Rate		Percentage of control 28 DAT		38 DAT		47DAT	
Pyroxasulfone	30	g ai/a	73.8	c	73.0	c	66.3	c[1]
Pyroxasulfone	60	g ai/a	90.0	ab	91.5	abc	92.5	ab
Pyroxasulfone	90	g ai/a	97.5	ab	99.4	a	93.8	ab
Pyroxasulfone	120	g ai/a	97.5	ab	98.7	ab	96.3	a
Treflan	1.5	pt/a	60	d	68.6	c	45.0	d
Dual EC	1.67	pt/a	85	bc	78.2	bc	76.3	bc
Pyroxasulfone + Treflan	45 + 1.5	g ai + pt/a	95	ab	93.6	abc	90.0	ab
Pyroxasulfone + Treflan	90 + 1.5	g ai + pt/a	98.8	a	99.7	a	98.8	a
Pyroxasulfone + Dual EC	45 + 1.67	g ai + pt/a	96.3	ab	99.0	a	97.5	a
Pyroxasulfone + Dual EC	90 + 1.67	g ai + pt/a	98.8	a	99.7	a	96.3	a
Pyroxasulfone + Treflan	90 + 0.75	g ai + pt/a	98.8	a	99.4	a	96.3	a
Pyroxasulfone + Dual EC	90 + 0.84	g ai + pt/a	99.5	a	100.0	a	99.2	a
Dual EC + Treflan	1.67 + 1.5	pt/a	85.0	bc	88.7	abc	83.8	abc
Untreated Check			0.0	e	0.0	d	0.0	e

DAT: Days after treatment application

1: Means followed by same letter do not significantly differ (P=.05, Tukey's HSD)

Table 2 Prostate pigweed control in safflower at UC Davis research station

Treatment	Rate		Percentage of control 28 DAT		38 DAT		47DAT	
Pyroxasulfone	30	g ai/a	80.5	bc	73.3	bc	61.7	b[1]
Pyroxasulfone	60	g ai/a	98.1	a	99.4	a	97.9	a
Pyroxasulfone	90	g ai/a	99.7	a	99.7	a	99.4	a
Pyroxasulfone	120	g ai/a	98.7	a	96.3	ab	99.7	a
Treflan	1.5	pt/a	56.4	c	66.7	c	55.0	b
Dual EC	1.67	pt/a	96.3	ab	98.1	a	89.4	ab
Pyroxasulfone + Treflan	45 + 1.5	g ai + pt/a	96.8	ab	93.6	ab	89.6	ab
Pyroxasulfone + Treflan	90 + 1.5	g ai + pt/a	100.0	a	100.0	a	100.0	a
Pyroxasulfone + Dual EC	45 + 1.67	g ai + pt/a	100.0	a	100.0	a	100.0	a
Pyroxasulfone + Dual EC	90 + 1.67	g ai + pt/a	100.0	a	100.0	a	100.0	a
Pyroxasulfone + Treflan	90 + 0.75	g ai + pt/a	99.4	a	98.7	a	98.3	a
Pyroxasulfone + Dual EC	90 + 0.84	g ai + pt/a	100.0	a	100.0	a	100.0	a
Dual EC + Treflan	1.67 + 1.5	pt/a	100.0	a	98.7	a	100.0	a
Untreated Check			0.0	d	0.0	d	0.0	c

DAT: Days after treatment application

1: Means followed by same letter do not significantly differ (P=0.05, Tukey's HSD)

Table 3 Yellow nutsedge control in safflower at UC Davis research station

Treatment		Rate	Percentage of control 28 DAT		38 DAT		47DAT	
Pyroxasulfone	30	g ai/a	90.0	ab	85.0	ab	90.3	a[1]
Pyroxasulfone	60	g ai/a	75.4	ab	81.3	ab	86.8	a
Pyroxasulfone	90	g ai/a	91.2	ab	88.8	ab	96.2	a
Pyroxasulfone	120	g ai/a	86.8	ab	83.8	ab	91.1	a
Treflan	1.5	pt/a	63.3	b	68.8	b	96.7	a
Dual EC	1.67	pt/a	96.8	a	87.5	ab	99.0	a
Pyroxasulfone + Treflan	45 + 1.5	g ai + pt/a	84.6	ab	85.0	ab	91.1	a
Pyroxasulfone + Treflan	90 + 1.5	g ai + pt/a	96.0	ab	81.3	ab	87.8	a
Pyroxasulfone + Dual EC	45 + 1.67	g ai + pt/a	80.6	a	91.3	a	95.4	a
Pyroxasulfone + Dual EC	90 + 1.67	g ai + pt/a	96.3	a	96.3	a	99.7	a
Pyroxasulfone + Treflan	90 + 0.75	g ai + pt/a	93.9	ab	96.3	a	97.2	a
Pyroxasulfone + Dual EC	90 + 0.84	g ai + pt/a	97.1	a	96.3	a	92.6	a
Dual EC + Treflan	1.67 + 1.5	pt/a	97.6	a	96.3	a	96.3	a
Untreated Check			0.0	c	0.0	ab	0.0	b

DAT: Days after treatment application

1: Means followed by same letter do not significantly differ (P=0.05, Tukey's HSD)

Table 4 Safflower yield at UC Davis research station

Treatment		Rate	Yield (lb/a)	
Pyroxasulfone	30	g ai/a	2507	a[1]
Pyroxasulfone	60	g ai/a	2854	a
Pyroxasulfone	90	g ai/a	3069	a
Pyroxasulfone	120	g ai/a	2777	a
Treflan	1.5	pt/a	2683	a
Dual EC	1.67	pt/a	2884	a
Pyroxasulfone + Treflan	45 + 1.5	g ai + pt/a	2916	a
Pyroxasulfone + Treflan	90 + 1.5	g ai + pt/a	2971	a
Pyroxasulfone + Dual EC	45 + 1.67	g ai + pt/a	3006	a
Pyroxasulfone + Dual EC	90 + 1.67	g ai + pt/a	3125	a
Pyroxasulfone + Treflan	90 + 0.75	g ai + pt/a	2729	a
Pyroxasulfone + Dual EC	90 + 0.84	g ai + pt/a	3420	a
Dual EC + Treflan	1.67 + 1.5	pt/a	3211	a
Untreated Check			1106	b

1: Means followed by same letter do not significantly differ (P=0.05, Tukey's HSD)

Weed control and crop injury with single or sequential herbicide applications in grain sorghum. Randall S. Currie and Patrick W. Geier. (K-State Southwest Research-Extension Center, 4500 E. Mary Street, Garden City, KS 67846) An experiment at the Kansas State University Southwest Research-Extension Center near Garden City, KS evaluated the crop response and efficacy of pyrasulfotole\bromoxynil tank mixtures in grain sorghum. Pyrasulfotole\bromoxynil treatments were applied either as stand-alone postemergence treatments or as sequential treatments following a preemergence application of *S*-metolachlor. Preemergence applications were made June 6, 2015 and postemergence applications were made July 6, 2015 when sorghum was 6 to 10 inches tall and weeds were 2 to 7 inches in height. All treatments were applied using a tractor-mounted, compressed CO2 sprayer delivering 20 gpa at 3 mph and 30 psi. Soil was a Ulysses silt loam with 1.4% organic matter, pH of 8.0, and cation exchange capacity of 18.4. Plots size was 10 by 35 feet, and plots were arranged in a complete randomized block with four replications. Visual sorghum injury was taken on July 13 and July 30, 2015: 7 and 24 days after postemergence application (DA-B). Weed control was estimated visually on September 15, 2015 which was 71 DA-B. Grain yields were not determined. All pyrasulfotole\bromoxynil treatments caused 5 to 10% sorghum necrosis at 7 DA-B (Table 2), but sorghum had completely recovered by 24 DA-B. Palmer amaranth control at 71 DA-B was greatest (78 to 81%) when *S*-metolachlor PRE was followed by pyrasulfotole\bromoxynil at 13 oz/A, atrazine, dicamba, NIS and AMS or with pyrasulfotole\bromoxynil at 16 oz/A plus atrazine and NIS. *S*-metolachlor applied PRE increased Palmer amaranth control with pyrasulfotole\bromoxynil at 13 oz/A plus atrazine and 2,4-D or dicamba or pyrasulfotole\bromoxynil at 16 oz/A plus atrazine POST compared to the same treatments applied alone POST. *S*-metolachlor alone PRE controlled green foxtail 68%. When *S*-metolachlor was applied PRE prior to any pyrasulfotole\bromoxynil POST treatment, green foxtail control increased 34 to 65% compared to the POST-only pyrasulfotole\bromoxynil treatments.

Table. Weed control and crop injury with single or sequential herbicide applications in grain sorghum.

Treatment[b]	Rate	Timing[c]	7 DAB[a] Sorghum necrosis	71 DAB Palmer amaranth	71 DAB Green foxtail
			% Visual		
S-metolachlor	1.5 pt	PRE	0	50	68
S-metolachlor	1.5 pt	PRE	6	43	72
Pyrasulfotole/ Bromoxynil	13 oz	POST			
Atrazine	16 oz	POST			
NIS	0.25 %	POST			
AMS	1.0 lb	POST			
S-metolachlor	1.5 pt	PRE	9	55	75
Pyrasulfotole/ Bromoxynil	16 oz	POST			
Atrazine	16 oz	POST			
NIS	0.25 %	POST			
AMS	1.0 lb	POST			
S-metolachlor	1.5 pt	PRE	9	58	78
Pyrasulfotole/ Bromoxynil	13 oz	POST			
Atrazine	16 oz	POST			
2,4-D ester	4 oz	POST			
NIS	0.25 %	POST			
AMS	1.0 lb	POST			
S-metolachlor	1.5 pt	PRE	6	81	84
Pyrasulfotole/ Bromoxynil	13 oz	POST			
Atrazine	16 oz	POST			
Dicamba	4 oz	POST			
NIS	0.25 %	POST			
AMS	1.0 lb	POST			
S-metolachlor	1.5 pt	PRE	5	78	85
Pyrasulfotole/ Bromoxynil	16 oz	POST			
Atrazine	16 oz	POST			
NIS	0.25 %	POST			
S-metolachlor	1.5 pt	PRE	9	47	77
Atrazine	16 oz	POST			
Bromoxynil	16 oz	POST			
Pyrasulfotole/ Bromoxynil	13 oz	POST	8	30	20
Atrazine	16 oz	POST			
NIS	0.25 %	POST			
AMS	1.0 lb	POST			
Pyrasulfotole/ Bromoxynil	16 oz	POST	10	45	23
Atrazine	16 oz	POST			
NIS	0.25 %	POST			
AMS	1.0 lb	POST			
Pyrasulfotole/ Bromoxynil	13 oz	POST	5	40	25
Atrazine	16 oz	POST			
2,4-D ester	4 oz	POST			
NIS	0.25 %	POST			
AMS	1.0 lb	POST			

Pyrasulfotole/ Bromoxynil	13 oz	POST	6	55	38
Atrazine	16 oz	POST			
Dicamba	4 oz	POST			
NIS	0.25 %	POST			
AMS	1.0 lb	POST			
Pyrasulfotole/ Bromoxynil	16 oz	POST	10	35	23
Atrazine	16 oz	POST			
NIS	0.25 %	POST			
Atrazine	16 oz	POST	5	33	23
Bromoxynil	16 oz	POST			
Untreated	---	---	0	0	0
LSD (0.05)			3.8	16.1	14.0

[a] DAB is days after postemergence application.
[b] NIS is nonionic surfactant and AMS is ammonium sulfate.
[c] PRE is preemergence, POST is postemergence.

Weed control with single or sequential herbicide applications in acetolactase synthase-tolerant grain sorghum. Randall S. Currie and Patrick W. Geier. (K-State Southwest Research-Extension Center, 4500 E. Mary Street, Garden City, KS 67846) An experiment in 2015 at the Kansas State University Southwest Research-Extension Center near Garden City, KS evaluated the crop tolerance and efficacy of nicosulfuron plus atrazine postemergence application timings in acetolactase synthase-tolerant grain sorghum. Herbicides were applied preemergence (PRE) alone, mid-postemergence following 15 day preplant (15 DPP) or preemergence treatments, postemergence (POST) following PRE treatments, or POST alone (Table 1). All herbicides were applied using a tractor-mounted or backpack-type CO_2 pressurized sprayer delivering 20 gpa at 3 mph and 27 to 30 psi. Soil was a Ulysses silt loam with organic matter of 1.4%, pH of 8.0, and cation exchange capacity of 18.4. Plots were 10 by 35 feet arranged in a randomized complete block with four replications. Visual weed control was determined September 15, 2015 which was 53 days after POST application. Grain yields were not determined. Palmer amaranth control was best (83 to 88%) when rimsulfuron plus thifensulfuron and glyphosate were applied 15 DPP followed by nicosulfuron and atrazine POST, or by nicosulfuron plus atrazine alone POST (Table 2). Palmer amaranth control was less than 80% with all other herbicide treatments. All herbicides except *S*-metolachlor/atrazine alone PRE (60%) controlled puncturevine 73 to 78%. Preemergence herbicides alone provided less than 60% green foxtail control at 53 days after POST applications, and nicosulfuron plus atrazine alone POST controlled green foxtail 70%. Sequential applications of herbicides provided the best green foxtail control. The relatively low weed control provided by these treatments may be partially explained by the precipitation and irrigation during the study. Rainfall was slightly above normal at 9.6 inches during the growing season, and irrigation totaled 3.0 inches during this timeframe.

Table 1. Application information.

Application timing	15 days preplant	Preemergence	Mid postemergence	Late postemergence
Application date	June 3, 2015	June 18, 2015	July 15, 2015	July 24, 2015
Air temperature (F)	90	76	84	80
Relative humidity (%)	33	55	46	60
Soil temperature (F)	76	77	77	75
Wind speed (mph)	2 to 3	5 to 6	2 to 3	3 to 4
Wind direction	South	Northwest	Southwest	South
Soil moisture	Good	Fair	Good	Good

Table 2. Weed control with single or sequential herbicide applications in acetolactase synthase-tolerant grain sorghum.

Treatment[a]	Rate	Timing[b]	53 days after POST application		
			Palmer amaranth	Puncturevine	Green foxtail
			% Visual		
Rimsulfuron	1.8 oz	15 DPP	83	75	85
Thifensulfuron	0.9 oz	15 DPP			
Glyphosate	32 oz	15 DPP			
Nicosulfuron	12 oz	MPOST			
Atrazine	24 oz	MPOST			
COC	1 %	MPOST			
AMS	2 lb	MPOST			
Rimsulfuron	1.0 oz	PRE	78	78	55
Thifensulfuron	0.5 oz	PRE			
S-metolachlor/ Atrazine	51 oz	PRE			
S-metolachlor/ Atrazine	51 oz	PRE	70	60	53
Rimsulfuron	1.0 oz	PRE	73	75	80
Thifensulfuron	0.5 oz	PRE			
S-metolachlor/ Atrazine	51 oz	PRE			
Nicosulfuron	12 oz	MPOST			
Atrazine	24 oz	MPOST			
COC	1 %	MPOST			
AMS	2 lb	MPOST			
S-metolachlor/ Atrazine	51 oz	PRE	78	73	78
Nicosulfuron	12 oz	POST			
Atrazine	24 oz	POST			
COC	1 %	POST			
AMS	2 lb	POST			
Nicosulfuron	12 oz	POST	88	73	70
Atrazine	24 oz	POST			
COC	1 %	POST			
AMS	2 lb	POST			
Untreated			0	0	0
LSD (0.05)			9.7	9.3	11.0

[a] All plots received glyphosate at 32 oz/A preemergence. COC is crop oil concentrate and AMS is ammonium sulfate.

[b] 15 DPP is 15 days preplant, PRE is preemergence, MPOST is mid-postemergence, and POST is postemergence.

Preemergence weed control with acetochlor, *S*-metolachlor, atrazine, and mesotrione in grain sorghum. Randall S. Currie and Patrick W. Geier. (K-State Southwest Research-Extension Center, 4500 E. Mary Street, Garden City, KS 67846) An experiment was conducted the Kansas State University Southwest Research-Extension Center near Garden City, KS to determine the efficacy of preemergence applications of acetochlor\atrazine at three rates compared to standard treatments in grain sorghum. All herbicides were applied June 6, 2015 using a tractor-mounted, compressed-CO_2 sprayer delivering 20 gpa at 3.0 mph and 30 psi. Soil was a Ulysses silt loam with 1.4% organic matter, pH of 8.0, and cation exchange capacity of 18.4. Plots were 10 by 35 feet and arranged in a randomized complete block, replicated four times. Visual weed control ratings were taken on August 20, 2015 which was 71 days after treatment. Sorghum yields were determined on October 20, 2015 by machine harvesting the center two rows of each plot, weighing the grain, and correcting for 14.0% moisture. At 71 days after treatment, acetochlor\atrazine at 2.5 or 3.0 qt/a and *S*-metolachlor\atrazine\mesotrione at 2.0 qt/a were the only treatments to control Palmer amaranth 90% or more. All treatments provided similar velvetleaf control. Puncturevine control was best (78 to 83%) with acetochlor\atrazine at 3.0 qt/a and *S*-metolachlor\atrazine\mesotrione at 2.0 qt/a. Similarly, green foxtail control was 75 to 83% with all rates of acetochlor\atrazine or *S*-metolachlor\atrazine\mesotrione. Sorghum receiving acetochlor\atrazine at 2.5 or 3.0 qt/a or *S*-metolachlor\atrazine\mesotrione yielded 31 to 53 bu/a more grain than untreated sorghum.

Table. Preemergence weed control with acetochlor, *S*-metolachlor, atrazine, and mesotrione in grain sorghum.

Treatment	Rate	71 days after treatment				Yield
		Palmer amaranth	Velvetleaf	Puncturevine	Green foxtail	
	qt/a	% Visual				bu/A
Acetochlor/ Atrazine	2.0	80	95	70	75	54.2
Acetochlor/ Atrazine	2.5	90	93	75	78	69.7
Acetochlor/ Atrazine	3.0	93	100	78	83	60.9
S-metolachlor/ Atrazine	1.6	78	100	70	73	44.7
Atrazine	1.0	68	90	65	55	42.3
S-metolachlor/ Atrazine/ Mesotrione	2.0	94	100	83	80	82.6
Untreated	---	0	0	0	0	28.6
LSD (0.05)		12.8	10.4	8.2	9.1	29.1

<u>Control of sharppoint fluvellin in spearmint.</u> Kyle C. Roerig, Andrew G. Hulting, Daniel W. Curtis, and Carol A. Mallory-Smith. (Department of Crop and Soil Science, Oregon State University, Corvallis, OR 97331) Sharppoint fluvellin is a spreading annual weed affecting mint fields, especially in the spring. This trial was conducted in a field of spearmint north of Independence, Polk County, Oregon. The objectives of this trial were to evaluate herbicides that could be utilized to control sharppoint fluvellin and identify herbicides that may have adequate crop safety to be used in mint. Amicarbazone, flumetsulam, thiencarbazone and sequential application of saflufenacil significantly reduced yield (p-value 0.05). Saflufenacil followed by an additional application of saflufenacil and flumioxazin each provided 90% or greater control of sharppoint fluvellin. Pyroxasulfone-flumioxazin controlled 100% of sharppoint fluvellin.

Table. Sharppoint fluvellin control in spearmint.

	Rate	Application	Mint Injury[a]	Sharppoint fluvellin Control[b]	Mint Injury[c]	Mint Oil yeild[d]
	lb ai/a	date	---------------------	%	---------------------	lb/a
Untreated			0	0	0	59
Terbacil	1.2	2/20	61	66	10	52
+ paraquat	0.75	2/20				
Pyroxasulfone	0.09	2/20	96	100	25	50
+ flumioxazin	0.08	2/20				
Flumioxazin	0.08	2/20	89	93	13	53
Saflufenacil	0.0445	2/20	91	75	18	54
Saflufenacil	0.0223	2/20	86	97	40	45
+ saflufenacil	0.0223	4/16				
Thiencarbazone	0.00444	4/16	-	74	55	40
Flumetsulam	0.0665	4/16	-	79	75	25
Amicarbazone	0.219	4/16	-	80	38	41
Asulam	1.5	4/16	-	32	0	54
Carfentrazone	0.0156	4/16	-	13	0	57
LSD P=0.05			6.7	28.6	20.5	13.4

[a]Evaluated 3/20/15
[b]Evaluated 5/12/15
[c]Evaluated 6/12/15
[d]Harvested 6/19/15

Enhanced wild oat control with triallate added to pinoxaden. Samara L. Arthur, Don W. Morishita, and Kyle G. Frandsen. (Kimberly Research and Extension Center, University of Idaho, Kimberly, ID 83341). Preliminary observations indicate that triallate, a soil-active preplant wild oat herbicide may increase the effectiveness of pinoxaden for controlling wild oat and other grass weeds. A study was conducted at the University of Idaho Research and Extension Center near Kimberly, Idaho to determine the benefit of adding triallate to pinoxaden applied postemergence for wild oat control in irrigated spring wheat. 'Cabernet' was planted March 19, 2015 at 100 lb/A. Experimental design was a randomized complete block with four replications and individual plots were 8 by 30 ft. Soil type was a Portneuf silt loam (29% sand, 65% silt, and 6% clay) with a pH of 8.1, 1.6% organic matter, and CEC of 14-meq/100 g soil. Herbicides were applied using a CO_2-pressurized bicycle-wheel sprayer with 11001 flat fan nozzles calibrated to deliver 10 gpa at 25 psi and 3 mph. Common lambsquarters, Russian thistle, kochia, and wild oat were the major weeds present. Crop injury and weed control was evaluated visually 29 and 59 days after last application (DALA) on May 27 and June 26. Weed control was evaluated visually 59 DALA for all weed species with and additional wild oat evaluation 92 days DALA on June 26th and July 29th respectively. Grain was harvested July 29 with a small-plot combine

Table 1. Environmental conditions and weed species densities at application

Application date	3/19/2015	4/28/2015
Application timing	pre-germination	2 leaf
Air temperature (F)	57	62
Soil temperature (F)	-	48
Relative humidity (%)	26	37
Wind velocity (mph)	8	9
Cloud cover (%)	55	5
Time of day	-	1040
Weed species/ft^2		
kochia	< 1	5
lambsquarters, common	< 1	1
thistle, Russian	< 1	2
oat, wild	< 1	6

No crop injury was present for any treatments on either evaluation date (Table 2). At 59 DALA common lambsquarters control was poor for all treatments ranging from 11 to 65%. The treatments containing GWN-10444 or triallate showed a substantial increase in wild oat control when they were tank mixed with pinoxaden. Surprisingly the opposite was shown for broadleaf weeds with these treatments showing reduced weed control. This unexpected difference in control is likely due to the treatments having poor control of wild oat which consequently outcompeted other weeds increasing their control ratings for these treatments. Yields ranged from 50 to 94 bu/A, with the untreated control yielding 43 bu/A. Treatments with poor wild oat control had significantly reduced yields likely from competition between the wheat and wild oat. Competition between other weed species did not appear to reduce yields significantly. All treatments containing pinoxaden provided acceptable control of wild oat. However, GWN-10444 and triallate alone provided little to no control of wild oat resulting in competition for the crop and reduced yields. In this study, the addition of triallate to pinoxaden did not improve wild oat control since pinoxaden alone controlled 97 to 99% over both evaluation dates.

Table 2. Crop tolerance, broadleaf and wild oat control, test weight and yield in spring wheat near Kimberly, ID[1]

	Application		Crop injury		Weed control[1]						
					CHEAL	KCHSC	SASKR	AVEFA		Test	Grain
Treatment[3]	rate	date	5/27	6/26	6/26	6/26	6/26	6/26	7/29	weight	yield
	lb ai/A		%							lb/bu	bu/A
Untreated control			-	-	-	-	-	-		60 a	43 c
Triallate + pinoxaden	0.25 + 0.054	4/28	0 a	0 a	20 ab	19 c	29 abc	97 a	97 a	61a	78 abc
Triallate + pinoxaden	0.125 + 0.054		0 a	0 a	16 ab	25 c	50 ab	95 a	95 a	59 a	92 a
GWN-10444 + pinoxaden	0.125 qt/A+ 0.054		0 a	0 a	31 ab	31 c	26 abc	98 a	99 a	57 a	94 a
GWN-10444 + pinoxaden	0.25 qt/A + 0.054		0 a	0 a	14 ab	10 c	5 bc	95 a	97 a	60 a	86 ab
Triallate fb Pinoxaden	1 fb 0.054	3/19 4/28	0 a	0 a	14 ab	9 c	0 c	99 a	100 a	61 a	69 abc
Pinoxaden	0.054		0 a	0 a	26 ab	15 c	5 bc	99 a	97 a	59 a	85 ab
Triallate	0.25		0 a	0 a	46 ab	66 ab	48 ab	4 b	28 b	61 a	50 bc
Triallate	0.5		0 a	0 a	53 ab	80 a	90 a	7 b	33 b	62 a	58 abc
GWN-10444	0.125 qt/A		0 a	0 a	43 ab	41 bc	95 a	2 b	12 b	60 a	50 bc
GWN-10444	0.25 qt/A		0 a	0 a	65 a	70 ab	65 a	3 b	20 b	57 a	57 abc
Triallate	1	3/19	0 a	0 a	11 b	21 c	0 c	90 a	90 a	61 a	81 abc

[1]Means followed by the same letter are not significantly different (P=0.05, LSD)
[2]Weed species evaluated for control were: common lambsquarters (CHEAL), kochia (KCHSC), Russian thistle (SASKR) and wild oat (AVEFA)
[3]Triallate is sold as Far-Go and GWN-10444 is an experimental triallate formulation made by Gowan Chemical Company. Pinoxaden is sold as Axial XL.

Broadleaf and wild oat control with various tank mixtures in spring wheat. Kyle G. Frandsen, Don W. Morishita, and Samara L. Arthur. (Kimberly Research and Extension Center, University of Idaho, Kimberly, ID 83341). A study was conducted at the University of Idaho Research and Extension Center near Kimberly, Idaho to compare various herbicide pre-mixtures and tank mixtures for broadleaf and wild oat control in irrigated spring wheat. 'Cabernet' was planted March 19, 2015 at 100 lb/A. Experimental design was a randomized complete block with four replications and individual plots were 8 by 30 ft. Soil type was a Portneuf silt loam (29% sand, 65% silt, and 6% clay) with a pH of 8.1, 1.6% organic matter, and CEC of 14-meq/100 g soil. Herbicides were applied on May 13 with a CO_2-pressurized bicycle-wheel sprayer using 11001 flat fan nozzles calibrated to deliver 10 gpa at 25 psi and 3 mph. Environmental conditions at application were as follows: air temperature 58 F, soil temperature 59 F, relative humidity 24%, wind speed 4 mph, and 90% cloud cover. Common lambsquarters, Russian thistle, redroot pigweed, kochia, and wild oat, densities averaged 5, 7, and 3, 2, and 11 plants/ft^2, respectively. Application began at 12:45 pm on May 13. Crop injury was evaluated visually 14 and 44 days after application (DAA) on May 27 and June 26. Weed control was evaluated visually 44 DAA. Grain was harvested July 29 with a small-plot combine.

No differences in crop injury were observed for any of the treatments (Table). All herbicide treatments controlled common lambsquarters 80 to 99% with the exception of pinoxaden + clopyralid and pinoxaden + florasulam/ fluroxypyr which averaged 58 and 33% control, respectively. Wild oat control with all herbicide treatments ranged from 91 to 100%. Fenoxaprop/pyrasulfotole/bromoxynil + bromoxynil/MCPA had the lowest control at 91%. Kochia and redroot pigweed control ranged from 98 to 100% with all herbicide treatments. Russian thistle control ranged from 96 to 100% for all treatments except pinoxaden + clopyralid/fluroxypyr and pinoxaden + florasulam/fluroxypyr which averaged 57 and 73% control, respectively. Wheat yields for the herbicide treatments ranged from 88 to 96 bu/A. The untreated control yielded 47 bu/A. Overall, the yields in this study were reduced to some extent by high rodent (mostly vole) activity, although it is unknown exactly how much grain yields were affected by the rodents.

Table 2. Crop tolerance, broadleaf and wild oat control weed control and grain yield in spring wheat near Kimberly, ID[1]

Treatment[3]	rate	date	Crop injury 5/27	Crop injury 6/26	Weed control[2] CHEAL 6/26	KCHSC 6/26	SASKR 6/26	AMARE 6/26	AVEFA 6/26	Test weight	Grain yield
	lb ai/a		%							lb/bu	bu/A
Untreated Control			-	-	-	-	-	-	-	60 a	47 b
Fenoxaprop/pyrasulfotole/bromoxynil-1 + MCPA LVE	0.34 + 0.357 lb ae/a	5/13	0 a	3 a	91 a	100 a	100 a	99 a	98 a	60 a	93 a
Fenoxaprop/pyrasulfotole/bromoxynil-1 + bromoxynil/MCPA	0.34 + 0.375 lb ae/a	5/13	0 a	0 a	86 a	100 a	100 a	100 a	91 b	57 a	92 a
Fenoxaprop/pyrasulfotole/bromoxynil-1 + thifensulfuron/tribenuron	0.34 + 0.0187	5/13	0 a	1 a	82 a	100 a	100 a	99 a	98 a	61 a	92 a
Fenoxaprop/pyrasulfotole/bromoxynil-2 + fluroxypyr	0.294 + 0.0656 lb ae/a	5/13	0 a	0 a	99 a	100 a	100 a	99 a	99 a	60 a	95 a
Bromoxynil/pyrasulfotole + pinoxaden	0.217 + 0.054	5/13	0 a	0 a	92 a	100 a	100 a	98 a	100 a	59 a	89 a
Florasulam/fluroxypyr/pyroxsulam + NIS+ AMS	0.194 lb ae/a + 0.5 % v/v 1.52	5/13	3 a	3 a	80 a	100 a	98 a	98 a	100 a	60 a	91 a
Florasulam/fluroxypyr/pyroxsulam + 2,4-D LVE + AMS	0.194 lb ae/a + 0.238 lb ae/a 1.52	5/13	1 a	0 a	93 a	99 a	100 a	100 a	100 a	56 a	88 a
Clopyralid/fluroxypyr/pyroxsulam + NIS + AMS	0.2 lb ae/a + 0.5% v/v 1.52	5/13	0 a	1a	90 a	100 a	100 a	100 a	99 a	60 a	93 a
Clopyralid/fluroxypyr/pyroxsulam 2,4-D LVE + AMS	0.2 lb ae/a + 0.238 lb ae/a + 1.52	5/13	3 a	0 a	98 a	100 a	99 a	100 a	99 a	53 a	90 a
Clopyralid/fluroxypyr/pyroxsulam + MCPA LVE + AMS	0.2 lb ae/a + 0.357 lb ae/a + 1.52	5/13	3 a	1 a	93 a	99 a	96 a	100 a	100 a	58 a	90 a
Pinoxaden + Clopyralid/fluroxypyr	0.054 + 0.187 lb ae/a	5/13	0 a	3 a	58 ab	100 a	57 a	100 a	100a	53 a	92 a
Pinoxaden + florasulam/fluroxypyr	0.054 + 0.092 lb ae/a	5/13	0 a	1 a	33 b	100 a	73 a	99 a	100 a	57 a	96 a

[1]Means followed by same letter do not significantly differ (P=0.05, LSD).
[2]Weed species evaluated for control were: common lambsquarters (CHEAL), kochia (KCHSC), Russian thistle (SASKR), redroot pigweed (AMARE) and wild oat (AVEFA).
[3]Fenoxaprop/pyrasulfotole/bromoxynil-1 is a premix sold as Wolverine Advanced. MCPA LVE is a low volatility MCPA formulation. Bromoxynil/MCPA is Bromac. Thifensulfuron/tribenuron- is a 4:1 formulation sold as Affinity Tankmix. Fenoxaprop/pyrasulfotole/bromoxynil-2 is a premix sold as Wolverine. Fluroxypyr is Starane Ultra. Bromoxynil/pyrasulfotole is sold as Huskie. Pinoxaden is Axial XL. Florasulam/fluroxypyr/pyroxsulam is sold as Goldsky. NIS is a nonionic surfactant sold as Activator 90. AMS is ammoniums sulfate sold as BroncMax. 2,4-D LVE is a low volatility 2,4-D ester formulation. Clopyralid/fluroxypyr/pyroxsulam is a premix sold as PerfectMatch. Clopyralid/fluroxypyr is sold as Widematch. Florasulam/fluroxypyr is a premix sold as Starane Flex.

Enhancement of broadleaf weed control with triallate in spring wheat. Samara L. Arthur, Don W. Morishita, and Kyle G. Frandsen. (Kimberly Research and Extension Center, University of Idaho, Kimberly, ID 83341). A study was conducted at the University of Idaho Research and Extension Center near Kimberly, Idaho to determine crop safety and the effectiveness of adding a commercial and experimental triallate formulation to bromoxynil + pyrasulfotole to enhance broadleaf weed control in irrigated spring wheat. 'Cabernet' was planted March 19, 2015 at 100 lb/A. Experimental design was a randomized complete block with four replications and individual plots were 8 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, with a CEC of 14-meq/100 g soil. Herbicides were applied on May 13 with a CO_2-pressurized bicycle-wheel sprayer using 11001 flat fan nozzles calibrated to deliver 10 GPA at 25 PSI and 3 MPH. Environmental conditions at application were as follows: air temperature 58 F, soil temperature 59 F, relative humidity 34%, wind speed 8.5 MPH, with 98% cloud cover. Common lambsquarters (CHEAL) and redroot pigweed (AMARE) densities averaged 3 and 1 plants/ft^2, respectively. Application began at 0900. Crop injury and weed control were evaluated visually 14 and 33 days after application (DAA) on May 27 and June 15. Grain was harvested July 29 with a small-plot combine.

No crop injury was observed in any treatments (Table). All treatments containing bromoxynil/pyrasulfotole controlled all weed species 97 to 100% for these treatments on both evaluation dates. At 14 DAA the treatments containing triallate or the experimental triallate formulation GWN-10444 that were not tank mixed with bromoxynil/pyrasulfotole controlled common lambsquarters 18 to 44%. However, by 33 DAA CHEAL for the same treatments had increased to 82 to 87% control. This was due in part to the triallate, variable weed populations, and crop competition. Redroot pigweed control ranged from 93 to 99% on both evaluation dates for all herbicide treatments. Crop yield ranged from 87 to 97 bu/A for all treatments, with no statistical differences among treatments. The lack of yield differences compared to the untreated control is likely due to variable weed population and significant damage to plots caused by rodents. Treatments containing bromoxynil/pyrasulfotole had very good weed control that was consistent throughout the growing season. In this study, bromoxynil/pyrasulfotole alone controlled weeds as well or better than when it was tank mixed with triallate or GWN-10444. However, if higher weed pressures were present tank mixtures may have increased treatment efficacy. Results from this study also indicate that triallate or GWN-10444 do not adequately control common lambsquarters when applied alone. If the trial was repeated and increased weed pressure and consistent field conditions were present it is likely that differences in yield between treatments would be observed.

Table 2. Crop tolerance, weed control, test weight and yield in spring wheat near Kimberly, ID[1]

	Application		Crop injury		Weed control[2]				Test	Grain
					CHEAL		AMARE			
Treatment[3]	rate	date	5/27	6/15	5/27	6/15	5/27	6/15	weight	yield
	lb ai/A	5/13	----	----	----	%	----	----	lb/bu	bu/A
Untreated Control			-	-	-	-	-	-	60 a	95 a
Triallate + bromoxynil/pyrasulfotole	0.25 + 0.21	5/13	0 a	0 a	100 a	99 a	100 a	97 a	56 a	95 a
Triallate + bromoxynil/pyrasulfotole	0.5 + 0.21	5/13	0 a	0 a	100 a	96 a	100 a	98 a	59 a	97 a
GWN-10444 + bromoxynil/pyrasulfotole	0.125 qt/A + 0.21	5/13	0 a	0 a	100 a	98 a	100 a	99 a	62 a	97 a
GWN-10444 + bromoxynil/pyrasulfotole	0.25 qt/A+ 0.21	5/13	0 a	0 a	100 a	98 a	100 a	99 a	59 a	93 a
Bromoxynil/ pyrasulfotole	0.21	5/13	0 a	0 a	100 a	98 a	100 a	99 a	58 a	96 a
Triallate	0.25	5/13	0 a	0 a	29 bc	87 b	99 a	97 a	56 a	95 a
Triallate	0.5	5/13	0 a	0 a	44 b	82 b	99 a	96 a	61 a	92 a
GWN-10444	0.125 qt/A	5/13	0 a	0 a	17 c	85 b	96 b	93 a	58 a	91 a
GWN-10444	0.25 qt/A	5/13	0 a	0 a	18 c	82 b	95 b	98 a	53 a	87 a

[1]Means followed by the same letter do not significantly differ (P=0.05, LSD)

[2]Weed species evaluated for control were: common lambsquarters (CHEAL) and redroot pigweed (AMARE)

[3]Triallate is sold as Far-Go and GWN-10444 is an experimental triallate formulation made by Gowan Chemical Company. Bromoxynil/pyrasulfotole is sold as Huskie.

Italian ryegrass control with pyroxasulfone in wheat. Traci A. Rauch and Joan M. Campbell. (Crop and Weed Science Division, University of Idaho, Moscow, ID 83844-2339) Studies were established to evaluate wheat response and Italian ryegrass (LOLMU) control with 1) pyroxasulfone and 2) pyroxasulfone/carfentrazone near Moscow, ID in winter wheat and 3) pyroxasulfone and pyroxasulfone/carfentrazone near Pullman, WA in spring wheat. The plots were arranged in a randomized complete block design with four replications and included an untreated check. All herbicide treatments were applied using a CO_2 pressurized backpack sprayer calibrated to deliver 10 gpa at 32 psi and 3 mph (Table 1). At Moscow, both studies were oversprayed with glyphosate at 1.4 and 0.7 lb ae/A on October 2 and 12, 2014, respectively. Studies were oversprayed with thifensulfuron/tribenuron at 0.031 lb ai/A, pyrasulfotole/bromoxynil at 0.193 lb ai/A, and florasulam/fluroxypyr at 0.092 lb ai/A for broadleaf weed control and azoxystrobin/propiconazole at 0.131 lb ai/A for stripe rust control on May 12 at Moscow and May 26 at Pullman. Wheat injury and Italian ryegrass control were evaluated visually during the growing season. Grain was harvested with a small plot combine on July 30 at the pyroxasulfone/carfentrazone- Moscow study.

Table 1. Application and soil data.

Study - Location	Pyroxasulfone – Moscow			Pyroxasulfone/carfentrazone - Moscow			
Wheat variety – seeding date	Winter-‘WB235/WB238’ – 10/14/14						
Application date	10/14/14	10/24/14	4/27/15	10/2/14	10/16/14	4/27/15	5/7/15
Application timing	postplant pre	delayed pre	post	preplant	postplant pre	early post	late post
Wheat	no germ	1 inch radicle	2 tiller	--	no germ	2 tiller	3 tiller
Italian ryegrass	pre	pre	3 leaf	pre	pre	3 leaf	1 tiller
Air temperature (F)	59	49	67	58	63	67	56
Relative humidity (%)	66	94	44	58	53	44	65
Wind (mph, direction)	1, SE	4, SE	2, SW	4, NW	1, SE	2, SW	3, W
Cloud cover (%)	100	100	10	0	30	10	0
Soil moisture	dry	wet	adequate	dry	adequate	adequate	dry
Soil temperature at 2 inch (F)	50	38	55	45	50	55	44
Next rain occurred	10/15/14	10/29/14	5/13/15	10/11/14	10/23/14	5/13/15	5/13/15
pH	4.8						
OM (%)	4.4						
CEC (meq/100g)	15.6						
Texture	silt loam						

Study -Location	Pyroxasulfone and pyroxasulfone/carfentrazone - Pullman	
Wheat variety – seeding date	Spring-‘WB6121’ – 4/5/15	
Application date	4/10/15	5/8/15
Application timing	postplant pre	postemergence
Wheat	pre (germinated)	3 leaf
Italian ryegrass	pre	2 leaf
Air temperature (F)	56	57
Relative humidity (%)	74	55
Wind (mph, direction)	5, E	1, W
Cloud cover (%)	30	0
Soil moisture	adequate	dry
Soil temperature at 2 inch (F)	35	40
Next rain occurred	4/11/15	5/13/15
pH	4.8	
OM (%)	5.6	
CEC (meq/100g)	17.4	
Texture	silt loam	

At the pyroxasulfone Moscow site, all pyroxasulfone treatments applied preemergence (on the day of planting or 10 days after planting) controlled Italian ryegrass 88 to 99 and 86 to 98% on June 6 and 30, respectively (Table 2). Pyroxasulfone does not have much postemergence herbicidal activity on Italian ryegrass. Other postemergence treatments did not control Italian ryegrass likely due to herbicide resistant biotypes.

At the pyroxasulfone/carfentrazone Moscow site, all pyroxasulfone/carfentrazone treatments, except the lowest rate, controlled Italian ryegrass 90% or better (Table 3). Flufenacet/metribuzin and pinoxaden controlled Italian ryegrass 83 and 82%, respectively. Flucarbazone, mesosulfuron, and pyroxsulam did not control Italian ryegrass most likely due to resistant ALS biotypes but control was improved compared to the previous study due to an overall lower Italian ryegrass population. Winter wheat yield and test weight did not differ among treatments including the untreated check.

At the Pullman site, flucarbazone + thifensulfuron/tribenuron and pyroxsulam/fluroxypyr/florasulam treatments visibly injured spring wheat 10 to 21% on May 29 (Table 4). No treatment adequately controlled Italian ryegrass likely due to heavy robust population of Italian ryegrass. The pyroxasulfone/carfentrazone rate had a 52% increase in the amount of pyroxasulfone compared to the pyroxasulfone rate and therefore controlled Italian ryegrass better (60-71% vs. 30 to 59%).

Table 2. Italian ryegrass control with pyroxasulfone in winter wheat near Moscow, ID in 2015.

Treatment[1]	Rate	Application timing[2]	Italian ryegrass control[3] June 6	Italian ryegrass control[3] June 30
	lb ai/A		%	%
Pyroxasulfone	0.08	day of planting – no germ	88	87
Pyroxasulfone +	0.08	day of planting – no germ		
metribuzin	0.07	day of planting – no germ	88	86
Pyroxasulfone	0.16	day of planting – no germ	98	96
Pyroxasulfone	0.08	delayed pre – 1 inch radicle	88	90
Pyroxasulfone +	0.08	delayed pre – 1 inch radicle		
metribuzin	0.07	delayed pre – 1 inch radicle	91	91
Pyroxasulfone	0.16	delayed pre – 1 inch radicle	99	98
Flufenacet/metribuzin	0.425	delayed pre – 1 inch radicle	81	81
Pyroxasulfone +	0.08	2 tiller		
metribuzin +	0.07	2 tiller		
pinoxaden	0.054	2 tiller	52	40
Pyroxsulam	0.164	2 tiller	38	33
Pinoxaden	0.054	2 tiller	16	8
LSD (0.05)			22	29
Density (plants/ft^2)			12	

[1]A 90% nonionic surfactant at 0.5% v/v and urea ammonium nitrate at 5% v/v was applied with pyroxsulam.
[2]Application timing based on winter wheat growth stage.
[3]Only 3 replications analyzed due to a low Italian ryegrass population.

Table 3. Winter wheat response and Italian ryegrass control with pyroxasulfone/carfentrazone near Moscow, ID in 2015.

Treatment[1]	Rate	Application timing[2]	LOLMU control[3]	Wheat[3] Yield	Wheat[3] Test weight
	lb ai/A		%	bu/A	lb/bu
Pyroxasulfone/carfentrazone	0.102	preplant	90	88	60
Pyroxasulfone/carfentrazone	0.117	preplant	99	87	61
Pyroxasulfone/carfentrazone	0.14	preplant	93	89	60
Pyroxasulfone/carfentrazone	0.078	postplant pre –no germ	70	88	61
Pyroxasulfone/carfentrazone	0.102	postplant pre –no germ	96	88	61
Pyroxasulfone/carfentrazone	0.117	postplant pre –no germ	95	84	61
Pyroxasulfone/carfentrazone	0.14	postplant pre –no germ	99	86	60
Flufenacet/metribuzin	0.34	postplant pre –no germ	83	86	60
Pyroxasulfone/carfentrazone +	0.102	preplant			
flucarbazone	0.027	2 tiller	99	87	60
Pyroxasulfone/carfentrazone +	0.102	preplant			
mesosulfuron	0.0134	2 tiller	96	89	60
Pyroxasulfone/carfentrazone +	0.094	preplant			
pyroxsulam	0.016	3 tiller	90	87	59
Pyroxasulfone/carfentrazone +	0.102	preplant			
pinoxaden	0.054	3 tiller	96	86	60
Pyroxasulfone/carfentrazone +	0.078	preplant			
pyroxasulfone/carfentrazone +	0.062	3 tiller			
pyroxsulam	0.016	3 tiller	91	87	59
Flucarbazone	0.027	2 tiller	35	87	60
Mesosulfuron	0.0134	2 tiller	67	89	61
Pyroxsulam	0.0164	3 tiller	60	90	60
Pinoxaden	0.054	3 tiller	82	87	61
Untreated check			--	86	60
LSD (0.05)			20	NS	NS
Density (plants/ft^2)			3		

[1]A 90% nonionic surfactant at 0.25% v/v and ammonium sulfate at 1 lb ai/A was applied with flucarbazone, mesosulfuron, and pyroxsulam.

[2]Application timing based on winter wheat growth stage. Preplant = 12 day before planting. Postplant pre = Wheat planted but not emerged or germinated.

[3]LOLMU = Italian ryegrass. Evaluation date June 8, 2015. Only 3 replications analyzed due to a low Italian ryegrass population and poor wheat stand.

Table 4. Italian ryegrass control in spring wheat with pyroxasulfone and pyroxasulfone/carfentrazone alone near Pullman, WA in 2015.

Treatment[1]	Rate	Application timing[2]	Spring wheat injury[3]	Italian ryegrass control[4]
	lb ai/A		%	%
Pyroxasulfone/carfentrazone	0.109	preemergence	2	64
Pyroxasulfone	0.049	preemergence	0	59
Pyroxasulfone/carfentrazone +	0.109	preemergence		
flucarbazone +	0.027	2 leaf		
thifen/triben	0.0125	2 leaf	14	71
Pyroxasulfone +	0.049	preemergence		
flucarbazone +	0.027	2 leaf		
thifen/triben	0.0125	2 leaf	10	40
Pyroxasulfone/carfentrazone+	0.109	preemergence		
pinoxaden	0.054	2 leaf	0	66
Pyroxasulfone +	0.049	preemergence		
pinoxaden	0.054	2 leaf	0	50
Pyroxasulfone/carfentrazone +	0.109	preemergence		
Pyroxsulam/fluroxypyr/florasulam	0.105	2 leaf	10	60
Pyroxasulfone +	0.049	preemergence		
Pyroxsulam/fluroxypyr/florasulam	0.105	2 leaf	12	30
Flucarbazone +	0.027	2 leaf		
thifen/triben	0.0125	2 leaf	21	25
Pinoxaden	0.054	2 leaf	2	44
Pyroxsulam/fluroxypyr/florasulam	0.105	2 leaf	10	32
LSD (0.10)			7	20
Density (plants/ft^2)				20

[1]Thifen/triben is thifensulfuron/tribenuron at 1:1 ratio. Flucarbazone and pyroxsulam/florasulam/fluroxypyr treatments were applied with nonionic surfactant at 0.25% v/v and ammonium sulfate at 1 lb ai/A.

[2]Application timing based on Italian ryegrass growth stage. Preemergence = spring wheat and Italian ryegrass seed germinated but not emerged.

[3]Evaluation date May 29, 2015.

[4]Evaluation date June 23, 2015.

Broadleaf weed control in winter wheat with bicyclopyrone/bromoxynil. Traci A. Rauch and Joan M. Campbell. (Crop and Weed Science Division, University of Idaho, Moscow, ID 83844-2339) Two studies were established to evaluate winter wheat response and broadleaf weed control with bicyclopyrone/bromoxynil. The studies were arranged in a randomized complete block design with four replications and included an untreated check. All herbicide treatments were applied using a CO_2 pressurized backpack sprayer calibrated to deliver 10 gpa at 32 psi and 3 mph (Table 1). Studies at Culdesac and Genesee were oversprayed with azoxystrobin/propiconazole at 0.18 lb ai/A to control stripe rust on April 16 and May 4, 2015, respectively. Wheat response and weed control were evaluated visually at both locations. At Genesee, grain was harvested with a small plot combine on July 27.

Table 1. Application and soil data.

	Culdesac	Genesee
Application date	4/9/15	4/27/15
Winter wheat variety	ORCF 102/WB 1070CL blend	WB 1529
Growth stage		
Winter wheat	3 tiller	6 tiller
Prickly lettuce (LACSE)	--	2 leaf
Catchweed bedstraw (GALAP)	3 node	--
Mayweed chamomile (ANTCO)	4 leaf	--
Common lambsquarters (CHEAL)	--	cotyledon
Air temperature (F)	57	56
Relative humidity (%)	81	47
Wind (mph), direction	3, S	1, W
Next moisture occurred	5/13/15	5/13/15
Cloud cover (%)	50	50
Soil moisture	wet	good
Soil temperature at 2 inch (F)	45	55
pH	5.3	5.3
OM (%)	4.8	6.5
CEC (meq/100g)	19.7	21.7
Texture	silt loam	silt loam

At Culdesac, no treatment injured winter wheat (data not shown). All treatments controlled catchweed bedstraw 84 to 93% (Table 2). All rates of bicyclopyrone/bromoxynil controlled mayweed chamomile 85 to 94%, but mayweed chamomile was not controlled by pyrasulfotole/bromoxynil or fluroxypyr/florasulam (66 and 50%).

At Genesee, no treatment injured winter wheat (data not shown). All treatments, except fluroxypyr/florasulam, controlled common lambsquarters 94 to 99% (Table 2). Bicyclopyrone/bromoxynil treatments did not control prickly lettuce (42 to 74%). Pyrasulfotole/bromoxynil and fluroxypyr/florasulam controlled prickly lettuce 98%. Grain yield and test weight did not differ among treatments, including the untreated check.

Table 2. Broadleaf weed control and wheat response with bicyclopyrone/bromoxynil near Culdesac and Genesee, ID in 2015.

		Culdesac		Genesee			
		Weed control[2]		Weed control[2]		Wheat	
Treatment[1]	Rate	GALAP	ANTCO	LACSE	CHEAL	Yield	Test weight
	lb ai/A	%	%	%	%	bu/A	lb/bu
Bicyclopyrone/bromoxynil +	0.193						
sodium bicarbonate +	0.2% v/v						
COC	1% v/v	82	92	67	99	104	61.2
Bicyclopyrone/bromoxynil +	0.225						
sodium bicarbonate +	0.2% v/v						
COC	1% v/v	93	85	42	95	102	61.1
Bicyclopyrone/bromoxynil +	0.256						
sodium bicarbonate +	0.2% v/v						
COC	1% v/v	84	94	74	94	104	61.2
Pyrasulfotole/bromoxynil +	0.177						
AMS +	1						
NIS	0.25% v/v	89	66	98	98	106	61.4
Fluroxypyr/florasulam	0.093	89	52	98	60	103	61.6
Untreated check	--	--	--	--	--	101	61.0
LSD (0.05)		NS	10	31	25	NS	NS
Density (plants/ft^2)		0.5	5	5	2		

[1]COC is a crop oil concentrate. AMS is ammonium sulfate. NIS is nonionic surfactant. Sodium bicarbonate was used as a buffer.
[2]GALAP = catchweed bedstraw, ANTCO = mayweed chamomile, LACSE = prickly lettuce, and CHEAL = common lambsquarters.

Downy brome control in winter wheat. Traci A. Rauch and Joan M. Campbell. (Crop and Weed Science Division, University of Idaho, Moscow, ID 83844-2339) Two studies were established in 'Ovation' winter wheat to evaluate downy brome control with pyroxasulfone/carfentrazone, flucarbazone, and pyroxsulam combinations near Moscow, ID. The plots were arranged in a randomized complete block design with four replications and included an untreated check. All herbicide treatments were applied using a CO_2 pressurized backpack sprayer calibrated to deliver 10 gpa at 32 psi and 3 mph (Table 1). Both studies were oversprayed on April 16, 2015 with pyrasulfotole/bromoxynil at 0.19 lb ai/A and thifensulfuron/tribenuron at 0.025 lb ai/A for broadleaf weed control and fluxapyroxad/pyraclostrobin at 0.130 lb ai/A for stripe rust control. Crop injury and downy brome control were evaluated visually during the growing season.

Table 1. Application and soil data.

	Preemergence/postemergence study		Postemergence study	
Winter wheat seeding date		10/7/14		
Application date	10/9/14	4/10/15	4/10/15	4/21/15
Growth stage				
Winter wheat	pre	2 tiller	2 tiller	4 tiller
Downy brome (BROTE)	pre	3 tiller	3 tiller	4 tiller
Air temperature (F)	73	69	69	67
Relative humidity (%)	44	52	52	57
Wind (mph, direction)	1, W	2, S	2, S	2, E
Cloud cover (%)	20	80	80	50
Soil moisture	dry	adequate	adequate	dry
Soil temperature at 2 inch (F)	60	60	60	48
Next rain occurred	10/11/14	5/13/15	5/13/15	5/13/15
pH		4.6		
OM (%)		2.5		
CEC (meq/100g)		11.7		
Texture		loam		

In the preemergence/postemergence study, no treatment injured winter wheat (data not shown). Treatments containing pyroxasulfone/carfentrazone and pyroxsulam controlled downy brome 94 to 99% (Table 2).

In the postemergence study, no treatment injured winter wheat (data not shown). Average downy brome control was better at the 4 tiller than the 3 tiller application time (62 vs. 77%) (Table 3). Flucarbazone alone or combined with thifensulfuron/tribenuron at the early timing did not control downy brome (8 to 48%). Downy brome control increased as pyroxsulam rate increased. Pyroxsulam at 0.008 (combined with flucarbazone) and 0.016 lb ai/A controlled downy brome 90 to 98%.

Table 2. Downy brome control in winter wheat in the preemergence/postemergence study with pyroxasulfone/carfentrazone, flucarbazone, and pyroxsulam combinations near Moscow, ID in 2015.

Treatment[1]	Rate	Application timing[2]	Downy brome control[3]
	lb ai/A		%
Pyroxasulfone/carfentrazone	0.094	preemergence	94
Pyroxasulfone/carfentrazone +	0.094	preemergence	
pinoxaden	0.054	3 tiller	98
Pyroxasulfone/carfentrazone +	0.094	preemergence	
flucarbazone +	0.027	3 tiller	
ARY-0547-102	0.013	3 tiller	98
Pyroxasulfone/carfentrazone +	0.094	preemergence	
pyroxsulam	0.016	3 tiller	99
Flucarbazone	0.027	3 tiller	42
Flucarbazone +	0.027	3 tiller	
ARY-0547-102	0.013	3 tiller	60
Pyroxsulam	0.016	3 tiller	94
Pyroxsulam +	0.008	3 tiller	
flucarbazone	0.027	3 tiller	99
LSD (0.05)			14
Density (plants/ft^2)			5

[1]ARY-0547-102 is a 1:1 ratio of thifensulfuron and tribenuron. A non-ionic surfactant at 0.25% v/v and ammonium sulfate at 1 lb ai/A were applied with flucarbazone and pyroxsulam treatments.
[2]Application timing based on downy brome growth stage.
[3]Evaluation date June 11, 2015.

Table 3. Downy brome control in winter wheat in the postemergence study with flucarbazone and pyroxsulam combinations near Moscow, ID in 2015.

Treatment[1]	Rate	Application timing[2]	Downy brome control[3]
	lb ai/A		%
Flucarbazone	0.027	3 tiller	8
Flucarbazone +	0.027		
thifensulfuron/tribenuron	0.019	3 tiller	44
Flucarbazone +	0.027		
pyroxsulam	0.004	3 tiller	73
Flucarbazone +	0.027		
pyroxsulam	0.008	3 tiller	90
Pyroxsulam	0.016	3 tiller	95
Average downy brome control from 3 tiller timing = 62%			
Flucarbazone	0.027	4 tiller	48
Flucarbazone +	0.027		
thifensulfuron/tribenuron	0.019	4 tiller	69
Flucarbazone +	0.027		
pyroxsulam	0.004	4 tiller	72
Flucarbazone +	0.027		
pyroxsulam	0.008	4 tiller	98
Pyroxsulam	0.016	4 tiller	98
Average downy brome control from 4 tiller timing = 77%			
LSD (0.05)			20
Density (plants/ft^2)			3

[1]A non-ionic surfactant at 0.25% v/v and ammonium sulfate at 1 lb ai/A were applied with all treatments.
[2]Application timing based on downy brome growth stage.
[3]Evaluation date June 11, 2015.

Mayweed chamomile control in winter wheat with A19278A. Drew Lyon and Henry Wetzel. (Dept. of Crop & Soil Sciences, Washington State Univ., Pullman, WA 99164-6420) A field study was conducted on the WSU Cook Agronomy Farm near Pullman, WA to evaluate the efficacy of A19278A on mayweed chamomile (ANTCO) in winter wheat. On November 6, 2014, 'ARS Amber' winter wheat was planted using a Horsch air drill with 12-inch row spacing. Plots were 10 ft by 33 ft and arranged in a randomized complete block design with four replications. On April 23, 2015, herbicides were applied using a CO_2 backpack sprayer set to deliver 10 gpa at 2.3 mph and 40 psi (Table 1). Visual ratings of ANTCO control was assessed on May 14th and 26th, and June 10th. Wheat seed was harvested with a small plot combine on July 10th.

Table 1. Application and soil data.

Location	Cook Agronomy Farm, Pullman, Washington
Application date	April 23, 2015
Wheat growth stage	Jointing initiated
Mayweed chamomile	2.5 inch diam. and 1.0 inch tall
Mayweed chamomile density	37 plants per ft^2
Air temperature (F)	52
Relative humidity (%)	32
Wind (mph, direction)	5, SW
Cloud cover (%)	60
Soil temperature at 6 in (F)	52
pH	5.6
OM (%)	3.2
Texture	Silt loam

The winter of 2014-2015 was very mild, with average precipitation and minimal snow cover, which led to ANTCO germination beginning in February. No crop injury was observed in this experiment (data not shown). A19278A applied at 0.19, 0.22 or 0.25 lb ae/A provided significantly better ANTCO control than pyrasulfotole/bromoxynil applied at 0.18, 0.22 or 0.24 lb ae/A (Table 2). A significant rate response was not observed with either compound. The addition of MCPA ester seemed to boost the activity of pyrasulfotole/bromoxynil on ANTCO control, but did little to improve the control provided by A19278A. Initially, clopyralid/fluroxypyr provided little control of ANTCO, but by the final rating provided similar control to the various rates of A19278A and the MCPA ester + A19278A tank-mix. There were no significant differences among yield or test weight (data not shown) between herbicide treatments, including the nontreated check. The average yield and test weight were 43 bu/A (range 37 to 50 bu/A, CV = 21) and 47 lb/bu (range 45 to 49 lb/bu, CV = 4), respectively.

Table 2. Mayweed chamomile control in 'ARS Amber' winter wheat with herbicides near Pullman, Washington in 2015.

Treatment	Rate	Mayweed chamomile control (0 to 100)		
	lb ae/A	5/14	5/26	6/10
Nontreated check	--	--	--	--
A19278A[1]	0.19	77	80	89
A19278A[1]	0.22	76	80	84
A19278A[1]	0.25	80	82	89
A19278A[1] + MCPA ester	0.22 + 0.37	80	88	94
pyrasulfotole/bromoxynil[2]	0.18	52	51	42
pyrasulfotole/bromoxynil[2]	0.22	50	54	50
pyrasulfotole/bromoxynil[2]	0.24	45	49	44
pyrasulfotole/bromoxynil[2] + MCPA ester	0.24 + 0.37	66	72	70
clopyralid/fluroxypyr	0.19	40	79	95
LSD (0.05)		12	14	20

[1]Treatments that contained A19278A were applied with A20916A at 0.2% v/v and a crop oil concentrate (Agri-Dex) at 1.0% v/v.

[2]Treatments that contained pyrasulfotole/bromoxynil were applied with ammonium sulfate at 1.0 lb/A and a 90% nonionic surfactant (R-11) at 0.25% v/v.

Rattail fescue control in winter wheat. Traci A. Rauch and Joan M. Campbell. (Crop and Weed Science Division, University of Idaho, Moscow, ID 83844-2339) A study was established in a 'Westbred 523/528' winter wheat blend to evaluate rattail fescue control with pyroxasulfone containing herbicides alone or in combination near Moscow, ID. The plots were arranged in a randomized complete block design with four replications and included an untreated check. All herbicide treatments were applied using a CO_2 pressurized backpack sprayer calibrated to deliver 10 gpa at 32 psi and 3 mph (Table 1). The site was oversprayed with pyrasulfotole/bromoxynil at 0.19 lb ai/A, florasulam/fluroxypyr at 0.092 lb ae/A and thifensulfuron/tribenuron at 0.031 lb ai/A for broadleaf weed control and with azoxystrobin/propiconazole at 0.24 lb ai/A for stripe rust control on May 4, 2015. Crop injury and rattail fescue control were evaluated visually during the growing season. Grain was harvested with a small plot combine on July 31, 2015.

Table 1. Application and soil data.

Winter wheat seeding date	9/30/14	
Application date	10/2/14	4/28/15
Growth stage		
Winter wheat	pre	5 tiller
Rattail fescue	pre	2 tiller
Air temperature (F)	62	76
Relative humidity (%)	44	41
Wind (mph, direction)	2, SW	1, NW
Cloud cover (%)	0	10
Next rain occurred	10/19/14	5/13/15
Soil moisture	dry	good
Soil temperature at 2 inch (F)	50	54
pH	5.2	
OM (%)	4.3	
CEC (meq/100g)	18.1	
Texture	silt loam	

All preemergence treatments injured winter wheat 2 to 11% on April 28 (Table 2). No treatment visibly injured winter wheat on June 16 (data not shown). All treatments containing flufenacet/metribuzin or pyroxasulfone controlled rattail fescue 82 to 98%. Flucarbazone was the best postemergence herbicide with 70% rattail fescue control. Grain yield was greater than the untreated check for all herbicide treatments expect pyroxsulam alone. Winter wheat test weight was less than the untreated check for flufenacet/metribuzin combined with flucarbazone or pyroxsulam and pyroxasulfone/fluthiacet plus flucarbazone.

Table 2. Rattail fescue control in winter wheat with pyroxasulfone combinations near Moscow, ID in 2015.

Treatment[1]	Rate	Application timing[2]	Rattail fescue control[3]	Winter wheat Injury[4]	Winter wheat Yield	Winter wheat Test weight
	lb ai/A		%	%	bu/A	lb/bu
Flufenacet/metribuzin	0.425	pre	91	8	101	56.1
Pyroxasulfone	0.08	pre	82	4	101	55.9
Pyroxasulfone/fluthiacet	0.091	pre	87	5	99	56.1
Flucarbazone	0.027	2 tiller	70	--	88	56.4
Pyroxsulam	0.016	2 tiller	45	--	82	55.9
Sulfosulfuron	0.031	2 tiller	38	--	88	56.3
Flufenacet/metribuzin +	0.425	pre				
flucarbazone	0.027	2 tiller	93	9	98	55.0
Flufenacet/metribuzin +	0.425	pre				
pyroxsulam	0.016	2 tiller	95	2	99	55.0
Flufenacet/metribuzin +	0.425	pre				
sulfosulfuron	0.031	2 tiller	90	10	101	56.0
Pyroxasulfone +	0.08	pre				
flucarbazone	0.027	2 tiller	94	6	103	55.6
Pyroxasulfone +	0.08	pre				
pyroxsulam	0.016	2 tiller	94	8	103	55.2
Pyroxasulfone +	0.08	pre				
sulfosulfuron	0.031	2 tiller	98	10	104	55.4
Pyroxasulfone/fluthiacet +	0.091	pre				
flucarbazone	0.027	2 tiller	98	11	106	55.0
Pyroxasulfone/fluthiacet +	0.091	pre				
pyroxsulam	0.016	2 tiller	97	9	100	55.4
Pyroxasulfone/fluthiacet +	0.091	pre				
sulfosulfuron	0.031	2 tiller	98	4	104	56.0
Untreated check	--	--	--	--	75	56.2
LSD (0.05)			21	NS	11	1
Density (plants/ft^2)			15			

[1]All postemergence treatments were applied with a non-ionic surfactant at 0.5% v/v and ammonium sulfate at 1.5 lb ai/A.
[2]Application timing based on rattail fescue growth stage.
[3]Evaluation date June 16, 2015.
[4]Postemergence alone treatments were control plots on the April 28, 2015 evaluation date.

Italian ryegrass control in winter wheat using pyroxasulfone/carfentrazone. Drew Lyon and Henry Wetzel. (Dept. of Crop & Soil Sciences, Washington State Univ., Pullman, WA 99164-6420) A field study was conducted on the WSU Cook Agronomy Farm near Pullman, WA to generate weed control and crop response data for winter wheat treated with the pyroxasulfone/carfentrazone herbicide premixture at various application times. 'ARS Amber' winter wheat was seeded on October 27, 2014 at a rate of 62 lb/A using a Monosem precision air seed drill with 10-inch row spacing at a depth of 1.5 inches. Soils were dry and hard at planting which resulted in a range of seeding depth from 0.5 to 1.5 inches. Plots were 10 ft by 33 ft and arranged in a randomized complete block design with four replications. All herbicide treatments were applied using a CO_2 backpack sprayer set to deliver 10 gpa at 2.3 mph and 40 psi (Table 1). A visual rating of crop injury was taken on May 1st and Italian ryegrass (LOLMU) control was assessed on May 1st and June 10th. Wheat seed was harvested with a small plot combine on July 24th.

Table 1. Application and soil data.

Location	Cook Agronomy Farm, Pullman, Washington		
Application date	October 24, 2014	October 28, 2014	March 20, 2015
Wheat growth stage	n/a	Beginning of imbibition	Two tiller
Italian ryegrass growth stage	n/a	n/a	Two leaf
Air temperature (F)	53	45	60
Relative humidity (%)	66	78	52
Wind (mph, direction)	8, SE	2, SE	5, SE
Cloud cover (%)	100	100	100
Soil temperature at 6 in (F)	49	48	46
pH		5.1	
OM (%)		4.7	
Texture		Silt loam	

Extremely cold temperatures the week of November 9, 2014 affected seedling development of LOLMU as well as further fall germination. The majority of the LOLMU germinated from late-winter to early-spring, as a result of very mild winter conditions with average precipitation and minimal snow cover. Crop injury observed was primarily plant stunting. While there were no significant differences (Table 2) some treatments had greater injury than others. The injury might have been due to inconsistent planting depth. On the final rating date (6/10/15), all treatments except pyroxasulfone/carfentrazone, pyroxsulam and flucarbazone applied at the rates of 0.0781, 0.0164 and 0.027 lb ai/A, respectively, provided good control of LOLMU. There were no significant differences among yield or test weight (data not shown) between herbicide treatments, including the nontreated check. The average yield and test weight were 68 bu/A (range 59 to 78, CV = 19) and 47 lb/bu (range 44 to 49, CV = 8), respectively.

Table 2. Italian ryegrass control in 'ARS Amber' winter wheat with pyroxasulfone/carfentrazone near Pullman, Washington in 2015.

	Application		Crop Injury	Italian ryegrass control	
Treatment[1]	rate	date	5/1/15	5/1/15	6/10/15
	lb ai/A		(0 to 100)	(0 to 100)	
Nontreated check			--	--	--
pyroxasulfone/carfentrazone[2]	0.0781	10/24/14	4	67	61
pyroxasulfone/carfentrazone	0.1	10/24/14	2	79	75
pyroxasulfone/carfentrazone	0.117	10/24/14	4	90	86
pyroxasulfone/carfentrazone	0.141	10/24/14	11	91	75
pyroxasulfone/carfentrazone	0.117	10/28/14	0	85	75
pyroxasulfone/carfentrazone	0.141	10/28/14	5	84	76
pyroxasulfone/carfentrazone fb	0.1	10/24/14	6	91	85
pyroxsulam	0.0164	3/20/15			
pyroxasulfone/carfentrazone fb	0.1	10/24/14	11	89	76
flucarbazone	0.027	3/20/15			
pyroxsulam	0.0164	3/20/15	6	51	32
flucarbazone	0.027	3/20/15	1	22	25
pyroxasulfone/carfentrazone fb	0.0781	10/24/14	11	96	91
pyroxasulfone/carfentrazone +	0.0625	3/20/15			
pyroxsulam	0.0114	3/20/15			
LSD (0.05)			ns	17	16

[1]Treatments that contained pyroxsulam or flucarbazone were applied with 90% nonionic surfactant (R-11) at 0.25% v/v.
[2]Pyroxasulfone/carfentrazone is the commercial herbicide premixture of Anthem Flex.

Effect of planting date and application timing of flufenacet-metribuzin and pyroxasulfone on 'Bobtail' winter wheat yield and Italian ryegrass control. Kyle C. Roerig, Andrew G. Hulting, Daniel W. Curtis, and Carol A. Mallory-Smith. (Department of Crop and Soil Science, Oregon State University, Corvallis, OR 97331) Pyroxasulfone is an inhibitor of very-long-chain fatty acid synthesis and is used for control of grass and broadleaf weeds in winter wheat and other crops. Pyroxasulfone is registered for use in wheat in two products by two manufacturers. The first product is pyroxasulfone alone and the second is pyroxasulfone premixed with carfentrazone. In Western Oregon, pyroxasulfone is an important herbicide in wheat production because it is the only herbicide that will control all populations of multiple resistant Italian ryegrass tested to date. In Washington, Oregon, Idaho and Montana a range of rates from 0.037 to 0.133 lb ai/A and timings including preplant, preemergence, delayed preemergence, early postemergence, postemergence and sequential applications are permitted by the labels. This trial was conducted with objective of evaluating crop safety and control of two Italian ryegrass populations at the maximum labeled rate of each timing of pyroxasulfone, pyroxasulfone-carfentrazone and flufenacet-metribuzin in on-time and late planted wheat. 'Bobtail' winter wheat was chosen for this trial due to previous reports of sensitivity to flufenacet-metribuzin.

'Bobtail' winter wheat was planted October 13 (on-time) and November 12, 2014 (late). Both were planted at a rate of 130 lb/A. Immediately following planting of the on-time wheat, two strips of Italian ryegrass were planted over the top of the wheat using a three foot wide drop spreader. The first strip was from a population with no known herbicide resistance (susceptible) and the second was from a population resistant to multiple herbicide modes of action (resistant). Growth and development of the Italian ryegrass closely followed that of the winter wheat. The strip containing the resistant Italian ryegrass was mowed prior to anthesis to prevent the spread of pollen or production of seed from this population. Herbicide applications were made as indicated in Table 1.

Table 1. Timing of wheat planting and herbicide applications

Wheat and Italian ryegrass stage	On-time planting[1]	Late planting[2]
	------------------------date------------------------	
Preplant	13-Oct	NA
Preemergence	14-Oct	14-Nov
Delayed-preemergence[3]	20-Oct	26-Nov
Spike to 1 leaf	24-Oct	22-Dec
1-2 tillers	16-Dec	NA

[1]Planted 10/13/2014

[2]Planted 11/12/2014

[3]Delayed-preemergence is defined as "when 80% of germinated wheat seeds have a shoot at least 1/2-inch long until wheat spiking." (Anonymous 2015)

All applications of pyroxasulfone and pyroxasulfone-carfentrazone at both planting dates had adequate crop safety (Tables 2 and 3). Flufenacet-metribuzin applied preemergence and delayed-preemergence reduced wheat yield under the wet, cool conditions in the late planting (Table 3). The flufenacet-metribuzin label allows application following germination up to two leaf wheat in Washington, Oregon and Idaho. The preemergent application fell outside of the allowed application window and injury confirms the need for this restriction. However, the delayed preemergence application was within the allowed application window. This corroborates previous studies (Roerig et al. 2014) that documented sensitivity of 'Bobtail' wheat to flufenacet-metribuzin. Additional work is being conducted to understand the sensitivity of 'Bobtail' wheat to flufenacet-metribuzin, including a study to assess the effect of seeding rate and plant population on flufenacet-metribuzin injury in 'Bobtail' wheat.

All rates and timings of each herbicide controlled 100% of the susceptible Italian ryegrass population (Table 2). Flufenacet-metribuzin did not control resistant Italian ryegrass at any timing. Pyroxasulfone containing products provided 99% or greater control of resistant Italian ryegrass preplant, preemergence, delayed-preemergence or spike to 1 leaf. When pyroxasulfone and pyroxasulfone-carfentrazone applications were made at the 1-2 tiller stage tankmixed with pyroxsulam control was 55 and 45%, respectively. These data indicate that pyroxasulfone controls Italian ryegrass at the one leaf stage or earlier, but will not control larger plants. Postemergent applications require an effective tank mix partner to control emerged Italian ryegrass.

Table 2. Control of two populations of Italian ryegrass and yield of 'Bobtail' wheat planted October 13, 2014.

			Italian ryegrass		Wheat	
			susceptible	resistant		
	Rate	Appl	control[1]		injury[1]	yield[2]
	lb ai/a		-----------------------	-%-	----------------------	bu/A
Untreated			0	0	0	127
Flufenacet-metribuzin	0.425	pre	100	40	5	129
Flufenacet-metribuzin	0.425	delayed-pre	100	18	8	128
Pyroxasulfone	0.093	pre	100	100	0	139
Pyroxasulfone	0.0664	delayed-pre	100	100	0	137
Pyroxasulfone	0.0664	delayed-pre	100	100	0	139
+ pyroxasulfone	0.0664	spike-1 leaf				
Pyroxasulfone	0.106	spike-1 leaf	100	100	0	136
Pyroxasulfone-carfentrazone	0.14	pre plant	100	99	0	138
Pyroxasulfone-carfentrazone	0.14	pre plant	100	100	0	133
+ pyroxasulfone-carfentrazone	0.07	spike-1 leaf				
Pyroxasulfone-carfentrazone	0.14	delayed-pre	100	100	0	135
Pyroxasulfone-carfentrazone	0.14	spike-1 leaf	100	100	0	137
Pyroxasulfone-carfentrazone	0.07	delayed-pre	100	100	0	134
+ pyroxasulfone-carfentrazone	0.07	spike-1 leaf				
Flufenacet-metribuzin	0.425	1-2 tillers	100	18	0	138
+ pyroxsulam	0.0164	1-2 tillers				
Pyroxasulfone	0.106	1-2 tillers	100	55	0	135
+ pyroxsulam	0.0164	1-2 tillers				
Pyroxasulfone-carfentrazone	0.14	1-2 tillers	100	43	0	142
+ pyroxsulam	0.0164	1-2 tillers				
LSD P=.05			0	18	4	7

[1]Evaluated 5/8/15
[2]Harvested 7/21/15

Table 3.Yield of 'Bobtail' wheat planted November 11, 2014

			Wheat	
	Rate	Appl	injury[1]	yield[2]
	lb ai/a		%	bu/A
Untreated			0	124
Flufenacet-metribuzin	0.425	pre	35	106
Pyroxasulfone	0.093	pre	3	120
Flufenacet-metribuzin	0.425	delayed-pre	10	118
Pyroxasulfone	0.0664	delayed-pre	5	120
Pyroxasulfone	0.0664	delayed-pre	5	122
+ pyroxasulfone	0.0664	spike-1 leaf		
Pyroxasulfone	0.106	spike-1 leaf	5	123
Pyroxasulfone-carfentrazone	0.14	delayed-pre	3	119
Pyroxasulfone-carfentrazone	0.14	spike-1 leaf	5	120
Pyroxasulfone-carfentrazone	0.07	delayed-pre	8	119
+ pyroxasulfone-carfentrazone	0.07	spike-1 leaf		
LSD P=.05			8	4

[1]Evaluated 5/12/15
[2]Harvested 7/21/15

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Italian ryegrass control with pyroxasulfone combinations in winter wheat. Traci A. Rauch and Joan M. Campbell. (Crop and Weed Science Division, University of Idaho, Moscow, ID 83844-2339) A study was established near Moscow, ID to evaluate winter wheat response and Italian ryegrass (LOLMU) control with preemergence pyroxasulfone alone and plus fluthiacet or flumioxazin combined with postemergence mesosulfuron or pyroxsulam. Flufenacet/metribuzin was included as preemergence Italian ryegrass control standard. The plots were arranged in a randomized complete block design with four replications and included an untreated check. All herbicide treatments were applied using a CO_2 pressurized backpack sprayer calibrated to deliver 10 gpa at 32 psi and 3 mph (Table 1). The study was oversprayed with thifensulfuron/tribenuron at 0.031 lb ai/A, pyrasulfotole/bromoxynil at 0.193 lb ai/A, and florasulam/fluroxypyr at 0.092 lb ai/A for broadleaf weed control and azoxystrobin/propiconazole at 0.131 lb ai/A for stripe rust control on May 4. Winter wheat injury and Italian ryegrass control were evaluated visually during the growing season. Grain was harvested with a small plot combine on July 29, 2015.

Table 1. Application and soil data.

Wheat variety – seeding date	Bobtail – 10/3/14	
Application date	10/6/14	4/19/15
Growth stage		
Winter wheat	pre	4 tiller
Italian ryegrass (LOLMU)	pre	3 leaf
Air temperature (F)	74	66
Relative humidity (%)	52	39
Wind (mph, direction)	1, NE	1, S
Cloud cover (%)	0	0
Soil moisture	good	good
Soil temperature at 2 inch (F)	55	45
Next rain occurred	10/11/14	5/13/15
Soil pH	5.1	
OM (%)	4.2	
CEC (meq/100g)	18.6	
Texture	silt loam	

Visible winter wheat injury ranged from 0 to 13% and did not differ among treatments (Table 2). All treatments controlled Italian ryegrass 86% or greater except pyroxasulfone alone (82%), flufenacet/metribuzin plus pyroxsulam (76%), and pyroxsulam alone (25%). Pyroxsulam did not control Italian ryegrass most likely due to resistant biotypes. Grain yield was greater than the untreated check with all treatments, except pyroxsulam alone, pyroxasulfone/flumioxazin + mesosulfuron, and flufenacet/metribuzin combined with mesosulfuron or pyroxsulam. Winter wheat test weight did not differ among treatments including the untreated check and ranged from 55 to 56 lb/bu.

Table 2. Winter wheat response and Italian ryegrass control with pyroxasulfone combinations near Moscow, ID in 2015.

Treatment[1]	Rate	Application timing[2]	Wheat Injury[3]	Wheat Yield	Wheat Test weight	LOLMU control[3]
	lb ai/A		%	bu/A	lb/bu	%
Flufenacet/metribuzin	0.34	pre	0	126	56	86
Pyroxasulfone	0.08	pre	2	124	56	82
Pyroxasulfone/fluthiacet	0.091	pre	0	125	56	90
Pyroxasulfone/flumioxazin	0.143	pre	12	123	56	99
Mesosulfuron	0.013	post	7	122	56	91
Pyroxsulam	0.016	post	0	111	56	25
Flufenacet/metribuzin +	0.34	pre				
mesosulfuron	0.013	post	3	118	55	91
Flufenacet/metribuzin +	0.34	pre				
pyroxsulam	0.016	post	7	117	55	76
Pyroxasulfone +	0.08	pre				
mesosulfuron	0.013	post	13	122	56	96
Pyroxasulfone +	0.34	pre				
pyroxsulam	0.016	post	7	123	56	92
Pyroxasulfone/fluthiacet +	0.091	pre				
mesosulfuron	0.013	post	3	123	56	97
Pyroxasulfone/fluthiacet +	0.091	pre				
pyroxsulam	0.016	post	5	121	56	95
Pyroxasulfone/flumioxazin +	0.143	pre				
mesosulfuron	0.013	post	8	118	56	97
Pyroxasulfone/flumioxazin +	0.143	pre				
pyroxsulam	0.016	post	13	120	55	92
Untreated check			--	114	56	--
LSD (0.05)			NS	6	NS	14
Density (plants/ft^2)			-	-	-	5

[1]Ammonium sulfate at 5% v/v and a 90% nonionic surfactant at 0.5% v/v were applied with mesosulfuron and pyroxsulam.

[2]Application timing was based on winter wheat growth stage. Pre=Postplant preemergence (seed not germinated). Post= winter wheat 4 tiller and Italian ryegrass 3 leaf.

[3]Evaluation date was June 9, 2015.

Evaluation of herbicides and mowing to control smooth scouringrush in winter wheat. Drew Lyon, Derek Appel and Henry Wetzel. (Dept. of Crop & Soil Sciences, Washington State Univ., Pullman, WA 99164-6420) A field study was established on the ground of the Spokane Hutterian Brethren near Reardan, WA to evaluate the effects of mowing and herbicides on the control of smooth scouringrush in a direct-seed system. This study followed a year of chemical fallow. Plots were 8 ft by 33 ft, and arranged in a randomized complete block design with four replications. Four of the eight blocks, each block containing a nontreated check and 10 herbicide treatments, were rotary mowed July 24, 2014. Herbicides were applied on July 25th using a CO_2 backpack sprayer set to deliver 15 gpa at 30 psi and 3.5 mph (Table 1). On September 10th, Whetstone hard red winter wheat was seeded with a Bourgault 3710 disc drill on a 10-inch row spacing at the rate of 60 lb/A. Smooth scouringrush injury was rated visually on August 20th. Smooth scouringrush stem counts were taken by placing a meter stick between two wheat rows and counting all the stems between and within the rows on May 15 and August 10, 2015. This was done at two locations within each plot and values presented are an average. Wheat seed was harvested with a small plot combine on July 21, 2015.

Table 1. Application and soil data.

Location	Spokane Hutterian Brethren near Reardan, Washington
Application date	July 25, 2014
Application occurred on	chemical fallow ground
Smooth scouringrush at time of application	12 to 20 inches in height, 15 stems per square foot
Air temperature (F)	70
Relative humidity (%)	36
Wind (mph, direction)	6, SW
Cloud cover (%)	10
Soil temperature at 2 in (F)	60
pH	4.9
OM (%)	3.3
Texture	loam

Visual injury on the smooth scouringrush was assessed on August 20th, 26 days after treatment. Plants treated with clopyralid/MCPA ester, chlorsulfuron + MCPA ester and halosulfuron + MCPA ester exhibited the most injury (Table 2). Mowing in combination with the various herbicide treatments did not have a significant effect on smooth scouringrush control, thus treatment means are averaged over the mowing factor. MCPA ester, clopyralid/MCPA ester, fluroxypyr and glyphosate + glufosinate did not significantly reduce smooth scouringrush stem counts compared to the nontreated check when evaluated on May 15, 2015. The remaining treatments did have a significant effect on reducing smooth scouringrush stems in the spring when compared to the nontreated check on May 15th. Chlorsulfuron + MCPA ester was the most effective treatment in reducing smooth scouringrush stems in the spring and on the second evaluation date (August 10th), it was the only treatment that was significantly different from the nontreated check. There were no significant differences among yield or test weight (data not shown) between herbicide treatments, including the nontreated check. The average yield and test weight were 72 bu/A (range 67 to 76 bu/A, CV = 11) and 55 lb/bu (range 54 to 55 lb/bu, CV = 4), respectively.

Table 2. Smooth scouringrush injury and incidence in response to herbicide treatments near Reardan, Washington in 2014-2015.

Treatment[1]	Rate	Injury 8/20/14	Stem counts per linear meter 5/15/15	Stem counts per linear meter 8/10/15
	lb ae/A	%		
Nontreated check	--	--	38	38
2,4-D	1.0	33	22	34
MCPA ester	1.0	55	32	36
clopyralid/MCPA ester	0.81	70	30	42
chlorsulfuron + MCPA ester	0.02[2] + 1.0	79	1	2
halosulfuron + MCPA ester	0.06[2] + 1.0	67	23	28
glyphosate[3]	1.12	17	15	29
glyphosate + saflufenacil[3,4]	1.12 + 0.09	10	21	29
fluroxypyr	0.24	29	28	36
quinclorac[3,5]	0.25[2]	19	18	30
glyphosate + glufosinate[3]	1.12 + 0.55[2]	46	32	32
LSD (0.05)		10	13	15

[1]All treatments, except glyphosate plus saflufenacil and quinclorac, were applied with 90% nonionic surfactant (R-11) at 0.33% v/v.
[2]Chlorsulfuron, halosulfuron, quinclorac and glufosinate rates are expressed as lb ai/A.
[3]These treatments were applied with ammonium sulfate at 50 oz/A.
[4]This treatment was applied with a 99% crop oil concentrate (Agri-Dex) at 1.0% v/v.
[5]This treatment was applied with a 98.1% modified vegetable oil (Kalo) at 32 fl oz/A.

Winter wheat response to pyroxasulfone with and without irrigation. Traci A. Rauch and Joan M. Campbell. (Crop and Weed Science Division, University of Idaho, Moscow, ID 83844-2339) Two studies were established near Moscow, ID to evaluate winter wheat response to pyroxasulfone with and without supplemental sprinkler irrigation. In the irrigated study, the experimental design was a split block with four replications. Main plots were irrigation rate (30 by 30 ft) and subplots were pyroxasulfone rate (10 by 30 ft). 'Ovation' winter wheat was planted in the morning on October 3, 2014. Immediately after seeding, pyroxasulfone was applied at 0, 0.106 or 0.212 lb ai/A followed by sprinkler irrigation at 0, 1/3, 2/3, or 1 inch. No additional irrigation was used. In the non-irrigated study, plots were arranged in a randomized complete block design with four replications and included an untreated check. In both studies, herbicide treatments were applied using a handheld boom CO_2 pressurized backpack sprayer calibrated to deliver 10 gpa at 32 psi and 3 mph (Table 1). Both studies were oversprayed on April 16, 2015 with pyrasulfotole/bromoxynil at 0.19 lb ai/A and thifensulfuron/tribenuron at 0.025 lb ai/A for broadleaf weed control and fluxapyroxad/pyraclostrobin at 0.130 lb ai/A for stripe rust and eyespot control. Crop injury was evaluated during the growing season. Grain was harvested with a small plot combine on July 25 at the irrigated study and August 4, 2015 at the non-irrigated study.

Table 1. Application and soil data.

	Irrigated	Non-irrigated		
Seeding date	10/3/14		10/14/14	
Application date	10/3/14	10/9/14	10/14/14	10/20/14
Application timing	0 DAP	5 DBP	0 DAP	6 DAP
Air temperature (F)	64	74	57	58
Relative humidity (%)	43	46	67	63
Wind (mph, direction)	2, SE	2, W	3, W	2, E
Cloud cover (%)	10	20	100	5
Soil moisture	adequate	dry	adequate	adequate
Soil temperature at 2 inch (F)	53	60	43	40
Next moisture occurred	10/3/15 – irrigated	10/11/14	10/15/14	10/23/14
pH	5.3		4.6	
OM (%)	3.4		4.7	
CEC (meq/100g)	17.3		17.4	
Texture	silt loam		silt loam	

In the irrigated study, winter wheat injury increased with increasing irrigation rate at the November and March evaluation dates (Table 2). Injury was due to highly saturated soil that delayed growth. In April, winter wheat injury was greater at the high pyroxasulfone rate (3 vs. 2%) (Table 3). Irrigation and pyroxasulfone rate did not affect winter wheat yield and test weight (Table 2 and 3).

In the non-irrigated study, winter wheat injury ranged from 4 to 10% at the March evaluation date but did not differ among treatments (Table 4). Crop variability was most likely due to an uneven stand after winter and before active spring growth resumed. No visual winter wheat injury was present at any other evaluation time. Grain yield and test weight did not differ among treatments, including the untreated check.

Table 2. Winter wheat response averaged over herbicide treatment near Moscow, Idaho in 2014 and 2015.

	Injury[1]							Test
Irrigation rate	10/16	11/5	3/27	4/16	5/5	6/9	Yield[1]	weight[1]
	%	%	%	%	%	%	bu/A	lb/bu
0 inch	0a	0b	1b	0a	0a	0a	138a	61.2a
1/3 inch	3a	0b	2b	0a	0a	0a	138a	60.3a
2/3 inch	2a	0b	4ab	2a	0a	0a	128a	60.9a
1 inch	7a	2a	11a	5a	0a	0a	131a	60.0a

[1]Means followed by the same letter within a column do not differ significantly at $P \leq 0.05$.

Table 3. Winter wheat response averaged over irrigation rate near Moscow, Idaho in 2014 and 2015.

Treatment	Rate	Injury[1]						Yield[1]	Test weight[1]
		10/16	11/5	3/27	4/16	5/5	6/9		
	lb ai/A	%	%	%	%	%	%	bu/A	lb/bu
Pyroxasulfone	0.106	5a	1a	6a	2b	0a	0a	137a	60.4a
Pyroxasulfone	0.212	5a	1a	7a	3a	0a	0a	132a	60.8a
Untreated check	--	--	--	--	--	--	--	133a	60.6a

[1]Means followed by the same letter within a columndo not differ significantly at P≤0.05.

Table 4. Winter wheat response to pyroxasulfone and flufenacet/metribuzin near Moscow, Idaho in 2014 and 2015.

Treatment	Rate	Application timing	Injury					Yield	Test weight
			10/20	11/5	3/27	5/5	6/9		
	lb ai/A		%	%	%	%	%	bu/A	lb/bu
Pyroxasulfone	0.106	5 DBP	0	0	7	0	0	139	60.1
Pyroxasulfone	0.212	5 DBP	0	0	7	0	0	142	59.6
Flufenacet/metribuzin	0.425	5 DBP	0	0	10	0	0	137	59.6
Pyroxasulfone	0.106	0 DAP	0	0	4	0	0	141	59.8
Pyroxasulfone	0.212	0 DAP	0	0	10	0	0	138	60.2
Flufenacet/metribuzin	0.425	0 DAP	0	0	6	0	0	136	59.8
Pyroxasulfone	0.106	6 DAP	0	0	5	0	0	134	59.7
Pyroxasulfone	0.212	6 DAP	0	0	4	0	0	138	59.8
Flufenacet/metribuzin	0.425	6 DAP	0	0	7	0	0	135	59.7
Untreated check	--	--	--	--	--	--	--	146	60.1
LSD (0.05)			NS	NS	NS	NS	NS	NS	NS

A suggestion for planning cover crop mixtures: zones of occupancy. Randy L. Anderson. (USDA-ARS, Brookings SD 57006). Producers in the northern Great Plains are using cover crops to enhance sustainability of their farming systems. A further goal with cover crops is to suppress weeds. Cover crop mixtures are more suppressive of weed growth because they can produce more biomass; production is increased by using resources more effectively. However, producers have observed that some cover crop mixtures can yield considerably less biomass than sole crops, thus they are asking for guidelines in planning mixtures. We recently conducted a field study to evaluate cover crop growth following small grain harvest and our results may provide insight for planning mixtures.

Methodology:

The study was established near Brookings, SD, where yearly precipitation averages 590 mm. Four cover crop treatments were established following spring wheat harvest: 1) oat alone; 2) oat + dry pea + oilseed radish; 3) the 3 species in treatment 2, plus lentil, flax, and common vetch; and 4) the 6 species in treatment 3, plus buckwheat, cowpea, and hairy vetch. Seeding rates followed NRCS recommendations and were adjusted for mixtures; *i.e.*, planting a 1/6 rate for each species in a 6-species mixtures. Species were planted 1.5 inches deep with a no-till drill on August 16, 2014. Plot size was 20 ft by 60 ft and each treatment was replicated 5 times.

Fresh weight of individual species and cover crop mixtures was determined by harvesting plant material 2 inches above the soil surface in four 0.5 yd^{-2} quadrats in each plot. Sampling occurred in October 17, 2014.

Results:

The oat-pea-radish (O-P-R) mixture yielded 27% more fresh weight than oat alone, increasing from 1300 to 1650 g/yd^2. In contrast, the 6-species and 9-species mixtures produced less biomass, approximately 1150 g/yd^2 or 30% less than the O-P-R mixture.

Comparing the 3-species and 6-species mixtures, oat, dry pea, and oilseed radish produced 1000 $g\ m^{-2}$ in the 6-species mixture, or 61% of biomass in the 3-species mixture (see Table). Lower production of these species in the 6-species mixture was expected, as seeding rate for these species was lower. However, adding lentil, flax, and common vetch to the O-P-R mixture did not compensate for less biomass of oat, dry pea, and oilseed radish; these additional species produced only 140 g/yd^2. The lower biomass with the 6-species mixture was not related to plant community density, as number of plants among treatments were similar, approximately 55 plants/yd-of-row.

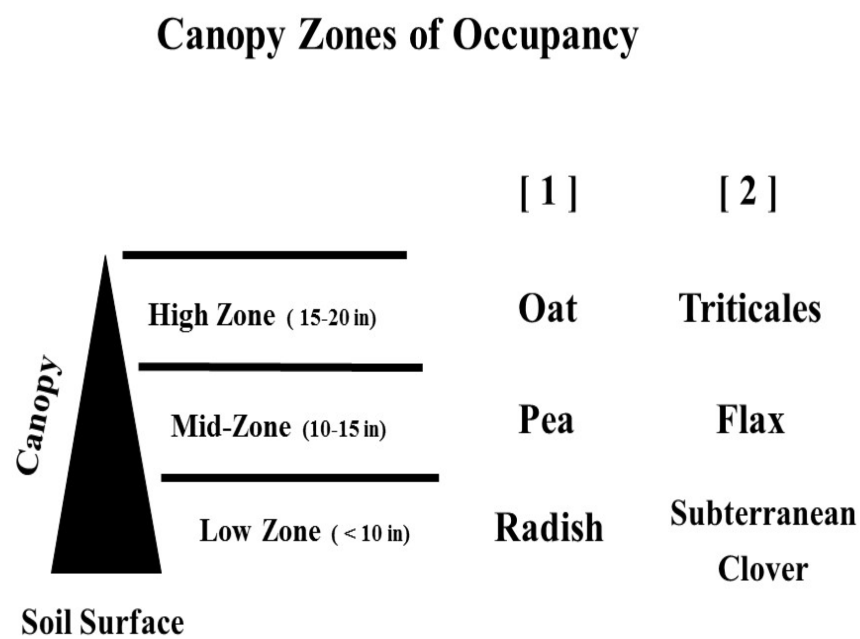
Table. Biomass of individual cover crops in various mixtures at Brookings SD. Data are grams of fresh weight/yd^2. The abbreviation, O-P-R, refers to oat, dry pea, and oil-seed radish.

	Cover Crop Mixtures		
Species	Oat	O-P-R	6 Species
Oat	1300	680	525
Dry Pea	- -	280	210
Oil-Seed Radish	- -	690	265
Flax	- -	- -	80
Lentil	- -	- -	50
Common Vetch	- -	- -	10
Total Biomass	1300	1650	1140

A striking trend, however, was the different response among individual species among mixtures. Oat and dry pea biomass in the 6-species mixture was more than 75% of corresponding biomasses in the 3-species mix (Table 1). In contrast, biomass of oilseed radish in the 6-species mix was only 38% of its biomass in the 3-species mix (265 compared with 690).

We speculate that canopy structure affected oilseed radish productivity. Cover crop biomass may be higher in the 3-species mix because each of the species occupied a different zone or level in the canopy (Figure 1). At biomass sampling, most of oat leaves occupied a layer 15 to 20 inches in height (referred to as the high zone), dry pea leaves grew mainly in the mid-zone (10 to 15 inches in height) and oilseed radish leaves remained in the low zone (less than 10 inches high). With the 6-species mix, dry pea, lentil, flax, and common vetch occupied the mid-zone of the canopy. We believe that these 4 species along with oat suppressed growth of oilseed radish, whose leaves were close to the soil surface. A similar reduction in oilseed radish biomass occurred with the 9-species mixture, where 8 of the 9 species grew in the high and mid-zones (data not shown). We believe that interspecies competition was minimized when only one species was prominent in each of the three zones.

Figure. Canopy structure of the oat-dry pea-oilseed radish mixture after 8 weeks of growth, based on zones of occupancy [1]. A second example of a 3-species mixture is also shown [2].



Management Implications:

We encourage producers to plan cover crop mixtures based on zones of occupancy in the canopy (see Figure). Arranging cover crop species to occupy these 3 zones equally may minimize interspecies competition, thus enabling a mixture such as oat + pea + oilseed radish to produce more biomass than mixtures with more species. If a producer prefers more species diversity, it may be more effective to add low-growing species first, rather than selecting species that occupy high or mid-zones. This approach would allow sunlight to reach low-growing species and lead to a more complete canopy.

Newly reported exotic species in Idaho for 2015. Larry Lass and Timothy S. Prather. (Idaho Agricultural Experiment Station, University of Idaho, Moscow, Idaho, 83844-2339). The Lambert C. Erickson Weed Diagnostic Laboratory received 215 specimens and digital images for identification in 2015 (Figure 1). Eighty introduced species were identified. The lab received 7 exotic species that were new weed records for the county, but none were new to the State of Idaho (see Table 1 and Figure 2). Many 2015 newly reported weeds are wide spread in the western states so it was surprising they had not been previously reported in the county. A total of 28 counties in Idaho submitted samples (Figure 3 and Map 1) and we had on-line photo submissions from western states, North Dakota and Alberta, Canada.

Table 1. Identified introduced species new to the county based on Erickson Weed Diagnostic Laboratory records and the USDA Plants Database.

COUNTY	FAMILY	*GENUS*	*SPECIES*	COMMON NAME
Blaine	Malvaceae	Malva	neglecta	Common Mallow
Boundary	Asteraceae	Tragopogon	dubius	Western Salsify
Boundary	Brassicaceae	Thlaspi	arvense	Field pennycress
Latah	Apiaceae	Torilis	arvensis	Hedgeparsley
Latah	Brassicaceae	Brassica	nigra	Black Mustard
Twin Falls	Asteraceae	Lactuca	serriola	Prickly Lettuce
Washington	Boraginaceae	Anchusa	officinalis	Common Bugloss

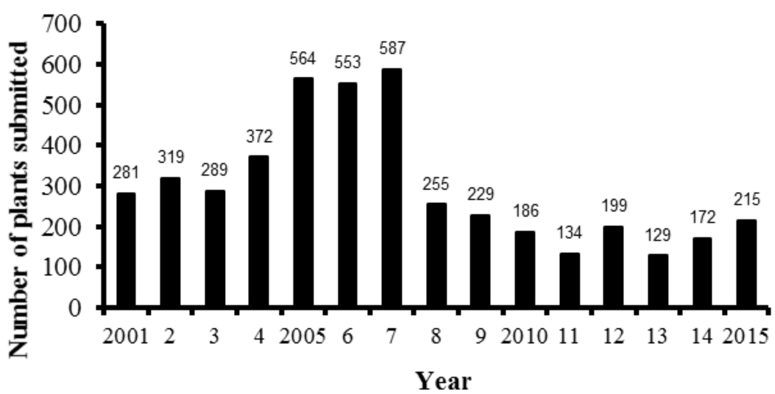


Figure 1. Erickson Weed Diagnostic Laboratory received 215 plants for identification in 2015.

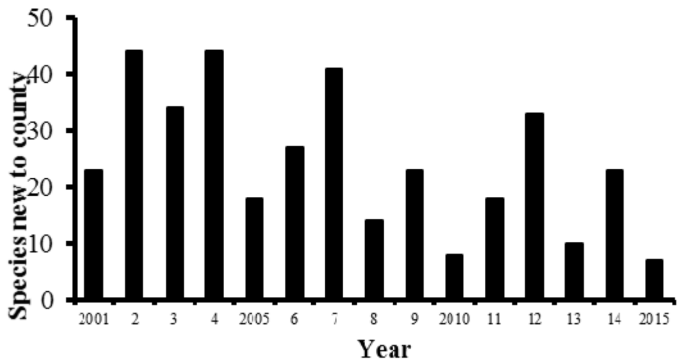


Figure 2. The lab identified 7 exotic species that were new county records for Idaho in 2015.

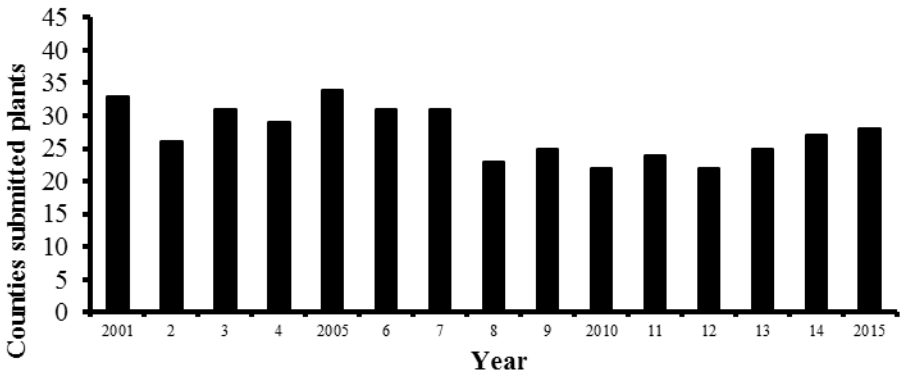


Figure 3. Twenty-eight Idaho counties submitted plants in 2015.

Map 1. Counties submitting in 2015 (black).

AUTHOR INDEX

KEYWORD INDEX