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FOREWORD

The 2014 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.

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Hoary alyssum control with aminocyclopyrachlor combinations. John Wallace and Tim Prather. (Crop & Weed Science Division, University of Idaho, Moscow, ID 83844-2339). An experiment was established near Post Falls ID at a non-crop site to evaluate hoary alyssum (BERIN) control with aminocyclopyrachlor alone or in combination with chlorsulfuron timed to the rosette growth stage and compared to an industry standard, metsulfuron methyl treatment. Treatments were replicated three times. Plot size was 10 by 30 feet. All treatments were applied with a CO_2-pressurized backpack sprayer (Table 1).

Table 1. Application data.

Application date	May 21, 2013
Weed growth stage	bud to flowering stage
Air temp (F)	74
Relative humidity (%)	46
Wind (mph, direction)	2 to 4, SW
Cloud cover (%)	66
Soil temp at 2 inches (F)	80
Soil Type	silt loam
Delivery rate (gpa)	15.4

Treatments were evaluated approximately 2 months after treatment (MAT) to determine effects on hoary alyssum. Foliar cover of hoary alyssum was significantly lower 2 MAT following aminocyclopyrachlor/chlorsulfuron treatments in comparison to aminocyclopyrachlor treatments alone, resulting in greater levels of control (Table 2). No differences in hoary alyssum foliar cover or control among application rates within aminocyclopyrachlor treatment combinations. Metsulfuron methyl applications resulted in hoary alyssum and foliar cover levels similar to aminocyclopyrachlor treatments applied alone.

Table 2. Hoary alyssum foliar cover and control (%) 2 months after treatment (MAT).

		Hoary Alyssum (BERIN)	
Treatment [1]	Rate	foliar cover	control
	oz ai /ac	------------------- %	-------------------
Aminocyclopyrachlor	1.07	70	35
Aminocyclopyrachlor	1.49	65	53
Aminocyclopyrachlor	1.88	66	50
Aminocyclopyrachlor /chlorsulfuron	1.07/0.43	2	98
Aminocyclopyrachlor /chlorsulfuron	1.49/0.59	0	100
Aminocyclopyrachlor /chlorsulfuron	1.88/0.75	1	98
Metsulfuron methyl	0.60	66	50
Untreated check	--	92	0
Tukey's HSD		37	19

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

<u>Annual glyphosate treatments to control downy brome and promote perennial grass recovery on Colorado Rangeland</u>. James R. Sebastian and K.G. Beck, Department of Bioagricultural Sciences and Pest Management, Colorado State University, Ft. Collins, Colorado 80523; Bobby Goeman and Tim D'Amato Larimer County Weed District. Downy brome (*Bromus tectorum*; BROTE) is a winter annual grass weed that reproduces by seed. BROTE readily invades roadsides, abandoned areas, and rangeland in Colorado. BROTE competes with desirable rangeland perennial grasses for moisture because of its fall/winter and early spring growth habit. An experiment was established near Loveland, Colorado in March 2011 to evaluate chemical control of BROTE on Colorado rangeland.

Past research conducted by CSU has shown that BROTE can be effectively controlled and remnant native perennial grasses re-establish with appropriately timed applications of glyphosate for one growing season. However, there often is unacceptable BROTE control during the following years when it emerges from seed and dominates the site again. Glyphosate is a systemic herbicide that does not provide residual herbicide control because of little to no soil activity.

The objectives of this study were to determine if consecutive, annual glyphosate applications would effectively control current BROTE growth and eliminate its soil seed reserve over time and determine remnant perennial grass response to such treatments. Eliminating BROTE seed stores is essential to prevent its re-invasion and site dominance and recovery of desirable perennial grasses is imperative also to prevent BROTE re-invasion and potential dominance. This study is set up as a 6-year project. Annual glyphosate treatments in this experiment were applied over the original treated plots starting in spring 2011. Yearly visual evaluations and soil cores were used to compare BROTE control and effect of treatments on soil seed longevity; however, seed bank data are not presented in this report. BROTE and perennial grass canopy cover and biomass also will be evaluated. Annual applications were set up as a randomized complete block design in 20' x 30' plots and treatments were replicated four times.

Baseline visual estimates of canopy cover were made on December 15, 2010 for each species. Baseline soil cores were collected in March of each year before annual glyphosate applications. Visual evaluations for BROTE control, biomass, and canopy cover were conducted in November of each year.

BROTE seedlings started emerging in October 2010 and continued emerging in April 2011. Late spring moisture promoted BROTE emergence after the March 15, 2011 application. There was 82% BROTE control in year one (Table 2). Glyphosate has no soil activity and all BROTE that emerged after the early spring glyphosate treatments were sprayed was not controlled. Spring 2012 and 2013 applications were delayed 2 to 3 weeks to accommodate late spring BROTE emergence. There was 100% BROTE control in 2012 and 2013. Western wheatgrass (*Pascopyrum smithii*, PASSM) was the only perennial grass species that was breaking dormancy and was 1 to 3" tall at all application dates.

BROTE and perennial grass biomass were collected at the end of the growing season in November of each year. Western wheatgrass, blue grama (*Bouteloua gracilis*, BOUGR), and sand dropseed (*Sporobolus cryptandrus*, SPOCR) were the dominant perennial grass species present at this site. There was a dramatic increase in total grass biomass and canopy cover in year 1 (Table 3). Untreated control plots produced 779 lb/A of BROTE and 100 lb/A of perennial grass compared to 18 lb/A of BROTE and 850 lb/A of perennial grass in first year-treated glyphosate plots in 2011. BROTE control dropped to 20% and BROTE biomass increased 3-fold from the single glyphosate treatment in year 2 compared to the untreated plots. There were fewer but much larger BROTE plants that took advantage of the little moisture that occurred in 2012 at this site. BROTE canopy cover was 83% in untreated plots and 25% in first year glyphosate-treated plots in year 1. In year 2 there was 63 or 78% BROTE canopy cover in year-1-treated or untreated plots, respectively. Year 2 glyphosate treatments had 100% BROTE control and 0% BROTE canopy cover. There was 20% BROTE control 1 year after treatment (YAT) with the first year glyphosate treatment and 93% BROTE control the year after 2 annual glyphosate treatments in 2013.

Warm season grass species (BOUGR and SPOCR) biomass and canopy cover dramatically increased after 2 years of treatment; however, PASSM that had emerged by the application dates decreased and disappeared after 3 years of treatment. This was likely due to glyphosate injury and competition from increasing BOUGR and SPOCR possibly related to late spring and summer precipitation.

This and past research conducted by CSU has shown that spring applications of glyphosate for one growing season can effectively control BROTE for 1 year and remnant native perennial grass begin to re-establish. It may take several consecutive years of applications to rid the soil of viable seed. It appears that this is happening in this experiment and soil cores will validate this. Fourth year treatments will be applied in spring 2014 over the original treated plots to compare untreated and 1 to 4 years of application responses by BROTE and perennial grasses.

Table 1. Plant community application information from annual glyphosate treatments to control downy brome on Colorado Rangeland.

Application date	Species	Common name	Growth stage	Height
				--(in.)--
March 15, 2011	BROTE	Downy brome	POST	0.5 to 1.5
	AGRSM	Western wheatgrass	65% dried out	1 to 2
	BOUGR	Blue grama	Dormant	0
	SPOCR	Sand dropseed	Dormant	0
March 27, 2012	BROTE	Downy brome	POST	1 to 1.5
	AGRSM	Western wheatgrass	65% dried out	1.5 to 3
	BOUGR	Blue grama	Dormant	0
	SPOCR	Sand dropseed	Dormant	0
April 11, 2013	BROTE	Downy brome	POST	0.8 to 1.5
	AGRSM	Western wheatgrass	2 to 3 leaf	1.5 to 3
	BOUGR	Blue grama	Dormant	0
	SPOCR	Sand dropseed	Dormant	0

Table 2. Downy brome control data from annual glyphosate treatments to control downy brome.

Herbicide[1,2]	Rate	Years of Treatment	BROTE 2011	2012	2013
	oz ai/A		------------------------------(% Control)---		
Untreated			0	0	0
Glyphosate	16	1	82	21	8
Glyphosate	16	1 + 2	-	100	93
Glyphosate	16	1 + 2 + 3	-	-	100
LSD (0.05)			8	2	13

[1] Methylated seed oil added to all treatments at 1 pint/A.

[2] Roundup Weathermax

Table 3. Downy brome and perennial grass species biomass influenced by yearly spring glyphosate treatments to control downy brome.

Herbicide[1,2]	Rate	Years of Treatment	AGRSM 2012	AGRSM 2013	BOUGR 2012	BOUGR 2013	SPOCR 2012	SPOCR 2013	Total Grass 2011	Total Grass 2012	Total Grass 2013	BROTE 2011	BROTE 2012	BROTE 2013
	oz ai/A		---(Biomass lb/A)---											
Untreated			Trace	71	114	223	75	0	100	214	276	779	98	526
Glyphosate	16	1	Trace	30	253	162	11	3	850	264	183	18	334	698
Glyphosate	16	1 + 2	Trace	20	620	1083	112	99	-	732	1212	-	0	0
Glyphosate	16	1 + 2 + 3		0		1083		287			1370			0
LSD (0.05)				21	121	234	15	42	84	76	176	64	21	36

Table 4. Canopy cover of BROTE and perennial grasses as influenced by annual spring applications of glyphosate.

Herbicide[1,2]	Rate	Years of Treatment	AGRSM 2011	AGRSM 2012	AGRSM 2013	BOUGR 2011	BOUGR 2012	BOUGR 2013	SPOCR 2011	SPOCR 2012	SPOCR 2013	BROTE 2011	BROTE 2012	BROTE 2013
	oz ai/A		--(Canopy Cover %)---											
Untreated			10	16	38	21	48	35	18	16	21	83	63	73
Glyphosate	16	1	25	13	29	71	56	61	19	14	21	33	78	68
Glyphosate	16	1 + 2	-	15	11	-	63	79	-	23	31	-	0	7
Glyphosate	16	1 + 2 + 3	-	-	0	-	-	70	-	-	48	-	-	0
LSD (0.05)			15	8	7	20	14	10	13	11	20	22	3	19

Brush control trial on mountain rangelands in southeastern Sierra Nevada, California. Julie A. Finzel, Steven D. Wright, Gerardo Banuelos (UC Cooperative Extension Tulare County, 4437-B S. Laspina St., Tulare, CA 93274), and Hugo T. Ramirez (DuPont Field Development, Visalia, CA 93292). Brush on mountain rangelands serves as important wildlife habitat and forage for some species, but it is also considered a ladder fuel, decreases water availability for downstream users, and decreases grass production, reducing carrying capacity for domestic livestock. These factors make it a candidate for control under some conditions. The objective of this project was to test the efficacy of multiple tank mixes in controlling shrub species on rangeland east of Fresno, California. Treatments were applied on October 28, 2011 before winter rainfall or snows were received. The major shrub species on or near the site at the time of application included yerba santa (*Eriodictyon californicum*; ERCA6), scrub oak (*Quercus berberidifolia*), and mountain mahogany (*Cercocarpus ledifolius*. Annual grass species included ripgut brome (*Bromus diandrus*; BRDI3) and soft chess brome (*Bromus hordeaceus*; BRHO2). Annual grass and forb species that appeared the following spring were foxtail barley (*Hordeum murinum*; HOMU), coast fiddleneck (*Amsinckia menziesii*), and redstem filaree (*Erodium cicutarium;* ERCI6). Yerba santa was the only shrub species that actually occurred within the treatment plots.

Plot size was 8 feet by 20 feet, arranged in a randomized complete block design with three replications per treatment, including an untreated control. All treatments were applied using a CO_2 backpack sprayer with an 8 ft boom, calibrated to 15 gpa at 30 psi and applied at a walking speed of 3 mph. Weather conditions at the time of application were 78° F with a wind speed of 0-2 mph. Treatments were evaluated to assess the efficacy of MAT28 (Aminocylopyrachlor) in combination with Arsenal (Imazapyr), Garlon (Triclopyr), or Escort (Metsulfuron), compared to an untreated control (Table). The treatments that provided the best control of yerba santa were treatments 5, 7, 8, and 9; each of which provided 90% or greater control. Once the initial evaluations were complete the site was visited once more for visual assessment.

Visual assessment of the treated plots on March 1, 2013, indicated that the production of naturalized annual grasses had been suppressed or delayed, as compared to nearby untreated areas. Visual assessment also indicated a greater abundance and diversity of annual forbs within the treated area. The forb response was most likely a result of the reduction in annual grasses within the treated area. Annual grasses are known to be highly competitive and can shade and crowd out less competitive plants. To some extent, the response of the treated plots mimics the effects of fire, as evidenced by the reduced production of annual grasses and the increase in forbs. The site was not visited again to determine the temporal duration of this effect.

Results of this project indicate that mountain shrub species can be successfully reduced and controlled using the right combination of herbicides. The study also showed promising results in controlling annual grasses and filaree.

Table. Application, formulation and weed control data (% control) for shrub control in foothills east of Fresno, CA

				ERCA6		BRDI3		BRHO2		HOMU	ERCI6	AMME
	Treatment[1]	**Formulation**	**Rate OZ AI/A**	**4/5**	**6/26**	**4/5**	**6/26**	**4/5**	**6/26**	**6/26**	**6/26**	**6/26**
1	MAT28 + Arsenal	50SG + 2SL	2 + 2.78	55	10	97	100	95	97	100	100	100
2	MAT28 + Arsenal	50SG + 2SL	4 + 5.60	85	85	100	100	96	100	100	100	100
3	MAT28 + Garlon	50SG + 4SL	2 + 2	73	20	85	0	67	0	100	98	100
4	MAT28 + Garlon	50SG + 4SL	4 + 4	80	20	87	0	67	0	100	100	100
5	MAT28 + Arsenal + Garlon	50SG + 2SL + 4SL	2 + 2.78 + 2	70	90	100	100	98	100	100	100	100
6	MAT28 + Arsenal + Garlon	50SG + 2SL + 4SL	4 + 5.60 + 4	75	78	100	100	100	100	100	100	100
7	MAT28 + Escort	50SG + 60WG	4 + 1.28	83	99	93	99	100	100	100	100	100
8	MAT28 + Arsenal + Escort	50SG + 2SL + 60WG	4 + 5.60 + 1.28	87	99	100	100	100	100	100	100	100
9	MAT28 + Escort	50SG + 60WG	2 + 0.60	88	92	93	83	87	97	100	100	100
10	Untreated Control			0	0	0	0	0	0	0	0	0

[1]All treatments were applied with 90% nonionic surfactant at 1% v/v

Meadow hawkweed control with aminocyclopyrachlor combinations. John Wallace and Tim Prather. (Crop & Weed Science Division, University of Idaho, Moscow, ID 83844-2339). An experiment was established near Santa ID in abandoned pasture to evaluate meadow hawkweed (HIECA) control with aminocyclopyrachlor alone or in combination with chlorsulfuron timed to the rosette growth stage and compared to an industry standard, aminopyralid treatment. Treatments were replicated three times. Plot size was 10 by 30 feet. All treatments were applied with a CO_2-pressurized backpack sprayer (Table 1).

Table 1. Application data.

Application date	May 23, 2013
Weed growth stage	rosette to pre-bolting
Air temp (F)	48
Relative humidity (%)	28
Wind (mph, direction)	0 to 3, E
Cloud cover (%)	20
Soil temp at 2 inches (F)	48
Soil Type	silt loam
Delivery rate (gpa)	15.4

Treatments were evaluated approximately 1 month after treatment (MAT) to determine effects on meadow hawkweed, as well as plant community composition. Complete meadow hawkweed control (100%) was observed in all herbicide treatments except for the low rate (1.07 oz ai/ac) of aminocyclopyrachlor alone (Table 2). No differences were detected in pairwise comparisons of other treatments. Visual ratings of herbicide injury symptoms, including stunting and decreased flower head production, were made for Idaho fescue (FESID) within treated plots. Greater injury levels (20 to 37%) were observed in aminocyclopyrachlor treatments in combination with chlorsulfuron. Trends suggest that higher aminocylopyrachlor/chlorsulfuron application rates result in greater Idaho fescue injury. In comparison, Idaho fescue injury was minimal in aminocylopyrachlor treatments applied alone. No differences were observed across application rates.

Table 2. Meadow hawkweed control 1 month after treatment (MAT).

Treatment [1]	Rate[2]	HIECA control	Idaho Fescue (FESID) cover	Idaho Fescue (FESID) injury
	oz ai /ac	--- % ---	---- % ----	--- % ---
Aminocyclopyrachlor	1.07	66	68	2
Aminocyclopyrachlor	1.49	100	62	3
Aminocyclopyrachlor	1.88	100	55	2
Aminocyclopyrachlor /chlorsulfuron	1.07/0.43	100	62	20
Aminocyclopyrachlor /chlorsulfuron	1.49/0.59	100	72	28
Aminocyclopyrachlor /chlorsulfuron	1.88/0.75	100	49	37
Aminopyralid	1.25	100	65	8
Untreated check	--	0	35	0
Tukey's HSD		45	32	31

[1] 90% non-ionic surfactant (R-11) at 0.25% v/v was applied with all treatments
[2]Aminopyralid expressed as oz ae/ac

<u>Houndstongue control in Colorado.</u> James R. Sebastian, Derek Sebastian, and K.G. Beck (Department of Bioagricultural Sciences and Pest Management, Colorado State University, Fort Collins, CO 80523). Houndstongue (*Cynoglossum officinale.*, CYWOF) is an invasive biennial species that reproduces from seed and is a member of the borage family. CYWOF seedlings emerge in fall or early spring with adequate moisture. First year rosettes over-winter and then bolt, flower, and set seed the second year. The barbed fruit is approximately 1/3 inch long and is readily dispersed by attaching to animals and clothing. CYWOF produces alkaloids that are toxic to horses. CYWOF favors disturbed areas such as roadsides, over grazed pastures and rangeland. CYWOF is particularly difficult to control with herbicides for more than one growing season.

An experiment was established at approximately 7,500 feet elevation in a pasture near Steamboat Springs, Colorado. Herbicides were applied at two timings when CYWOF was in the fall rosette growth stage (October 2011) or rosette to early flower (May 2012, Table 1). Good soil moisture existed in fall 2011; however, extreme drought conditions persisted after the May 2012 application through the 2012 growing season. There was excellent moisture during the 2013 growing season. The experiment was designed as a randomized complete block and treatments were replicated four times. All broadcast treatments were applied with a CO_2-pressurized backpack sprayer using 11002LP flat fan nozzles at 20 gal/A and 30 psi. Plot size was 10 by 30 feet. Visual evaluations for control compared to non-treated plots were conducted on September 2012 and 2013 (Table 2). CYWOF control was sub-divided into rosette and flowering (second year plant) categories at evaluation.

All aminocyclopyrachlor (MAT28) treatments that were sprayed alone regardless of application timing controlled 2 to 48% CYWOF. All MAT28 tank mix treatments controlled 100% of bolted CYWOF plants and 87 to 100% of CYWOF rosettes approximately 1 year after treatment (YAT). The only treatments that controlled 100% of rosette plus second year bolted CYWOF plants were MAT28 + Escort + 2,4-D Amine (both treatment timings) or MAT28 + chlorsulfuron at the spring timing in 2012. Several other treatments controlled rosettes similarly but did not eliminate all rosettes, which would be important if eradication was the goal. It appears that aminocyclopyrachlor has far less activity on houndstongue than chlorsulfuron, metsulfuron, and 2,4,D.

There was 100% control of bolted CYWOF plants in all but 1 tank mix treatment (spring-applied MAT28 + 2,4-D) regardless of application timing; however, CYWOF rosette control decreased in all treatments 2 YAT. Spring-applied chlorsulfuron tank mixes and all fall-applied tank mixes controlled 78 to 91% rosettes and 100% bolted CYWOF in 2013. All other spring-applied treatments controlled 5 to 61% of rosettes 16 MAT. CYWOF control will be evaluated 2014 to determine if rosette plants bolt and are capable of producing seed. Drought conditions made it impossible to evaluate perennial grass injury in 2012 but there was no green needlegrass injury in any treatment in September 2013.

Table 1. Application data for houndstongue control in Colorado.

Environmental data		
Application date	October 3, 2011	May 31, 2012
Air temperature, F	62	85
Relative humidity, %	41	32
Wind speed, mph	2 to 5	1 to 4

Application date	Species	Common Name	Growth stage	Diameter
				--(in.)--
October 3, 2011	CYWOF	Houndstongue	Fall Rosettes	4 to 12
May 31, 2012	CYWOF	Houndstongue	Early flower	3 to 12

Table 2. Houndstongue control in Colorado.

Herbicide[1]	Rate	Timing	Houndstongue Rosettes 2012	Bolted 2012	Rosettes 2013	Bolted 2013
	oz ai/A		----------(% Control)----------			
Aminocyclopyrachlor	1	Spring	16	21	5	2
	2	Spring	48	45	25	38
	3	Spring	35	35	27	54
Aminocyclopyrachlor + chlorsulfuron	1.8 + 0.7	Spring	100	100	91	100
Aminocyclopyrachlor (liquid) + 2,4-D amine	2 + 15	Spring	87	100	61	97
Metsulfuron + chlorsulfuron	0.3 + 0.1	Spring	99	100	88	100
Aminocyclopyrachlor + metsulfuron + 2,4-D	2 + 0.6 + 15	Spring	100	100	55	100
Aminocyclopyrachlor	1	Fall	20	25	10	7
	2	Fall	20	20	5	30
	3	Fall	24	45	0	27
Aminocyclopyrachlor + chlorsulfuron	1.8 + 0.7	Fall	99	100	86	100
Aminocyclopyrachlor (liquid) + 2,4-D amine	2 + 15	Fall	98	100	85	100
Metsulfuron + chlorsulfuron	0.3 + 0.1	Fall	99	100	78	100
Aminocyclopyrachlor + metsulfuron + 2,4-D	2 + 0.6 + 15	Fall	100	100	83	100
LSD (0.05)			15	16	16	19

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

<u>Feral rye control in Colorado.</u> James R. Sebastian, Derek Sebastian , and K.G. Beck (Department of Bioagricultural Sciences and Pest Management, Colorado State University, Fort Collins, CO 80523). Feral rye (*Secale cereale*, SECCE) is a winter annual that reproduces and spreads from seed. SECCE seedlings emerge in fall or early spring with adequate moisture. SECCE favors disturbed areas such as roadsides, overgrazed pastures, and abandoned crop fields and is co-invading such areas in Colorado along with downy brome.

Indaziflam is a relatively new Bayer compound that is currently registered for annual weed control in orchards, ornamentals, and noncrop. Indaziflam has excellent preemergence activity on many weed species. This study was designed to compare indaziflam and indaziflam tank mixes with other herbicides used to control SECCE (Table 2).

An experiment was established near Nunn, Colorado in October 2010 to control feral rye in an abandoned, dryland wheat field. Herbicides were applied at three timings; preemergence, 1 to 2 leaves (fall, early postemergence) and 2 to 3 leaves (early spring). The study site had a dense 3 to 3.5 ft tall canopy of standing dead feral rye plus a 2 to 3 inch deep litter layer (from previous year's growth). The experiment was designed as a randomized complete block and treatments were replicated three times. All broadcast treatments were applied with a CO_2-pressurized backpack sprayer using 11002LP flat fan nozzles at 20 gal/A and 30 psi. Plot size was 10 by 30 ft.

Visual evaluations for SECCE control compared to non-treated plots were conducted in May or October of 2011, 2012, and 2013 (Table 2) when SECCE was in flower or fall seedling growth stages. Indaziflam sprayed PRE controlled 80% SECCE in May 2011 and controlled 100% of fall-germinated SECCE in October 2011. It may take adequate moisture to move indaziflam into soil to control germinating SECCE PRE, especially when spraying through a dense layer of mulch. Glyphosate or rimsulfuron were added to all POST indaziflam treatments to control SECCE that had already emerged. All treatments with indaziflam or indaziflam tank mixes regardless of timing controlled 100% of SECCE at 10 to 12 months after treatment (MAT) and 80 to 99% at 26 to 31 MAT, respectively. The breaking point for long term SECCE control from indaziflam tended to be approximately 36 MAT. There was 55 to 67% control from PRE or fall-applied indaziflam and 78 to 83% SECCE control with spring-applied indaziflam 36 and 31 MAT, respectively. Glyphosate or rimsulfuron sprayed alone in October controlled 93% of SECCE the first growing season; however, there was only 38 or 68% SECCE control 12 MAT and 17 or 35% control 24 MAT. Sulfometuron + chlorsulfuron sprayed in October or December controlled 82 to 97% of SECCE 12 to 19 MAT; however, SECCE control from these treatments was 37 to 50% 24 MAT. Indaziflam is a good choice to control SECCE but will need to be tank-mixed with a postemergence active herbicide such as glyphosate or rimsulfuron if SECCE has emerged before indaziflam is applied. Indaziflam is an excellent option for long term SECCE control. Indaziflam and indaziflam tank mixes provided 89 to 98% SECCE control up to 36 MAT in this experiment.

Table 1. Application data for feral rye control in Colorado.

Application date	October 13, 2010	December 2, 2010	March 15, 2011
Air temperature, F	68	49	55
Relative humidity, %	34	31	31
Wind speed, mph	2 to 6	0	4 to 8

Application date	Species	Common Name	Growth stage	Height
				--(in.)--
October 13, 2010	SECCE	Feral rye	PRE	-
December 2, 2010	SECCE	Feral rye	1 to 2 leaf	1 to 2"
March 15, 2011	SECCE	Feral rye	2 to 3 leaf	1 to 2 1/2"

Table 2. Feral rye control in Colorado.

Herbicide[1]	Rate (oz ai/A)	Timing	Feral rye					
			May 2011	October 2011	May 2012	October 2012	May 2013	October 2013
			(% Control)					
Indaziflam	0.8	PRE	80	100	94	89	80	60
Sulfometuron + chlorsulfuron	0.5 + 0.3	Fall	92	97	94	50	0	0
Rimsulfuron	0.8	Fall	93	68	72	35	15	5
Glyphosate	13.5	Fall	93	38	27	17	0	0
Indaziflam + glyphosate	0.8 + 13.5	Fall	95	100	89	90	96	55
Indaziflam + rimsulfuron	0.8 + 0.8	Fall	99	100	100	98	91	67
Sulfometuron + chlorsulfuron	0.5 + 0.3	Spring	42	82	83	37	0	0
Rimsulfuron	0.8	Spring	48	55	68	35	0	0
Glyphosate	13.5	Spring	92	52	47	28	0	0
Indaziflam + glyphosate	0.8 + 13.5	Spring	100	100	99	96	96	78
Indaziflam + rimsulfuron	0.8 + 0.8	Spring	75	100	96	95	99	83
LSD (0.05)			23	28	15	19	9	17

[1]MSO added to all treatments at 1 pt/a.

<u>Yellow starthistle control and forage response following aminocyclopyrachlor applications</u>. John Wallace and Tim Prather. (Crop & Weed Science Division, University of Idaho, Moscow, ID 83844-2339). An experiment was established near Genesee ID, in canyon grassland, to evaluate yellow starthistle (CENSO) control with combinations of aminocyclopyrachlor and chlorsulfuron or 2,4-D timed to spring rosettes and compared to a standard aminopyralid application. Treatments were replicated three times. Plot size was 10 by 30 feet. All treatments were applied with a CO_2-pressurized backpack sprayer (Table 1).

Table 1. Application data.

Application date	April 25, 2012
Weed growth stage	spring rosette, 4 to 8 leaves
Air temp (F)	60
Relative humidity (%)	80
Wind (mph, direction)	3 to 5, W
Cloud cover (%)	33
Soil temp at 2 inches (F)	68
Soil type	silt loam
Delivery rate (gpa)	15

Treatments were evaluated on approximately 15 months after treatment (MAT) to determine differences in yellow starthistle (CENSO) cover and plant community composition, focusing on downy brome and other annual forbs. The aminopyralid application resulted in complete yellow starthistle control in the second growing season. In comparison, aminocyclopyrachlor treatment combinations resulted in yellow starthistle cover ranging from 21 to 52%. Aminocyclopyrachlor treatments with 2,4-D resulted in lower yellow starthistle cover in comparison to aminocyclopyrachlor treatments with chlorsulfuron. Within each treatment combination, application rate did not affect yellow starthistle cover. Greater yellow starthistle control in the second growing season, resulted in greater downy cover in aminopyralid treatments compared aminocyclopyrachlor combinations. No treatment differences in annual for cover, other than yellow starthistle, were detected.

Table 2. Plant community composition 15 months after herbicide application.

Treatment [1]	Rate	yellow starthistle	downy brome	other annual forbs
	oz ai /ac	------------------ % foliar cover -------------------		
Aminocyclopyrachlor /chlorsulfuron	0.83	52	31	11
Aminocyclopyrachlor /chlorsulfuron	1.38	57	21	20
Aminocyclopyrachlor + 2,4-D DMA	0.625 + 4.75	27	22	25
Aminocyclopyrachlor + 2,4-D DMA	1.00 + 7.60	21	31	33
Aminopyralid	2.00	0	51	30
Untreated check	--	58	19	12
Tukey's HSD		18	19	17

[1] 90% non-ionic surfactant (R-11) at 0.25% v/v was applied with all treatments
[2]MAT = months after treatment

Dalmatian toadflax control with aminocyclopyrachlor combinations. John Wallace and Tim Prather. (Crop & Weed Science Division, University of Idaho, Moscow, ID 83844-2339). An experiment was established at Farragut State Park, near Athol ID, in abandoned pasture to evaluate Dalmatian toadflax (LINDA) control with combinations of aminocyclopyrachlor and chlorsulfuron or 2,4-D timed to the flowering stage and compared to a standard picloram + metsulfuron methyl application. Treatments were replicated three times. Plot size was 10 by 30 feet. All treatments were applied with a CO_2-pressurized backpack sprayer (Table 1).

Table 1. Application data.

Application date	June 28, 2012
Weed growth stage	flowering
Air temp (F)	64
Relative humidity (%)	38
Wind (mph, direction)	1 to 3, W
Cloud cover (%)	0
Soil temp at 2 inches (F)	60
Soil Type	sandy loam
Delivery rate (gpa)	15.4

Treatments were evaluated approximately 12 months after treatment (MAT) to determine effects on Dalmatian toadflax density and cover, as well as perennial grass cover. All aminocyclopyrachlor treatments in combination with chlorsulfuron resulted in lower Dalmatian toadflax density and cover in comparison to the untreated check (Table 2). Mid- and high-rates of aminopyralid with 2,4-D resulted in lower Dalmatian toadflax density and cover than the untreated check. Dalmatian toadflax density and cover did not differ across application rates within treatment combinations. Picloram + metsulfuron methyl did not differ in comparison to the untreated check.

Table 2. Dalmatian toadflax density and foliar cover approximately 12 months after treatment (MAT).

		Dalmation toadflax		Perennial grass
Treatment [1]	Rate	plant density	foliar cover	cover
	oz ai /ac	--- plt/m^2 ---	--- % ---	---- % ----
Aminocyclopyrachlor /chlorsulfuron	1.38	0.83	2	26
Aminocyclopyrachlor /chlorsulfuron	2.49	0.33	2	33
Aminocyclopyrachlor /chlorsulfuron	3.32	1.00	4	34
Aminocyclopyrachlor + 2,4-D DMA	1 + 7.6	5.00	9	20
Aminocyclopyrachlor + 2,4-D DMA	2 + 15.2	1.16	7	25
Aminocyclopyrachlor + 2,4-D DMA	2.5 + 19.0	1.66	9	26
DPX-RDQ98	2.0	1.33	4	31
DPX-RDQ98	2.8	4.00	19	27
Picloram + metsulfuron methyl	3.9 + 0.9	8.16	44	7
Untreated check	--	9.33	35	23
Tukey's HSD		6.3	27	31

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

[2]DAT = days after treatment

Tolerance of desirable grasses to aminopyralid and aminocyclopyrachlor plus chlorsulfuron. Celestine Duncan (Weed Management Services, Helena MT). A field experiment was established on native rangeland near Helena, Montana to measure the tolerance of cool-season bunchgrass to applications of aminopyralid (Milestone®) compared to aminocyclopyrachlor plus chlorosulfuron (Perspective™). Perennial native grasses were dominantly bluebunch wheatgrass (PSSP), Idaho fescue (FEID), and Junegrass (KOCR) at 45, 15 and 10% visual cover, respectively. There were no noxious weeds present on the site; however, native forbs occupied about 25% visual cover within the study area. Livestock were excluded from grazing the season of application and for two years following treatment. Soils are sandy loam and elevation is 4320 feet.

Plots were arranged in a randomized complete block design, with three replications per treatment. Plot size was 10 by 20 feet. Herbicides were applied with a CO_2-pressurized backpack sprayer at 13.5 gallons/A in late spring (June 11, 2011) or fall (September 28, 2011). Applications were a typical timing for broadleaf weed control in the Intermountain Region. Aminopyralid was broadcast applied at two rates: the label rate of 1.75 oz ae/A applied in spring and fall, and the spot treatment rate of 3.5 oz ae/A (spring only). Aminocyclopyrachlor plus chlorsulfuron was applied in both spring and fall at the noxious weed control rate of 1.9 + 0.75 oz ai/A and 3.8 + 1.5 oz ai/A. All treatments included a non-ionic surfactant (NIS) at 0.25% (Table 1).

Table 1: Site conditions and herbicide application information.

Application date	June 11, 2011	September 28, 2011
Grass growth stage at application	FEID/KOCR- seed heads emerged PSSP-80% boot stage; 20% early seed-head emergence	Seed heads shattered; few green leaves remained on perennial grass; no fall basal regrowth present
Air temperature (F)	60	54
Relative humidity (%)	67	43
Wind (mph, direction)	NW-1	0
Soil moisture	moist	dry

Visual evaluations of perennial grass injury were collected approximately 30 and 60 days after spring application, and one and two years after treatment (YAT). Visual injury symptoms evaluated included epinasty, chlorosis, visual percent cover, and stunting compared to plants in non-treated plots. Perennial grass was also harvested at peak growth by clipping a 0.5 meter^2 frame within each plot 1 and 2 YAT. The second year after treatment, PSSP was selectively harvested from a 0.5 meter^2 frame in each plot; other grasses and forbs were not harvested. Harvested grasses were dried for seven days in a greenhouse, weighed to the nearest gram, and weight converted to pounds/A. Data were analyzed by analysis of variance.

Bluebunch wheatgrass (PSSP) was significantly impacted by aminocyclopyrachlor plus chlorsulfuron applications 1 and 2 YAT (Table 2). Injury was greater with the high rate of aminocyclopyrachlor plus chlorsulfuron; however, even the noxious weed rate of aminocyclopyrachlor plus chlorsulfuron 1.9 + 0.75 oz ai/A significantly reduced PSSP biomass 2 YAT (Table 3). Injury and biomass reduction to PSSP was significantly greater with aminocyclopyrachlor plus chlorsulfuron when compared to aminopyralid. There was less than 10% visual injury to KOCR the year of treatment with aminopyralid and aminocyclopyr plus chlorsulfuron, and no injury to FEID either 1 or 2 YAT by any herbicide treatment. The application of aminocyclopyrachlor plus chlorsulfuron shifted the plant community from a site dominated by PSSP to one dominated by FEID, KOCR and tolerant forbs. The change in plant structure caused by removal of PSSP by aminocyclopyrachlor plus chlorsulfuron could have long-term ecological implications to the rangeland resource, and an overall reduction in productivity of the site.

Table 2: Visual percent injury to bluebunch wheatgrass (PSSP) 1 and 2 years after treatment (YAT) with aminopyralid compared to aminocyclopyrachlor plus chlorsulfuron applied at various rates in June or September (P=0.10).

			Visual injury (%)	
			1 YAT	2 YAT
Herbicide treatment	Rate (oz ai/A)	Application date (2011)	PSSP	PSSP
Aminocyclopyrachlor + chlorsulfuron	1.9 + 0.75	6/11	21 c	13 c
Aminocyclopyrachlor + chlorsulfuron	3.8 + 1.5	6/11	38 b	78 a
Aminopyralid	1.75	6/11	3.3 e	0.0 d
Aminopyralid	3.5	6/11	12 d	0.0 d
Aminocyclopyrachlor + chlorsulfuron	1.9 + 0.75	9/28	23 c	33 b
Aminocyclopyrachlor + chlorsulfuron	3.8 + 1.5	9/28	45 a	70 a
Aminopyralid	1.75	9/28	12 d	0.6 d
Non-treated control			0.0 e	0.0 d

Table 3: Biomass production of bluebunch wheatgrass (PSSP) at 1 and 2 years after treatment (YAT) and Idaho fescue (FEID), Junegrass (KOCR) other perennial grasses[1] at 1 YAT (P=0.10).

			Biomass (lbs/A)		
			1 YAT	2 YAT	1 YAT
Herbicide treatment	Rate (oz ai/A)	Application date (2011)	PSSP	PSSP	FEID, KOCR, and other perennial grass
Aminocyclopyrachlor + chlorsulfuron	1.9 + 0.75	6/11	316 bc	213 b	161 a
Aminocyclopyrachlor + chlorsulfuron	3.8 + 1.5	6/11	149 c	62 c	89 a
Aminopyralid	1.75	6/11	577 ab	528 a	188 a
Aminopyralid	3.5	6/11	722 a	538 a	166 a
Aminocyclopyrachlor + chlorsulfuron	1.9 + 0.75	9/28	397 b	205 b	181 a
Aminocyclopyrachlor + chlorsulfuron	3.8 + 1.5	9/28	130 c	47 c	127 a
Aminopyralid	1.75	9/28	548 ab	437 a	179 a
Non-treated control			588 ab	495 a	187 a

[1] Other perennial grasses include Kentucky bluegrass (POPR) and sandberg bluegrass (POSE) at less than 5% visual cover.

Postemergence herbicide applications for *Poa annua* control on a bentgrass golf green. Kai Umeda. (University of Arizona Cooperative Extension, Maricopa County, 4341 E. Broadway Road, Phoenix, AZ 85040.) A small plot experiment was conducted at Prescott Lakes Golf Club in Prescott, AZ on a bentgrass practice green infested with *Poa annua*. The treated plots measured 5 ft wide by 10 ft length and each treatment was replicated four times in a randomized complete block design. Herbicides were applied using a backpack CO_2 sprayer equipped with a hand-held boom with three 8003LP flat fan nozzles spaced 20-inches apart. The sprays were applied in 43 gpa water that was pressurized to 30 psi. Multiple applications were made for each treatment on the following dates and weather conditions were: 30 April 2013 with air temperature at 79°F, wind averaging 3.5 mph, and soil temperature at 2-inch depth at 60°F; 10 May was 68°F, no wind, and soil at 56°F; 20 May was 62°F with winds gusting to 7 mph, and soil at 55°F; and 30 May was 74°F, clear sky with wind gusting to 5 mph and soil at 58°F. Methiozolin and bispyribac-sodium were applied on all four dates and amicarbazone was applied only on the first two dates.

Spring applications of methiozolin and bispyribac-sodium did not appear to be effective in reducing *P. annua*. Both methiozolin and bispyribac-sodium did not cause adverse effects on the bentgrass. Amicarbazone was injurious to bentgrass.

Table. Poa annua injury and control and bentgrass safety with spring herbicide applications, Prescott Lakes Golf Course, 2013.

Treatment	Rate (lb a.i./A)	Number of applications	POAN injury (%)		POAN control (%)			Bentgrass injury (%)				Bentgrass quality
			20 May	30 May	14 Jun	26 Jun	10 Jul	20 May	30 May	14 Jun	26 Jun	10 Jul
Untreated check			0	0	0	0	0	0	0	0	0	7.8
methiozolin	0.5	4	13	11	13	9	10	0	0	0	0	7.8
amicarbazone	0.088	2	30	55	26	31	30	5	16	10	9	6.3
amicarbazone	0.131	2	55	71	62	50	43	33	39	43	33	4.8
amicarbazone	0.175	2	79	92	93	89	73	73	78	76	76	1.5
bispyribac-sodium	0.022	4	13	16	40	65	18	0	5	9	0	7.3
bispyribac-sodium	0.033	4	11	26	61	66	29	4	5	10	3	7.5
LSD (p=0.05)			7.8	15.4	17.6	17.6	21.3	15.4	20.0	24.9	25.7	1.97

POAN = *P. annua*
Bentgrass quality rated on 1 – 9 scale where 1 is poor and 9 is best
Treatments applied 4 times at 10-day intervals on 30 April 2013, 10 May, 20 May, and 30 May.
Treatments applied 2 times on 30 April 2013 and 10 May.
Bispyribac-sodium treatments included non-ionic surfactant, Latron CS-7 at 0.25% v/v

Postemergence herbicides for goosegrass control study. Kai Umeda. (University of Arizona Cooperative Extension, Maricopa County, 4341 E. Broadway Road, Phoenix, AZ 85040) A small plot experiment was conducted at the Desert Canyon Golf Course in Fountain Hills, AZ in a rough area adjacent to a fairway with Tifway 419 bermudagrass. *Eleusine indica* was mature and seedheads were prevalent at the initiation of the field trial on 13 August 2013. The experimental units measured 5 ft by 10 ft and treatments were replicated four times in a randomized complete block design. Herbicides were applied using a backpack CO_2 sprayer equipped with a hand-held boom with three flat-fan 8003LP nozzles spaced 20 inches apart. The sprays were pressurized to 30 psi and delivered in 50 gpa water that included Hasten modified vegetable oil at 1% v/v. All treatments were initially applied on 13 August when the sky was clear, air temperature was 99°F, wind was from the SE at 4 mph, and soil temperature at 2-inch depth was 88°F. Sequential treatments were applied 3 weeks later on 03 September when air temperature was 86°F, clear sky, a breeze from the N at 2 mph, and soil temperature at 80°F. Topramezone at 0.022 lb a.i./A was not applied a second time.

A single application of topramezone at 0.022 lb a.i./A gave 95% goosegrass control but bermudagrass injury was severe for over 2 weeks. Two applications of topramezone at lower rates controlled goosegrass but injury following the second application was especially severe on bermudagrass.

Table. Postemergence herbicides for goosegrass control study, Desert Canyon Golf Course, Fountain Hills, AZ

Treatment	Rate (lb a.i./A)	ELEIN control (%) 27 Aug	03 Sep	11 Sep	17 Sep	26 Sep	Bermudagrass injury (%) 27 Aug	03 Sep	11 Sep	17 Sep	26 Sep
Untreated check		0	0	0	0	0	0	0	0	0	0
Thiencarbazone + Foramsulfuron + Halosulfuron	0.02 + 0.04 + 0.062	5	18	75	74	78	0	0	11	8	5
Sulfentrazone + Quinclorac	0.375 + 1.125	11	31	45	28	77	0	21	11	6	3
Topramezone	0.0055	69	66	84	81	86	12	13	65	15	8
Topramezone	0.011	76	71	88	91	93	21	16	71	28	29
Topramezone	0.016	81	81	93	95	94	29	16	80	50	55
Topramezone	0.022*	83	86	90	89	95	56	21	19	14	21
LSD (p=0.05)		4.3	6.4	4.1	9.2	4.1	9.1	12.3	7.1	9.7	14.3

Treatments applied sequentially on 13 August 2013 and 03 September.
*Applied once only on 13 August.
ELEIN = *Eleusine indica* (goosegrass)

Nutsedge control in turf with sequential applications of sulfonylurea herbicides and sulfentrazone. Kai Umeda. (University of Arizona Cooperative Extension, Maricopa County, Phoenix, AZ 85040) A small plot field trial was conducted at the Raven Golf Club in Phoenix, AZ on the driving range in a rough area with bermudagrass cv. Tifway 419 that was maintained at approximately 1.5 inch height. The treatment plots measured 5 ft by 5 ft and were replicated four times in randomized complete block design. The herbicides were applied with a CO_2 backpack sprayer equipped with a hand-held boom with three 8003LP flat fan nozzles spaced 20 inches apart. The sprays were applied in 50 gpa water pressurized to 30 psi. All treatments included a non-ionic surfactant, Latron CS-7 at 0.25% v/v. Treatments were initially applied on 11 July 2013 when the air temperature was 83°F, sky was cloudy, winds were less than 5 mph, and the soil temperature at 2 inch depth was 86°F. The nutsedge was approximately 4 inches tall with 6-8 leaves. The sequential applications were made on 15 August at 5 weeks after the first treatment applications (WAT) when the air temperature was 90°F, clear sky with some high clouds, winds at 3-5 mph, and soil temperature at 80°F. Sulfentrazone was applied alone on 11 July before a sequential application of a sulfonylurea herbicide on 15 August or it was applied alone sequentially on 15 August after a sulfonylurea herbicide application on 11 July. The sulfonylurea herbicides were also applied twice sequentially. Nutsedge control was visually rated at intervals following the applications.

On 29 August and 11 September, at 2 and 4 WAT-2, nutsedge control was acceptable at better than 85% for the sequential sulfonylurea herbicide applications. The sulfonylurea herbicides after an initial sulfentrazone application showed nearly comparable nutsedge control. Conversely, a sulfentrazone sequential application after the sulfonylurea herbicide did not adequately reduce nutsedge.

Table. Sequential applications of sulfonylurea herbicides and sulfentrazone for nutsedge control in turf at Raven Golf Club, Phoenix, AZ

Treatment	Rate (lb a.i./A)	Application Sequence	CYPRO Control				
			08 Aug	15 Aug	29 Aug	11 Sep	24 Sep
			----------------------- % -----------------------				
untreated check			0	0	0	0	0
halosulfuron	0.062		63	48	96	86	84
sulfosulfuron	0.059		89	84	98	86	90
flazasulfuron	0.14		78	79	97	88	91
thiencarbazone + foramsulfuron + halosulfuron	0.02 + 0.04 + 0.062		68	55	97	90	90
sulfentrazone	0.375	before	13	38	0	20	13
halosulfuron	0.062	before	25	50	91	80	65
sulfosulfuron	0.059	before	25	25	94	88	75
flazasulfuron	0.14	before	13	38	97	75	81
thiencarbazone + foramsulfuron + halosulfuron	0.02 + 0.04 + 0.062	before	25	50	93	90	83
sulfentrazone	0.375	after	0	0	0	15	30
halosulfuron	0.062	after	63	48	29	28	74
sulfosulfuron	0.059	after	89	84	49	53	76
flazasulfuron	0.14	after	78	79	73	65	86
thiencarbazone + foramsulfuron + halosulfuron	0.02 + 0.04 + 0.062	after	68	55	33	34	70
LSD (p=0.05)			21.1	25.3	19.1	29.5	23.2

CYPRO = *Cyperus rotundus*, purple nutsedge
Applications made on 11 July 2013 followed by 15 August
Application sequence of single sulfentrazone before or after single sulfonylurea herbicide application

Comparison of postemergence herbicides for nutsedge control in turf. Kai Umeda. (University of Arizona Cooperative Extension, Maricopa County, Phoenix, AZ 85040) A small plot field experiment was conducted on turfgrass in a rough area infested with purple nutsedge on the Padre Golf Course at Camelback Country Club in Scottsdale, AZ. The turf was bermudagrass cv. Tifway 419 maintained at approximately 1.5-in height. The treatment plots measured 5 ft by 10 ft and were replicated three times in a randomized complete block design. Herbicides were applied using a CO_2 backpack sprayer equipped with a hand-held boom with three 8003LP flat fan nozzles spaced 20 inches apart. The pressurized sprays at 30 psi were applied in 50 gpa water that included a non-ionic surfactant Latron CS-7 at 0.25% v/v. The test was initiated with all treatments being applied on 09 July 2013 when the air temperature was 93°F with high clouds, wind at less than 5 mph, soil temperature at 2-in depth was 86°F, and nutsedge was at the 4-5 leaf stage. Sequential applications were made on 13 August when the air temperature was 80°F, sky was clear, and no wind. Only single applications were made for the high rates of sulfentrazone products and MSMA. Nutsedge control was evaluated at intervals following the applications.

Through the summer, only sulfosulfuron, flazasulfuron, and the combination product thiencarbazone plus foramsulfuron plus halosulfuron continued to give marginally acceptable control at better than 82%. Sulfentrazone plus imazethapyr at a low rate sequentially was better than a single application at the high rate to reduce nutsedge at the end of the season. Sulfentrazone applied singly or sequentially did not perform up to the standard of a single application of MSMA.

Table. Comparison of herbicides for nutsedge control in turf, Camelback CC, Scottsdale, AZ

Treatment	Rate	CYPRO Control				
	(lb a.i./A)	30 Jul	13 Aug	27 Aug	11 Sep	26 Sep
		--------------------- % ---------------------				
Untreated check		0	0	0	0	0
Halosulfuron	0.062	88	65	93	75	75
Sulfosulfuron	0.059	95	87	98	93	85
Flazasulfuron	0.047	95	87	95	93	87
Thiencarbazone + Foramsulfuron + Halosulfuron	0.02 + 0.04 + 0.062	92	80	95	85	82
Sulfentrazone + Imazethapyr	0.188 + 0.038	68	57	87	73	57
Sulfentrazone + Imazethapyr*	0.375 + 0.075	83	67	47	40	33
Sulfentrazone	0.188	40	33	25	17	17
Sulfentrazone*	0.375	60	37	62	10	17
MSMA*	3.0	83	70	68	67	65
LSD (*p*=0.05)		24.1	21.6	21.9	24.7	32.4

CYPRO = *Cyperus rotundus*, purple nutsedge
*Single applications of herbicides made on 09 July 2013.
Sequential applications of other herbicides made initially on 09 July followed by 13 August.

Mayweed chamomile control in spring barley. Drew J. Lyon, Brianna Cowan, and Rod Rood. (Crop and Soil Sciences Department, Washington State University, PO Box 646420, Pullman, WA 99164-646420) A field study was conducted near Davenport, WA to investigate the control of mayweed chamomile with POST herbicides in spring barley. The soil was a Mondovi silt loam with 3.0% organic matter and a pH of 7.0. 'Champion' spring barley was planted at a rate of 80 pounds per acre on April 16, 2013 using a Flexi-coil drill with 12-inch row spacing. The herbicide applications were made on May 30, 2013 using a CO_2 backpack sprayer set to deliver 10 gpa at 30 psi and 3 mph. Mayweed chamomile was 2 inches in diameter and barley was at the two-leaf stage at the time of application. The plots were harvested for grain yield on August 28, 2013.

Slight crop injury was observed in a couple of the treatments containing 2,4-D ester (Table). No other crop injury was observed. Excellent control of mayweed chamomile was achieved with pyrasulfotole/bromoxynil + 2,4-D, clopyralid/fluroxypyr, and florasulam/fluroxypyr + bromoxynil/MCPA. Florasulam/fluroxypyr tank mixed with 2,4-D ester, MCPA ester, or thifensulfuron/tribenuron provided fair to good control of mayweed chamomile. There appeared to be some segregation of the mayweed chamomile population at this site for tolerance to the Group 2 herbicides, which may help explain why control was only fair with many of the treatments containing herbicides with this mechanism of action. The spring barley crop was very competitive in this study and no treatment had a grain yield significantly different from the nontreated check.

Table. Mayweed chamomile control in spring barley.

Treatment	Rate	13-Jun-13 Injury	13-Jun-13 Mayweed control	24-Jul-13 Mayweed control	28-Aug-13 Grain yield
	oz ai/a	-------------------------------%---		---------------------------	tons/acre
Clopyralid /fluroxypyr	3.0	0	63	93	2.80
Pyrasulfotole/bromoxynil +	0.43	4	87	95	3.00
2,4-D ester +	5.5				
AMS	1.5 lb/a				
Florasulam/fluroxypyr	1.49	0	50	82	3.10
Florasulam/fluroxypyr +	1.49	4	60	77	2.90
2,4-D ester	5.5				
Florasulam/fluroxypyr +	1.49	0	60	85	3.10
MCPA ester	5.5				
Florasulam/fluroxypyr +	1.49	1	53	81	3.10
Thifensulfuron/tribenuron +	0.2				
NIS	0.25% v/v				
Florasulam/fluroxypyr +	1.49	1	53	90	3.10
Bromoxynil/MCPA ester	8.0				
Pyrasulfotole/bromoxynil +	2.84	0	69	86	3.10
NIS +	0.25% v/v				
AMS	1.0 lb/a				
Thifensulfuron/tribenuron +	0.2	0	83	72	3.10
2,4 D ester +	5.5				
NIS	0.25% v/v				
Florasulam/MCPA	4.97	0	47	78	3.00
GF-2686 +	0.14	0	50	77	3.30
NIS	0.25% v/v				
Nontreated check		0	0	0	3.10
LSD (5%)		4	20	12	0.43

Weed control with preemergence herbicide combinations in dry bean. Don W. Morishita, Kyle G. Frandsen, and Neyle T. Perdomo. (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 the effectiveness of various preemergence herbicide combinations for hairy nightshade control and other weeds in dry bean. '*Bill Z*' pinto bean was planted May 31, 2013, at 95,041 seed/A. Experimental design was a randomized complete block with four replications and individual plots were 7.33 by 30 ft. Soil type was a Portneuf silt loam consisting of 20% sand, 58% silt, and 22% clay with a pH of 8.3, 1.4% organic matter, and CEC of 15-meq/100 g soil. Herbicides were applied on June 4 and June 20 with a CO_2-pressurized bicycle-wheel sprayer using 11001 flat fan nozzles calibrated to deliver 15 gpa at 22 psi and 3 mph. Additional environmental and agronomic information is presented in Table 1. Crop injury was evaluated visually 13 days after the first application (DAFA), 7 and 28 days after the last application (DALA) on June 17, 27 and July 18, respectively. Weed control was evaluated visually 7 DALA. Weed counts were taken 21 and 35 DALA on July 11 and July 25, respectively. Dry bean yield was determined by harvesting the two center rows of each plot on October 7 with a small-plot combine.

Table 1. Environmental conditions at application

Application date	6/4/2013	6/20/2013
Application timing	preemergence	3 to 5 inch weeds
Air temperature (F)	77	64
Soil temperature (F)	70	54
Relative humidity (%)	28	48
Wind speed (mph)	4	1
Cloud cover (%)	15	30
Time of day	1200	0945

Crop injury 13 DAFA ranged from 1 to 9 % (Table 2). However, there were no statistical differences among herbicide treatments. By 28 DALA, crop injury essentially disappeared and ranged from 0 to 1% across all herbicide treatments. Weed control in this experiment was confounded by the high variability in weed populations. This resulted in no differences in common lambsquarters, redroot pigweed and hairy nightshade control among herbicide treatments, even though control ranged from 51 to 93%, 29 to 86%, and 40 to 94%, respectively. Green foxtail control ranged from 41 to 85% and even though there were differences among herbicide treatments, the variability in green foxtail population resulted in wide ranges in control that were statistically equal. For example, those treatments with the best green foxtail control ranged from 69 to 85%. Weed counts by species also were variable across treatments (Table 3). The untreated control was among those treatments with the highest weed populations, with the exception of hairy nightshade at the 21 DALA counting date. Common lambsquarters densities at the 21 DALA counting date were lower than the control in all treatments except EPTC + ethalfluralin at 2.63 + 1.13 lb ai/A, dimethenamid-P + acetochlor at 0.7 + 1.125 lb ai/A, and dimethenamid-P at 0.7 lb ai/A followed by imazamox + bentazon at 0.0313 + 0.656 lb ai/A. However, common lambsquarters density was lower than the control with all treatments except dimethenamid + acetochlor by 35 DALA. Sulfentrazone/*s*-metolachlor at 0.98 lb ai/A consistently had the lowest common lambsquarters density at both counting dates. Redroot pigweed densities 21 DALA were 63 to 95% lower than the control with all herbicide treatments. By 35 DALA only one treatment, acetochlor + ethalfluralin had as much redroot pigweed as the control. Hairy nightshade density at 21 DALA was highest with EPTC + ethalfluralin rates applied, averaging 13 to 16 plants/ft^2 compared to the control which averaged 5 plants/ft^2. All herbicide treatments, except flumioxazin applied Pre only at 21 DALA, had lower densities than the control. Dimethenamid-P + pendimethalin at both rates were among those treatments with the lowest green foxtail density at either counting date. Dry bean yield among herbicide treatments ranged from 2,698 to 3,848 lb/A with the untreated control yielding at 2,203 lb/A. However, due to the variability in weed populations, there was no yield difference among treatments including the untreated control.

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

	Application		Crop injury			Weed control[2]			
						CHEAL	AMARE	SETVI	SOLSA
Treatment[3]	rate	date	6/17	6/27	7/18	6/27	6/27	6/27	6/27
	lb ai/A		%						
Untreated control			-	-	-	-	-	-	-
Flumioxazin	0.048	6/4	1 a	3 a	0 a	83 a	50 a	80 a	64 a
Flumioxazin + pendimethalin	0.048 + 0.95	6/4	9 a	1 a	0 a	61 a	29 a	59 bc	69 a
Flumioxazin + ethalfluralin	0.048 + 0.75	6/4	1 a	4 a	0 a	76 a	59 a	69 ab	64 a
EPTC + ethalfluralin	3.5 + 1.5	6/4	1 a	3 a	0 a	84 a	40 a	81 a	41 a
EPTC + ethalfluralin	2.63 + 1.13	6/4	3 a	3 a	0 a	78 a	71 a	76 ab	40 a
Slfntrzn/mtlchlr	0.82	6/4	4 a	4 a	0 a	90 a	59 a	70 ab	70 a
Slfntrzn/mtlchlr	0.98	6/4	9 a	8 a	1 a	93 a	68 a	74 ab	88 a
Dimethenamid-P + pendimethalin	0.7 + 0.83	6/4	4a	4 a	0 a	70 a	58 a	80 a	63 a
Dimethenamid-P + ethalfluralin	0.7 + 1.13	6/4	3 a	1 a	0 a	75 a	86 a	85 a	55 a
Dimethenamid-P + EPTC	0.7 + 2.63	6/4	5 a	3 a	0 a	53 a	76 a	84 a	63 a
Dimethenamid-P + acetochlor	0.7 + 1.125	6/4	1 a	5 a	0 a	69 a	36 a	71 ab	84 a
Dimethenamid-P fb imazamox + bentazon + MSO + UAN 32	0.7 0.0313 + 0.656 + 1% v/v + 2.5% v/v	6/4 6/20	0 a	3 a	0 a	88 a	83 a	76 ab	94 a
Acetochlor + ethalfluralin	1.125 + 1.13	6/4	3 a	3 a	0 a	70 a	15 a	43 c	65 a
Acetochlor + EPTC	1.125 + 2.63	6/4	1 a	4 a	0 a	51 a	56 a	41 c	58 a
Sftz/mtcr + ethalfluralin	0.82 + 1.13	6/4	5 a	3 a	0 a	91 a	36 a	56 bc	64 a

Table 2. Continued[1]

	Application		Weed counts[2]								Dry
	Application		CHEAL		AMARE		SOLSA		SETVI		bean
Treatment[3]	rate	date	7/11	7/25	7/11	7/25	7/11	7/25	7/11	7/25	yield
	lb ai/A		-------------	-------------	-------------	-------------	-plants/ft^2-	-------------	-------------	-------------	lb/A
Untreated control			43 a	28 a	19 a	5 a	4 cd	5 a	31 a	34 a	2,203 a
Flumioxazin	0.048	6/4	6 bcd	7 bcd	2 cde	1 bcd	2 de	1 def	28 a	10 b	3,028 a
Flumioxazin + pendimethalin	0.048 + 0.95	6/4	7 bcd	8 bcd	1 de	1 bcd	1 e	0 f	11 bcd	12 b	3,137 a
Flumioxazin + ethalfluralin	0.048 + 0.75	6/4	7 bcd	6 bcd	1de	0 d	1 e	0 f	10 bcd	6 bcd	3,151 a
EPTC + ethalfluralin	3.5 + 1.5	6/4	9 bc	8 bcd	3 b-e	2 b	16 a	3 ab	10 bcd	8 bc	3,160 a
EPTC + ethalfluralin	2.63 + 1.13	6/4	18 ab	7 bcd	4 bc	2 b	13 ab	2 b-e	13 b	12 b	3,538 a
Slfntrzn/mtlchlr	0.82	6/4	3 d	3 cde	2 cde	1 bc	7 bc	1 b-f	12 bc	8 bc	3,417 a
Slfntrzn/mtlchlr	0.98	6/4	1 e	0 e	1 de	0 cd	2 cde	1 c-f	6 bcd	4 c-f	3,848 a
Dimethenamid-P + pendimethalin	0.7 + 0.83	6/4	6 bcd	7 bcd	1 de	1 bc	2 cde	2 a-e	5 cd	2 f	3,135 a
Dimethenamid-P + ethalfluralin	0.7 + 1.13	6/4	7 bcd	9 bcd	2 cde	1 bcd	2 de	3 ab	8 bcd	2 ef	3,048 a
Dimethenamid-P + EPTC	0.7 + 2.63	6/4	7 bcd	13 b	2 cde	2 bc	1 de	1 b-f	3 d	3 def	2,965 a
Dimethenamid-P + acetochlor	0.7 + 1.125	6/4	17 ab	16 ab	3 b-e	1 bcd	1 de	1 ef	10 bcd	5 b-e	2,698 a
Dimethenamid-P fb imazamox + bentazon + MSO + UAN 32	0.7 0.0313 + 0.656 + 1% v/v + 2.5% v/v	6/4 6/20	14 ab	11 bcd	4 bcd	1 bcd	3 cde	3 abc	13 bc	5 b-e	3,427 a
Acetochlor + ethalfluralin	1.125 + 1.13	6/4	12 b	9 bcd	7 b	4 a	7 bc	1 b-f	9 bcd	9 b	3,414 a
Acetochlor + EPTC	1.125 + 2.63	6/4	13 b	11 bc	3 bcd	1 bcd	3 cde	2 a-d	10 bcd	11 b	2,713 a
Sftz/mtcr + ethalfluralin	0.82 + 1.13	6/4	3 cd	2 de	2 cde	1 bcd	4 cd	1 b-f	10 bcd	7 bc	3,532 a

[1]Means followed by same letter are not significantly different using Fisher's Protected LSD (P=0.05).
[2]Weeds evaluated for control and counted were: common lambsquarters (CHEAL), redroot pigweed (AMARE), hairy nightshade (SOLSA), and green foxtail (SETVI).
[4]Flumioxazin is Valor, pendimethalin is Prowl H_20, ethalfluralin is Sonalan, EPTC is Eptam, Slfntrzn/mtlchlr is sulfentrazone/metolachlor sold as Broad Axe, dimethenamid-P is Outlook, acetochlor is Warrant, imazamox is Raptor, bentazon is Basagran, fb is followed by, MSO is methylated seed oil, and UAN 32 is nitrogen fertilizer.

Preemergence and postemergence herbicides for weed control in dry bean. Don W. Morishita, Kyle G. Frandsen, and Neyle T. Perdomo. (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 evaluate the effectiveness of various preemergence (Pre) and postemergence (Post) herbicides for weed control in dry bean. '*Bill Z*' pinto bean was planted May 31, 2013, at 95,041 seed/A. Experimental design was a randomized complete block with four replications and individual plots were 7.33 by 30 ft. Soil type was Portneuf silt loam (20% sand, 58% silt, and 22% clay), with a pH of 8.3, 1.4% organic matter, and CEC of 15-meq/100 g soil. Herbicides were applied June 4 and June 20 with a CO_2-pressurized bicycle-wheel sprayer using 11001 flat fan nozzles calibrated to deliver 15 gpa at 22 psi and 3 mph. An environmental condition at application is given in Table 1. Crop injury was evaluated visually 5, 12, and 29 days after last application (DALA) on June 25, July 2 and July 19 respectively. Weed control was evaluated visually 12 and 29 DALA. Dry bean was harvested October 7 with a small-plot combine.

Table 1. Environmental conditions at application

Application date	6/4/2013	6/20/2013
Application timing	premergence	3 to 5 inch weeds
Air temperature (F)	77	64
Soil temperature (F)	70	54
Relative humidity (%)	28	48
Wind speed (mph)	4	1
Cloud cover (%)	15	30
Time of day	1200	0845

Crop injury for all evaluation dates was minimal, ranging from 1 to 6 % (Table 2). Common lambsquarters control 12 DALA ranged from 60 to 97%. Treatments containing dimethenamid-P and/or pendimethalin controlled common lambsquarters best and ranged from 93 to 97% with the exception of the dimethenamid-P applied alone PRE which only controlled common lambsquarters 60%. Common lambsquarters control 29 DALA ranged from 56 to 98%. The same treatments that controlled common lambsquarters >90% 12 DALA controlled it >90%. BAS 672 O1H at 0.574 lb ai/A plus MSO and UAN 32 also controlled common lambsquarters 90%. Redroot pigweed control for both evaluation dates was similar with control ranging from 69 to 100%. Only glyphosate + *s*-metolachlor at 0.94 lb ai/A plus pendimethalin at 0.95 lb ai/A controlled redroot pigweed <70%. Hairy nightshade control for both evaluation dates ranged from 55 to 100%. At 12 DALA, only *s*-metolachlor alone controlled hairy nightshade <80%. By 29 DALA, hairy nightshade was best controlled with all treatments containing BAS 762 O1H, regardless of whether it was applied alone or in combination with dimethenamid-P, pendimethalin, or imazamox. Green foxtail control for both dates ranged from 46 to 98%. Treatments with BAS 762 O1H applied in combination with dimethenamid-P, pendimethalin or imazamox controlled green foxtail 90% or better over both evaluation dates. However, treatments containing *s*-metolachlor alone or in combination and dimethenamid-P alone controlled green foxtail statistically equal. Dry bean yields ranged from 2,786 lb/A to 4,661 lb/A across all the herbicide treatments with the untreated control yielding 1,630 lb/A. The highest yielding treatments all contained BAS 762 O1H alone or in combination with another herbicide.

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

						Weed control[2]								Dry
	Application		Crop injury			CHEAL		AMARE		SOLSA		SETVI		bean
Treatment[3]	rate	date	6/25	7/2	7/19	7/2	7/19	7/2	7/19	7/2	7/19	7/2	7/19	yield
	lb ai/A		---%---											lb/A
Untreated control														1,630 f
Dimethenamid-P	0.656	6/4	1 a	0 c	1 a	60 d	63 de	85 d	86 cde	96 ab	79 bc	83 bcd	91 ab	2,786 e
Dimethenamid-P+	0.656 +	6/20	4 a	1 bc	0 a	97 a	98 a	100 a	99 a	100 a	99 a	96 a	98 a	4,303 ab
BAS 762 O1H +	0.574 +													
MSO +	1% v/v +													
UAN 32	2.5% v/v													
Pendimethalin fb	0.95	6/4	3 a	1 abc	0 a	93 a	97 ab	99 a	98 ab	99 ab	99 a	95 a	93 ab	4,450 a
BAS 762 O1H +	0.574 +	6/20												
MSO +	1% v/v +													
UAN 32	1% v/v													
Pendimethalin +	0.95 +	6/4	3 a	1 bc	0 a	93 a	96 ab	99 ab	99 a	99 ab	99 a	96 a	98 a	4,168 abc
Dimethenamid-P fb	0.656 +													
BAS 762 O1H +	0.574 +	6/20												
MSO +	1% v/v +													
UAN 32	2.5% v/v													
Imazamox +	0.0313 +	6/20	4 a	0 c	1 a	83 b	92 bc	97 abc	97 abc	98 ab	99 a	90 ab	94 ab	4,661 a
BAS 762 O1H +	0.574 +													
MSO +	1% v/v +													
UAN 32	2.5% v/v													
BAS 762 O1H +	0.438 +	6/20	3 a	2 abc	0 a	81 bc	88 c	91 bcd	92 abc	93 bc	94 a	88 abc	86 ab	4,548 a
MSO +	1% v/v +													
UAN 32	2.5% v/v													
BAS 762 O1H +	0.574 +	6/20	5 a	3 ab	0 a	83 b	90 bc	98 abc	96 abc	97 ab	98 a	88 abc	84 b	4,573 a
MSO +	1% v/v +													
UAN 32	2.5% v/v													
S-metolachlor	1.27	6/4	4 a	1 bc	1 a	71 cd	60 de	80 d	89 bcd	63 d	55 d	78 cd	89 ab	3,619 bcd
S-metolachlor +	1.27 +	6/4	3 a	0 c	1 a	78 bc	70 d	88 cd	91 abc	82 cd	83 b	79 cd	89 ab	3,500 cde
ethalfluralin	1.13													
S-metolachlor +	1.27 +	6/4	1 a	0 c	0 a	63 d	56 e	85 d	86 cde	92 bc	76 bc	73 de	90 ab	3,249 de
fomesafen	0.25													
Glyph/metol +	0.94 +	6/4	1 a	0 c	0 a	71 cd	66 de	78 d	69 e	81 cd	71 c	80 bcd	86 ab	3,545 cd
AMS +	1.28 +													
pendimethalin	0.95													
Fluazifop-P-butyl +	0.094 +	6/20	6 a	5 a	1 a	64 d	56 e	89 cd	72 de	81 cd	74 bc	65 e	46 c	3,035 de
fomesafen	0.25													

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

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

[3]Pendimethalin is Prowl H_2O, Dimethenamid-P is Outlook, BAS 762 O1H is Imazamox + Bentazon, *s*-metolachlor is Dual Magnum, imazamox is Raptor, ethalfluralin Sonalan, fomesafen is Reflex, glyph/metol is glyphosate + s-metolachlor and sold as Sequence, fluazifop is Fusilade DX, UAN 32 is urea ammonium nitrate fertilizer, and MSO is methylated seed oil, and fb is followed by.

Comparison of various adjuvants with glyphosate for weed control and crop tolerance in sugar beet. Don W. Morishita, Kyle G. Frandsen, and Neyle T. Perdomo. (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 compare the effectiveness of various adjuvants used with glyphosate for weed control in sugar beet. In this study, glyphosate was applied at either 0.5 or 1 lb ae/A for those treatments that did not include an insecticide or fungicide tank mix partner. Applying glyphosate at a below-label rate (0.5 lb ae/A) with the various adjuvants can sometime show differences in the effectiveness of adjuvants. 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 consisting of 29.4% sand, 65% silt, and 5.6% clay with a pH of 8.1, 1.55% organic matter, and CEC of 14-meq/100 g soil. 'Holly Hybrid SX1502RR' sugar beet was planted April 26, 2013, in 22-inch rows at a rate of 60,589 seed/A. Wild oat (AVEFA), common lamsquarters (CHEAL), kochia (KCHSC) 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 14 and 28 days after the last herbicide application (DALA) on July 1 and July 15. The two center rows of each plot were harvested mechanically October 1.

Table 1. Environmental conditions and weed species densities at application

Application date	5/29	6/1	6/17
Application timing	2 leaf	2 leaf	4 leaf
Air temperature (F)	51	54	72
Soil temperature (F)	50	52	58
Relative humidity (%)	54	48	31
Wind velocity (mph)	0	5	2
Cloud cover (%)	25	10	0
Time of day	0830	0830	0930
Weed species/ft^2			
kochia	11	-	11
lambsquarters, common	45	-	43
pigweed, redroot	7	-	4
oat, wild	54	-	59

Crop Injury at 14 and 28 DALA was ≤5% for all herbicide treatments (Table 2). Wild oat control 14 DALA ranged from 97 to 99% control with no differences among herbicide treatments. At 28 DALA, there were significant differences in wild oat control, but the control ranged from 89 to 99%. The lowest control rating (89%) was with glyphosate at 0.5 lb ae/a plus ammonium sulfate (AMS) at 2.5% v/v. Common lambsquarters control 14 DALA ranged from 84 to 100% control. The poorest control (84%) was with glyphosate at 1 lb ae/A plus zeta cypermethrin + pyraclostrobin + WE1411-1. By 28 DALA, common lambsquarters control ranged from 85 to 97%, but there were no significant differences among the herbicide treatments. Kochia control ranged from 93 to 100% for all herbicide treatments at 14 and 28 DALA. Similarly, redroot pigweed control ranged from 96 to 100% 14 DALA. At 28 DALA, redroot pigweed control became a little more variable among all of the treatments and ranged from 80 to 99%, with no differences among herbicide treatments. Even with the reduced glyphosate rates, there really was little or no difference among the various adjuvants tested for weed control. Sugar beet root and recoverable sucrose yield of the untreated control averaged 5 ton/A and 1,206 lb/A, respectively. There were no significant differences among the herbicide treatments in root yield which ranged from 36 to 44 ton/A or sucrose yield which ranged from 9,537 to 11,300 lb/A.

Table 2. Crop tolerance, weed control, root yield and ERS in sugar beets near Kimberly, ID[1]

	Application		Crop injury		Weed control[2] AVEFA		CHEAL		KCHSC		AMARE		Root	
Treatment[3]	rate	date	7/1	7/15	7/1	7/15	7/1	7/15	7/1	7/15	7/1	7/15	yield	ERS[4]
	lb ae/A		--------------------					%				--------------------	ton/A	lb/A
Untreated control			-	-	-	-	-	-	-	-	-	-	5 b	1,206 b
Glyphosate-1	0.5	6/1	2 a	3 a	99 a	92 cd	92 bcd	87 a	94 a	93 a	98 a	89 a	36 a	9,537 a
Glyphosate-1	0.375	6/17												
Glyphosate-1	1.0	6/1	1 a	1 a	99 a	97 abc	98 ab	91 a	99 a	100 a	99 a	94 a	38 a	10,026 a
Glyphosate-1	0.77	6/17												
Glyphosate-1 + AMS	0.5 + 2.5% v/v	6/1	2 a	3 a	99 a	89 d	90 cde	88 a	96 a	97 a	97 a	89 a	36 a	9,399 a
Glyphosate-1 + AMS	0.375 + 2.5% v/v	6/17												
Glyphosate-1 + AMS	1 + 2.5% v/v	6/1	1 a	1 a	99 a	97 abc	99 ab	96 a	100 a	98 a	98 a	90 a	42 a	11,057 a
Glyphosate-1 + AMS	0.77 + 2.5% v/v	6/17												
Glyphosate-1 + Class Act NG	0.5 + 2.5% v/v	6/1	1 a	1 a	99 a	97 abc	96 abc	96 a	100 a	99 a	96 a	94 a	39 a	10,216 a
Glyphosate-1 + Class Act NG	0.375 + 2.5% v/v	6/17												
Glyphosate-1 + Class Act NG	1 + 2.5% v/v	6/1	0 a	1 a	99 a	94 cd	97 ab	94 a	100 a	100 a	96 a	83 a	39 a	10,219 a
Glyphosate-1 + Class Act NG	0.77 + 2.5% v/v	6/17												
Glyphosate-1 + Class Act NG	0.5 + 1.25% v/v	6/1	3 a	0 a	99 a	95 bc	95 a-d	91 a	100 a	100 a	100 a	91 a	42 a	10,159 a
Glyphosate-1 + Class Act NG	0.375 + 1.25% v/v	6/17												
Glyphosate-1 + Class Act NG	1 + 1.25% v/v	6/1	3 a	1 a	99 a	95 bc	99 a	96 a	100 a	100 a	99 a	90 a	40 a	10,349 a
Glyphosate-1 + Class Act NG	0.77 + 1.25% v/v	6/17												
Glyphosate-1 + AG 08034	0.5 + 2% v/v	6/1	1 a	1 a	98 a	95 bcd	95 a-d	93 a	100 a	100 a	99 a	94 a	41 a	10,671 a
Glyphosate-1 + AG 08034	0.375 + 2% v/v	6/17												

Table 2. continued.

Treatment[3]	Application rate	Application date	Crop injury 7/1	Crop injury 7/15	AVEFA 7/1	AVEFA 7/15	CHEAL 7/1	CHEAL 7/15	KCHSC 7/1	KCHSC 7/15	AMARE 7/1	AMARE 7/15	Root yield	ERS[4]
					Weed control[2]									
	lb ae/A		%										ton/A	lb/A
Glyphosate-1 + AG 08034	1 + 2% v/v	6/1	1 a	1 a	99 a	99 a	99 ab	95 a	100 a	100 a	97 a	83 a	39 a	9,976 a
Glyphosate-1 + AG 08034	0.77 + 2% v/v	6/17												
Glyphosate-1 + AG 08034	0.5 + 1% v/v	6/1	5 a	4 a	99 a	98 ab	97 ab	96 a	99 a	100 a	99 a	95 a	37 a	9,595 a
Glyphosate-1 + AG 08034	0.375 + 1% v/v	6/17												
Glyphosate-1 + AG 08034	1 + 1% v/v	6/1	2 a	3 a	99 a	97 abc	99 a	94 a	100 a	100 a	99 a	91 a	40 a	10,141 a
Glyphosate-1 + AG 08034	0.77 + 1% v/v	6/17												
Glyphosate-1 + AG 11011	0.5 + 1% v/v	6/1	1 a	1 a	99 a	97 abc	98 ab	94 a	98 a	95 a	97 a	96 a	37 a	9,966 a
Glyphosate-1 + AG 11011	0.375 + 1% v/v	6/17												
Glyphosate-1 + AG 11011	1 + 1% v/v	6/1	3 a	3 a	98 a	95 bc	100 a	95 a	100 a	100 a	98 a	89 a	39 a	10,557 a
Glyphosate-1 + AG 11011	0.77 + 1% v/v	6/17												
Glyphosate-1 + AG 11011	0.5 + 1.25% v/v	6/1	0 a	1 a	97 a	96 abc	97 ab	93 a	98 a	96 a	97 a	89 a	39 a	10,346 a
Glyphosate-1 + AG 11011	0.375 + 1.25% v/v	6/17												
Glyphosate-1 + AG 11011	1 + 1.25% v/v	6/1	2 a	3 a	98 a	96 abc	99 ab	92 a	99 a	99 a	99 a	94 a	39 a	10,270 a
Glyphosate-1 + AG 11011	0.375 + 1.25% v/v	6/17												
Glyphosate-2 + zeta cypermethrin + pyraclostrobin	1 + 0.151 lb ai/A + 0.196 lb ai/A	5/29	1 a	1 a	99 a	98 ab	92 bcd	90 a	100 a	100 a	99 a	94 a	44 a	11,300 a
Glyphosate-2 + zeta cypermethrin + pyraclostrobin	0.77 + 0.151 lb ai/A + 0.196 lb ai/A	6/17												

Table 2. continued.

	Application		Crop injury		Weed control[2]								Root	
					AVEFA		CHEAL		KCHSC		AMARE			
Treatment[3]	rate	date	7/1	7/15	7/1	7/15	7/1	7/15	7/1	7/15	7/1	7/15	yield	ERS[4]
	lb ae/a		%										ton/A	lb/A
Glyphosate-2 +	1 +	5/29	1 a	3 a	98 a	98 ab	92 bcd	97 a	98 a	98 a	99 a	99 a	39 a	10,155 a
zeta cypermethrin +	0.151 lb ai/A +													
pyraclostrobin +	0.196 lb ai/A +													
NIS	0.25% v/v													
Glyphosate-2 +	0.77 +	6/17												
zeta cypermethrin +	0.151 lb ai/A +													
pyraclostrobin +	0.196 lb ai/A +													
NIS	0.25% v/v													
Glyphosate-2 +	1 +	5/29	2 a	3 a	99 a	97 abc	84 e	85 a	98 a	96 a	96 a	80 a	41 a	10,879 a
zeta cypermethrin +	0.151 lb ai/A +													
pyraclostrobin +	0.196 lb ai/A +													
WE1411-1	0.25% v/v													
Glyphosate-2 +	0.77 +	6/17												
zeta cypermethrin +	0.151 lb ai/A +													
pyraclostrobin +	0.196 lb ai/A +													
WE1411-1	0.25% v/v													
Glyphosate-2 +	1 +	5/29	1 a	0 a	99 a	95 bc	89 de	86 a	99 a	97 a	96 a	87 a	39 a	10,578 a
zeta cypermethrin +	0.151 lb ai/A +													
pyraclostrobin +	0.196 lb ai/A +													
WE1279-2	0.25% v/v													
Glyphosate-2 +	0.77 +	6/17												
zeta cypermethrin +	0.151 lb ai/A +													
pyraclostrobin +	0.196 lb ai/A +													
WE1279-2	0.25% v/v													

[1]Means followed by same letter are not significantly different using Fisher's Protected LSD (P=0.05).
[2]Weeds evaluated for control were: wild oat (AVEFA), common lambsquarters (CHEAL), kochia (KCHSC), and redroot pigweed (AMARE).
[3]Glyphosate-1 is Cornerstone Plus. AMS is ammonium sulfate sold as N Pak AMS. Class Act NG is an ammonium sulfate and nonionic surfactant blend used for drift control. AG 08034 is an unregistered adjuvant. AG 11011 is an unregistered adjuvant. Glyphosate-2 is Roundup PowerMax. Zeta cypermethrin is Mustang. Pyraclostrobin is Headline. NIS is the nonionic surfactant R-11. WE1411-1 is an unregistered adjuvant. WE1279-2 is an unregistered adjuvant.
[4]ERS is estimated recoverable sugar.

Weed resistance management tank mixtures in sugar beet. Don W. Morishita, Kyle G. Frandsen, Neyle T. Perdomo. (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 various tank mixtures for weed control and as a potential resistance management tool 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 Rad silt loam (14.3% sand, 66.6% silt, and 19% clay) with a pH of 8.1, 1.59% organic matter, and CEC of 16.9-meq/100 g soil. 'Holly Hybrid SX1502RR' sugar beet was planted April 26, 2013, in 22-inch rows at a rate of 60,589 seed/A. Common lambsquarters (CHEAL), redroot pigweed (AMARE), hairy nightshade (SOLSA), Russian-thistle (SASKR) 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. Crop injury and weed control were evaluated visually 38 days after the first herbicide application (DAFA) on June 13 and again 20 days after the last application (DALA) on July 23. The two center rows of each plot were harvested mechanically on September 27.

Table 1. Environmental conditions and weed species densities at application

Application date	5/6/2013	5/23/2013	6/12/2013	6/18/2013	7/3/2013
Application timing	pre-germination	2 leaf	4 leaf	6 leaf	row closure
Air temperature (F)	74	57	75	75	73
Soil temperature (F)	-	68	80	62	73
Relative humidity (%)	21	23	37	25	58
Wind velocity (mph)	4	2	2	1	2
Cloud cover (%)	75	10	80	20	100
Time of day	1610	1200	1600	0820	0700
Weed species/ft^2					
foxtail, green	-	4	3	-	-
lambsquarters, common	-	20	20	-	-
nightshade, hairy	-	6	4	-	-
oat, wild	-	-	6	-	-
pigweed, redroot	-	1	1	-	-
Russian-thistle	-	4	4	-	-

Crop injury 38 DAFA and 20 DALA ranged from 0 to 8% and did not impact crop yield. Common lambsquarters control 38 DAFA ranged from 0 to 97% with the most consistent control with ethofumesate applied preemergence. At 20 DALA, common lambsquarters control improved greatly from the previous evaluation and ranged from 80 to 99%. The poorest common lambsquarters control was with glufosinate applied preemergence followed by (fb) glyphosate + acetochlor fb glyphosate alone. Redroot pigweed control 38 DAFA ranged from 0 to 98% and was poorest with glufosinate applied preemergence fb glyphosate + acetochlor fb glyphosate alone. However, by 20 DALA, redroot pigweed control ranged from 98 to 100% for all herbicide treatments. Hairy nightshade control 38 DAFA evaluation ranged from 35 to 97%. All of the glufosinate preemergence applications had the poorest control, which was 61% or less. At 20 DALA, hairy nightshade control was 100% with all treatments. Russian-thistle and green foxtail control 38 DAFA ranged from 2 to 98%. Similar to what was observed for hairy nightshade control, Russian-thistle and green foxtail control improved to 88 to 100%. The reason why weed control was so poor with the glufosinate preemergence application was because most of the weeds emerged after it was applied. Root yield ranged from 20 to 48 ton/A with the untreated control having the lowest yield at 20 ton/A. Even though weed control with the glufosinate applications was so poor, there were no differences in root yield among any of the herbicide treatments. Estimated recoverable sugar (ERS) yield ranged from 5,312 to 13,168 lb/A. Only glufosinate at 0.66 lb ai/A fb glyphosate + acetochlor fb glyphosate alone had an ERS lower than the highest yielding treatments.

Table 2. Crop tolerance, weed control, root yield, and ERS in sugar beet near Kimberly, ID[1]

	Application		Crop injury		Weed control[2]										Root	
					CHEAL		AMARE		SOLSA		SASKR		SETVI			
Treatment[3]	rate	date	6/13	7/23	6/13	7/23	6/13/	7/23	6/13	7/23	6/13	7/23	6/13	7/23	yield	ERS[4]
	lb ai/A		------------	------------	------------	------------	------------	------------	%	------------	------------	------------	------------	------------	ton/A	lb/A
Untreated control			-	-	-	-	-	-	-	-	-	-	-	-	20 b	5,312 c
Glyphosate +	0.77 lb ae/A +	5/23, 6/18,	0 a	1 b	2 bc	97 abc	94 a	100 a	86 a	100 a	13 c	96 ab	20 ab	100 a	40 a	11,042 ab
AMS	2.5	7/3														
Glyphosate +	1.125 lb ae/A +	5/23	2 a	1 b	62 a	97 abc	93 a	100 a	89 a	100 a	56 ab	96 ab	74 a	100 ab	48 a	13,168 a
AMS	2.5															
Glyphosate +	0.77 lb ae/A +	6/18, 7/3														
AMS	2.5															
Gulfosinate ammonium +	0.53 +	5/6	0 a	8 a	0 c	81 e	15 c	98 bc	38 cd	100 a	24 bc	98 ab	5 bc	100 bc	36 a	10,073 ab
AMS	3															
Glyphosate +	1.125 lb ae/A +	6/12														
acetochlor +	1.125 +															
AMS	2.5															
Glyphosate +	0.77 lb ae/A +	7/3														
AMS	2.5															
Gulfosinate ammonium +	0.66 +	5/6	0 a	6 a	0 c	80 e	0 c	97 c	38 cd	100 a	24 bc	94 bc	2 c	99 c	33 ab	8,655 bc
AMS	3															
Glyphosate +	1.125 lb ae/A +	6/12														
acetochlor +	1.125 +															
AMS	2.5															
Glyphosate +	0.77 lb ae/A +	7/3														
AMS	2.5															
Gulfosinate ammonium +	0.53 +	5/6	0 a	0 b	6 b	94 bc	71 ab	100 a	35 d	100 a	24 bc	95 ab	28 ab	100 a	46 a	12,513 ab
ethofumesate +	2 +															
AMS	3															
Glyphosate +	1.125 lb ae/A +	6/12														
acetochlor +	1.125 +															
AMS	2.5															
Glyphosate +	0.77 lb ae/A +	7/3														
AMS	2.5															
Gulfosinate ammonium +	0.66 +	5/6	0 a	1 b	7 b	89 d	85 ab	100 a	61 bc	100 a	59 ab	95 ab	86 a	100 a	35 ab	9,615 ab
ethofumesate +	2 +															
AMS	3															
Glyphosate +	1.125 lb ae/A +	6/12														
acetochlor +	1.125 +															
AMS	2.5															
Glyphosate +	0.77 lb ae/A +	7/3														
AMS	2.5															
Ethofumesate	3.75	5/6	1 a	0 b	97 a	99 a	95 a	100 a	95 a	100 a	88 a	99 a	98 a	100 a	47 a	12,884 ab
Glyphosate +	1.125 lb ae/A +	5/23														
AMS	2.5															
Glyphosate +	0.77 lb ae/A +	6/18														
acetochlor +	1.125 +															
AMS	2.5															
Glyphosate +	0.77 lb ae/A +	7/3														
AMS	2.5															

Table 2. continued

	Application		Crop injury		Weed control[2]										Root	
					CHEAL		AMARE		SOLSA		SASKR		SETVI			
Treatment[3]	rate	date	6/13	7/23	6/13	7/23	6/13/	7/23	6/13	7/23	6/13	7/23	6/13	7/23	yield	ERS[4]
	lb ai/A		-------	-------	-------	-------	-------	--%--	-------	-------	-------	-------	-------	-------	ton/A	lb/A
Ethofumesate	3.75	5/6	1a	0 b	96 a	98 ab	97 a	100 a	97 a	100 a	93 a	99 a	98 a	100 a	41 a	11,233 ab
Glyphosate +	1.125 lb ae/A +	5/23														
AMS	2.5															
Glyphosate +	0.77 lb ae/A +	6/12														
triflusulfuron +	0.015 +															
clopyralid +	0.25 lb ae/A +															
AMS	2.5															
Glyphosate +	0.77 lb ae/A +	7/3														
AMS	2.5															
Cycloate	2.5	5/6	0 a	1 b	6 b	93 cd	64 b	100 ab	81 ab	100 a	23 bc	89 c	84 a	100 ab	46 a	12,487 ab
Glyphosate +	1.125 lb ae/A +	6/12														
acetochlor +	1.125 +															
AMS	2.5															
Glyphosate +	0.77 lb ae/A +	7/3														
AMS	2.5															
Cycloate	2.5	5/6	2 a	1 b	94 a	98 ab	98 a	100 a	97 a	100 a	77 a	97 ab	96 a	100 a	36 a	9,486 abc
Glyphosate +	1.125 lb ae/A +	5/23														
AMS	2.5															
Glyphosate +	0.77 lb ae/A +	6/18														
acetochlor +	1.125 +															
AMS	2.5															
Glyphosate +	0.77 lb ae/A +	7/3														
AMS	2.5															
Glyphosate +	1.125 lb ae/A +	5/23	1 a	0 b	77 a	94 bc	91 ab	100 ab	89 a	100 a	66 a	94 bc	86 a	100 a	47 a	13,003 a
Phmd/dsmp +	0.244 +															
ethofumesate +	0.165 +															
AMS	2.5															
Glyphosate +	0.77 lb ae/A +	6/18														
acetochlor +	1.125 +															
AMS	2.5															
Glyphosate +	0.77 lb ae/A +	7/3														
AMS	2.5															
Glyphosate +	1.125 lb ae/A +	5/23	1 a	3 b	79 a	98 ab	96 a	100 a	93 a	100 a	60 ab	96 ab	91 a	100 a	46 a	12,343 ab
AMS	2.5															
Glyphosate +	0.77 lb ae/A +	6/18														
dimethenamid-P +	0.984 +															
AMS	2.5															
Glyphosate +	0.77 lb ae/A +	7/3														
AMS	2.5															

[1]Means followed by same letter are not significantly different using Fisher's Protected LSD (P=0.05).
[2]Weeds evaluated for control were: common lambsquarters (CHEAL), redroot pigweed (AMARE), hairy nightshade (SOLSA), Russian-thistle (SASKR), and green foxtail (SETVI).
[3]Glyphosate is sold as Roundup PowerMax. AMS is ammonium sulfate and is sold as Actamaster. Gulfosinate ammonium is sold as Liberty 280. Acetochlor is sold as Warrant. Ethofumesate is sold as Nortron SC. Triflusulfuron is sold as UpBeet. Clopyralid is sold as Stinger. Phmd/dsmp is Phenmedipham/desmedipham and is sold as Betamix. Dimethenamid-P is sold as Outlook.
[4]ERS is estimated recoverable sugar.

Preemergence weed control in irrigated glyphosate-resistant corn with tank mixes of glyphosate or glufosinate with atrazine, isoxaflutole, thiencarbazone-methly, tembotrione, dicamba, mesotrione, or s-metolachlor. Randall S. Currie and Jennifer Jester. (K-State Southwest Research-Extension Center, 4500 E Mary Street, Garden City, KS 67846) No herbicide tank mix caused visual injury or affected corn yield. Due to extreme heat and drought, weed pressure was very low. All herbicide treatments provided greater than 96% control of all weed species 68 days after treatment (DAT).

With the advent of glyphosate-resistant weed species, herbicide tank-mix partners with multiple modes of action are needed to augment glyphosate's weed control. Furthermore, the efficacy of glufosinate as an alternative burndown product in conjunction with some of the tank-mix partners needs to be evaluated. The objective of this study was to test such tank mixes.

Broadleaf and grassy weed control was evaluated in irrigated corn at the Kansas State University Research-Extension Center in Garden City, KS. Corn was planted on May 9, 2012, with preemergence herbicides applied within 24 hours of planting. Preemergence application conditions with regards to air temperature, soil temperature, wind speed, relative humidity, and soil moisture were 78ºF, 71ºF, 3 mph, 46%, and inadequate, respectively. Soil was Ulysses silt loam, and organic matter, soil pH, and cation exchange capacity (CEC) were 1.4%, 8, and 18.4, respectively. All herbicide treatments were applied with a tractor-mounted CO_2-pressurized windshield sprayer calibrated to deliver 20 gal/a at 30 psi and 4.1 mph. Adjuvant and ammonium sulfate (AMS) were added per manufacturer recommendations. Postemergence herbicide applications were made on June 20, 2012. Air temperature, soil temperature, wind speed, relative humidity, and soil moisture at the time of herbicide application were 91ºF, 86ºF, 11 mph, 34%, and adequate. The trial was established as a randomized complete block design with four replications, and plots were 10 × 30 feet. Crop injury and percentage weed control were visually rated.

No crop injury was observed. Due to inconsistent distribution of weeds, percentage weed control was rated as overall monocot and dicot control. (Table 1) Monocot species observed were *Cenchrus longispinus* (Hack.) Fernald, *Digitaria sp*. L., and *Setaria veridis* (L.) P. Beauv. Dicot species observed were *Abutilon theophrasti* Medik., *Amaranthus palmeri* S. Watson, *Euphorbia maculata* L., *Kochia scoparia* L. Schrad., *Proboscidea louisianica* (Mill.) Thell, *Salsola kali* L., *Solanum rostratum* Dunal, and *Xanthium strumarium* L. Due to extreme heat and drought, weed pressure was very low. All herbicide treatments provided greater than 96% control of all weed species 68 DAT. Although control of grassy weeds declined by 96 DAT to 88% in the least effective treatment, overall control remained excellent. The degree of broadleaf weed control seen at 68 DAT was maintained at or above 96% 96 DAT.

Table. Preemergence weed control in irrigated glyphosate- resistant corn with tank mixes of glyphosate or glufosinate with atrazine, isoxaflutole, thiencarbazone, tembotrione, dicamba, mesotrione, or s-metolachlor.

				% Control				
				68 DAP[2]		96 DAP[2]		Yield
Active Ingredient	Rate		Timing[1]	Monocot	Dicot	Monocot	Dicot	(bu/A)
Untreated check				0	0	0	0	77
Isoxaflutole + Thiencarbazone	3	OZ/A	A					
Atrazine	1	QT/A	A					
Glyphosate	22	OZ/A	B	97	99.5	92	98	61
Tembotrione + Isoxadifen-ethyl	3	OZ/A	B					
Dicamba	8	OZ/A	B					
Isoxaflutole + Thiencarbazone-	3	OZ /A	A					
Atrazine	1	QT/A	A					
Glyphosate	22	OZ/A	B	97	99.8	94	97	73
Tembotrione + Isoxadifen-ethyl	3	OZ/A	B					
Dicamba	16	OZ/A	B					
Isoxaflutole + Thiencarbazone-	3	OZ /A	A					
Atrazine	1	QT/A	A					
Glyphosate	22	OZ/A	B	98	99.5	97	96	44
Tembotrione + Thiencarbazone-	3	OZ/A	B					
Dicamba	8	OZ/A	B					
Isoxaflutole + Thiencarbazone-	3	OZ /A	A					
Atrazine	1	QT/A	A					
Glyphosate	22	OZ/A	B	99	99.8	94	97	58
Tembotrione + Thiencarbazone-	3	OZ/A	B					
Dicamba	16	OZ/A	B					
Isoxaflutole	3	OZ/A	A					
Atrazine	2	QT/A	A					
Glyphosate	22	OZ/A	B	97	99.3	91	96	52
Tembotrione + Thiencarbazone-	3	OZ/A	B					
Dicamba	8	OZ/A	B					
Isoxaflutole	3	OZ/A	A					
Atrazine	2	PT/A	A					
Glyphosate	22	OZ/A	B	96	98.3	88	95	64
Tembotrione + Isoxadifen-ethyl	3	OZ/A	B					
Dicamba	16	OZ/A	B					
Isoxaflutole	3	OZ/A	A					
Atrazine	2	PT/A	A					
Glyphosate	22	OZ/A	B	97	99.5	94	97	57
Tembotrione + Thiencarbazone-	3	OZ/A	B					
Dicamba	8	OZ/A	B					
Isoxaflutole	3	OZ/A	A					
Atrazine	2	PT/A	A					
Glyphosate	22	OZ/A	B	98	99.3	95	98	69
Tembotrione + Thiencarbazone-	3	OZ/A	B					
Dicamba	16	OZ/A	B					
Isoxaflutole	3	OZ/A	A					
Atrazine	2	PT/A	A					
Glufosinate	22	OZ/A	B	96	99.8	90	97	58
Tembotrione + Isoxadifen-ethyl	3	OZ/A	B					
Mesotrione + S-Metolachlor + Glyphosate	1.5	QT/A	A	99	99.3	99	98	62
Mesotrione + S-Metolachlor + Glyphosate	3.6	PT/A	B					
LSD (P=0.05				3.65	1.12	4.69	3.5	41.47

[1]A is PRE, B is V4-V5

[2]DAP= days after planting

Weed control with pyroxasulfone, fluthiacet-methyl, isoxaflutole, acetochlor, mesotrione, dimethenamid-P, topramezone, atrazine, and glyphosate. Randall S. Currie and Jennifer Jester. (K-State Southwest Research-Extension Center, 4500 E Mary Street, Garden City, KS 67846)The herbicide package mixes of pyroxasulfone with fluthiacet or dimethenamid-P have both recently received federal labels. Both are tank mixes of new active ingredient pyroxasulfone and a second herbicide to extend the treated weed spectrum. The objective of this study was to compare these products to several other herbicide tank mixes.

Broadleaf and grassy weed controls were evaluated in irrigated corn at the Kansas State University Research-Extension Center in Garden City, KS. Corn was planted on May 15, 2012, with preemergence herbicides applied within 24 hours of planting. Preemergent application conditions of air temperature, soil temperature, wind speed, relative humidity, and soil moisture were 83ºF, 70ºF, 3 mph, 49%, and adequate, respectively. Soil was Ulysses silt loam, and organic matter, soil pH, and cat ion exchange capacity (CEC) were 1.4%, 8, and 18.4, respectively. All herbicide treatments were applied with a tractor-mounted CO_2 pressurized windshield sprayer calibrated to deliver 20 gal/a at 30 psi and 4.1 mph. Adjuvant and AMS were added per manufacturer recommendation. The first postemergence herbicide application was made on June 21, 2012. The first post-application conditions of air temperature, soil temperature, wind speed, relative humidity and soil moisture were 73ºF, 73ºF, 4 mph, 38%, and adequate, respectively. The second post-application was made on June 25, 2012. Second post-application conditions of air temperature, soil temperature, wind speed, relative humidity, and soil moisture were 85ºF, 80ºF, 2 mph, 30%, and adequate, respectively. The trial was established as a randomized complete block design with four replications, and plots were 10 × 30 feet.

Crop injury and percentage weed control were both visually rated. No crop injury was observed. Due to inconsistent distribution of weeds, percentage weed control was rated as overall monocot and dicot control (Table 1). Monocot species observed were *Cenchrus longispinus* (Hack.) Fernald, *Digitaria sp*. L., and *Setaria veridis* (L.) P. Beauv. Dicot species observed were *Abutilon theophrasti* Medik., *Amaranthus palmeri* S. Watson, *Euphorbia maculata* L., *Kochia scoparia* L. Schrad., *Proboscidea louisianica* (Mill.) Thell, *Salsola kali* L., *Solanum rostratum* Dunal, and *Xanthium strumarium* L. Treatments that produced greater than 91.4% control 62 days after treatment (DAT) were not statistically superior to the best treatments. There were no differences between products for broadleaf control 62 and 83 DAT. Treatments providing greater than 79.8% grass control were not statistically superior to the best treatment 83 DAT.

Table. Weed control with anthem pyroxasulfone, fluthiacet-methyl, isoxaflutole, acetochlor, mesotrione, dimethenamid-P, topramezone, atrazine, and glyphosate.

				Weed control (%)				
				62 DAP[2]		96 DAP[2]		Yield
Active ingredient	Rate		Timing[1]	Monocot	Dicot	Monocot	Dicot	(bu/A)
Untreated check				0	0	0	0	51
Pyroxasulfone + Fluthiacet-methyl + Atrazine	8	FL OZ /A	A	93	98	91	99	54
Fluthiacet-methyl	0.75	FL OZ/A	B					
Glyphosate	22	FL OZ/A	B					
Pyroxasulfone + Fluthiacet-methyl + Atrazine	2	PT/A	A	96	99.5	93	99	55
Fluthiacet-methyl	0.75	FL OZ/A	B					
Glyphosate	22	FL OZ/A	B					
Pyroxasulfone + Fluthiacet-methyl + Atrazine	2.5	PT/A	A	92	99	93	99	62
Fluthiacet-methyl	0.75	FL OZ/A	B					
Glyphosate	22	FL OZ/A	B					
Pyroxasulfone + Fluthiacet-methyl + Atrazine	8	FL OZ /A	A	99	99.5	95	99	46
Isoxaflutole	2	FL OZ/A	A					
Fluthiacet-methyl	0.75	FL OZ/A	B					
Glyphosate	22	FL OZ/A	B					
Pyroxasulfone + Fluthiacet-methyl + Atrazine	2	PT/A	A	99	99.5	94	99	55
Isoxaflutole	2	FL OZ/A	A					
Fluthiacet-methyl	0.75	FL OZ/A	B					
Glyphosate	22	FL OZ/A	B					
Mesotrione + S-Metolachlor + Atrazine	3	QT/A	A	97	99.5	90	99	77
Fluthiacet-methyl	0.75	FL OZ/A	B					
Glyphosate	22	FL OZ/A	B					
Acetochlor + Atrazine	2	OZ/A	A	92	99	86	99	69
Fluthiacet-methyl	0.75	OZ/A	B					
Glyphosate	22	FL OZ/A	B					
Pyroxasulfone + Fluthiacet-methyl + Atrazine	8	FL OZ /A	A	73	99	60	99	56
Fluthiacet-methyl	0.75	FL OZ/A	B					
Mesotrione	3	FL OZ/A	B					
Atrazine	1	PT/A	B					
Pyroxasulfone + Fluthiacet-methyl + Atrazine	2	PT/A	A	85	99.3	85	99	73
Fluthiacet-methyl	0.75	FL OZ/A	B					
Mesotrione	3	FL OZ/A	B					
Atrazine	1	PT/A	B					
Pyroxasulfone + Fluthiacet-methyl + Atrazine	2	PT/A	A	97	99.5	91	99	49
Glyphosate	22	FL OZ/A	B					
Mesotrione	3	FL OZ/A	B					
Dimethenamid-P + Saflufenacil	15	FL OZ/A	A	89	99.8	89	99	51
Atrazine	1	QT/A	A					
Glyphosate	22	FL OZ/A	C					
Dicamba	5	OZ/A	C					
Dimethenamid-P + Saflufenacil	15	FL OZ/A	A	89	89	85	99	62
Atrazine	1	QT/A	A					
Glyphosate	22	FL OZ/A	C					
Topramezone	0.75	FL OZ/A	C					
Atrazine	1	PT/A	C					

Table. continued

Active ingredient	Rate		Timing[1]	Weed control (%) 62 DAP[2] Monocot	62 DAP[2] Dicot	96 DAP[2] Monocot	96 DAP[2] Dicot	Yield (bu/A)
Pyroxasulfone	2	PT/A	A					
Atrazine	1	QT/A	A					
Glyphosate	22	FL OZ/A	C	96	96	93	99	91
Topramezone	0.75	FL OZ/A	C					
Atrazine	1	PT/A	C					
Glyphosate	22	FL OZ/A	B					
Dimethenamid-P + Atrazine	3	PT/A	B	80	80	84	99	80
Topramezone	0.75	FL OZ/A	B					
Glyphosate	22	FL OZ/A	B					
Pyroxasulfone	2	PT/A	B	88	88	81	99	75
Atrazine	22	FL OZ/A	B					
LSD (P=0.05)				7.59	0.98	15.2	0.87	35.57

[1]A is PRE, B is 2-4" Weeds, C is 10-14" Corn
[2]DAP= days after planting

Irrigated corn response to high rates of isoxaflutole, compared to the package mix of isoxaflutole plus thiencarbazone-methyl tank-mixed with dicamba, mesotrione, s-metolachlor and glyhosate herbicide. Randall S. Currie and Jennifer Jester. (K-State Southwest Research-Extension Center, 4500 E Mary Street, Garden City, KS 67846) No herbicide tank mix produced visual injury or affected corn yield. Due to extreme heat and drought, weed pressure was very low. All herbicide treatments provided greater than 89% grass control. Broadleaf weed control was greater than 93% with all treatments.

Corn was often injured by high rates of isoxaflutole herbicide prior to the introduction of isoxaflutole plus a safener to enhance corn tolerance to this herbicide. Now that the safer version is available, it is unknown how high rates of the safer isoxaflutole product compare to other products. The objective of this study was to compare such tank mixes.

Broadleaf and grassy weed control were both evaluated in irrigated corn at the Kansas State University Research-Extension Center in Garden City, KS. Corn was planted on May 9, 2012, with preemergence (PRE) herbicides applied within 24 hours of planting. Air temperature, soil temperature, wind speed, and relative humidity at the time of PRE herbicide application were 78ºF, 71ºF, 3 mph, and 46%, respectively. Soil moisture conditions were poor. Soil was Ulysses silt loam, with organic matter, soil pH, and cation exchange capacity (CEC) of 1.4%, 8, and 18.4, respectively. All herbicide treatments were applied with a tractor-mounted CO_2 pressurized windshield sprayer calibrated to deliver 20 gal/a at 30 psi and at 4.1 mph. Adjuvant and ammonium sulfate (AMS) were added as per the manufacturer recommendation. Postemergence (POST) herbicide application was made on June 20, 2012. Air temperature, soil temperature, wind speed, and relative humidity at the time of POST herbicide application were 91ºF, 86ºF, 11 mph, and 34%, respectively. Soil moisture was adequate. The trial was established as a randomized complete block design with four replications, and plots were 10 × 30 feet. Crop injury and percentage weed control were visually rated in a scale of 0 to 100%, with 0 being no control and 100 being complete control/plant death.

No crop injury was observed with any herbicide tank mix. Due to inconsistency in weed population/densities, percentage weed control was rated as overall monocot and dicot control. (Table 1). Monocot species observed were *Cenchrus longispinus* (Hack.) Fernald, *Digitaria sp*. L., and *Setaria veridis* (L.) P. Beauv. Dicot species observed were *Abutilon theophrasti* Medik., *Amaranthus palmeri* S. Watson, *Euphorbia maculata* L., *Kochia scoparia* L. Schrad., *Proboscidea louisianica* (Mill.) Thell., *Salsola kali* L., *Solanum rostratum* Dunal, and *Xanthium strumarium* L. Dicot control remained high at 96 days after planting (DAP), with all but treatment 11 maintaining greater than 95% control. Monocot control at 96 DAP was between 85 and 95%. Due to extreme heat and drought, weed pressure was very low and corn yields in the control plots were not different from the herbicide-treated plots. This makes comparisons of these products of weed control difficult, but it does clearly demonstrate that even at high rates, these herbicides have very litte potential to injure corn.

Table. Broadleaf and grassy weed control with high rates of isoxaflutole compared to the package tank mixes of isoxaflutole plus thiencarbazone-methyl tank-mixed with, dicamba, mesotrione, s-metolachlor and glyphosate.

				% Control				
				68 DAP[2]		96 DAP[2]		
Active Ingredient	Rate		Timing[1]	Monocot	Dicot	Monocot	Dicot	Yield[3]
Untreated Check				0	0	0	0	61
Isoxaflutole + Thiencarbazone-methyl	5.6	OZ /A	A	95	99	94	98	56
Atrazine	1.5	QT/A	A					
Isoxaflutole + Thiencarbazone-methyl	5.6	OZ /A	A	95	98	89	96	64
Dicamba	0.5	PT/A	A					
Isoxaflutole + Thiencarbazone-methyl	5.6	OZ /A	A	96	99	89	97	64
Dicamba	1	PT/A	A					
Isoxaflutole	6	OZ /A	A	94	99	85	96	49
Atrazine	1.5	QT/A	A					
Isoxaflutole	6	OZ/A	A	91	99	88	97	49
Atrazine	1.5	QT/A	A					
Acetochlor	2.25	PT/A	A					
Tembotrione + Thiencarbazone-methyl	3	OZ/A	B	96	97	95	96	50
Atrazine	2	PT/A	B					
Glyphosate	22	FL OZ/A	B					
Tembotrione + Thiencarbazone-methyl	3	OZ/A	B	98	99	95	99	45
Atrazine	2	PT/A	B					
Glyphosate	22	OZ /A	B					
Dicamba	0.5	PT/A	B					
Tembotrione + Thiencarbazone-methyl	3	OZ /A	B	96	99	91	96	54
Atrazine	2	PT/A	B					
Glyphosate	22	OZ /A	B					
Dicamba	1	PT/A	B					
S-Metolachlor + Atrazine + Mesotrione	3	QT/A	B	90	99	89	97	61
Mesotrione + S-Metolachlor + Glyphosate	3.6	PT/A	B	94	97	90	93	58
LSD (P=0.05)				5.41	1.34	6.46	3.84	25.59

[1]A is PRE, B is V4-V5
[2]DAP =days after planting
[3]Yield=bushels per acre

Economics of control options for glyphosate-resistant kochia. Randall S. Currie, Troy Dumler, Curtis Thompson, Phillip Stahlman and Alan Schlegel. (K-State Southwest Research-Extension Center, 4500 E Mary Street, Garden City, KS 67846) The growing resistance of kochia to glyphosate has caused crop producers in western Kansas to consider alternative methods of weed control. The primary alternatives to a glyphosate-based no-till herbicide program include using a diversified mix of additional herbicides or using tillage to control weeds. Because returns in dryland rotations that use no-till have been significantly higher than those that incorporate tillage, the relevant questions is: How much can farmers spend on additional herbicides and still earn greater returns than using tillage to control weeds? Results from a tillage intensity study in Tribune, KS indicate that using an enhanced herbicide program to manage in a no-till wheat-sorghum-fallow rotation will cost about $30 per tillable acre more than a glyphosate-based program, but still return $50 per tillable acre more than using tillage in a reduced-till rotation.

The growing resistance of kochia to glyphosate has led many producers to consider returning to tillage options for weed control in Western Kansas dryland crop rotations. Regardless of the path chosen, profitability will be less compared with the period prior to the advent of weed resistance. Long-term data from the Kansas State University Research Center in Tribune, KS, has indicated that there is a significant economic advantage to incorporating no-till practices in a wheat-sorghum-fallow (WSF) rotation. With the growing difficulty of controlling kochia with a glyphosate-oriented herbicide program, the natural question becomes how much can be spent on herbicides for kochia control to maintain the economic advantage of no-till. Consequently, an example herbicide budget for kochia control was developed with the assistance of weed scientists at Kansas State University to compare the relative profitability of tillage systems in a WSF rotation to that of an herbicide program that used glyphosate as the primary herbicide option. The results indicate that although herbicide costs nearly double for the kochia control program, returns for the no-till rotation were nearly $50/a greater than reduced-till and $55/a greater than conventional-till; however, the profitability of the no-till rotation decreased by $30/a compared with cropping systems without glyphosate resistance.

A long-term tillage intensity study was established at the Kansas State University Research Center in Tribune, KS, in 1991 (see “Benefits of Long-Term No-Till in a Wheat-Sorghum-Fallow Rotation,” SRP 1070, Southwest Research-Extension Center Field Day 2012, p. 5–6). The study compared three weed control regimes in a wheat-sorghum-fallow (WSF) rotation. The weed control options included conventional tillage, reduced tillage, and no-till. Conventional tillage typically required 4 to 5 tillage operations per year to control weeds prior to planting. Reduced-till used a combination of herbicides (1 to 2 spray operations) and tillage (2 to 3 operations) to control weeds prior to planting. No-till exclusively used herbicides for weed control. In 2001, the reduced-till component of the study was modified. Instead of including tillage operations prior to both wheat and sorghum, wheat was planted using conventional-till, whereas sorghum incorporated no-till. Thus, the rotation became a reduced-till rotation by including conventional-till and no-till components.

Table 1 shows the annual yields of wheat and sorghum in a tillage intensity study on wheat-sorghum-fallow rotation From 2001–2011, no-till wheat and sorghum yields were approximately 8 bu/a and 43 bu/a higher, respectively, in no-till than with conventional-till rotation. Similarly, wheat and sorghum yields were 5 bu/a and 30 bu/a higher, respectively, in no-till than in a reduced-till rotation (conventional-till prior to wheat and no-till prior to sorghum). Average production costs for the three tillage scenarios are shown in Table 2. Without including harvest costs, reduced-till costs are approximately $26/a higher than conventional-till, whereas no-till costs are about $21 higher than reduced-till. Using market year average prices for 2011 of $7.02 for wheat and $5.99 for sorghum, the higher yields associated with no-till resulted in a $63/a advantage for no-till over reduced-till and an $83/a advantage for no-till over conventional-till (Figure 1).

Table 1. Wheat and sorghum yields in a wheat-sorghum-fallow rotation at Tribune, KS, 2001–2011

Year	Wheat yield (bu/a)			Sorghum yield (bu/a)		
	Conventional tillage	Reduced tillage	No-till	Conventional tillage	Reduced tillage	No-till
2001	17	40	31	6	43	64
2002	0	0	0	0	0	0
2003	22	15	30	7	7	37
2004	1	2	4	44	67	108
2005	32	32	39	28	38	61
2006	0	2	16	4	3	29
2007	26	36	51	26	43	62
2008	21	19	9	16	25	40
2009	9	10	22	19	5	72
2010	29	35	50	10	26	84
2011	22	20	20	37	78	113
Avg.	16.3	19.2	24.7	17.9	30.5	60.9

Abbreviations: bu/a, bushels per acre.

Table 2. Wheat-sorghum-fallow cost of production[1]

Tillage	Wheat	Sorghum	Total
	---------------------------- ($/a) ----------------------------		
Conventional Tillage	100.71	119.52	220.23
Reduced tillage	107.58	138.90	246.48
No-till	122.59	144.70	267.29

[1] Input costs do not include harvest costs, which vary with yield.

Controlling kochia in no-till systems with glyphosate-oriented treatments has become problematic for many farmers in western Kansas; consequently, no-till crop producers have been considering alternative herbicide strategies or even using tillage as means to control kochia. Tables 3 and 4 show typical glyphosate-based herbicide treatments for no-till wheat and sorghum, respectively. Tables 5 and 6 show alternative herbicide treatments for wheat and sorghum to manage glyphosate-resistant kochia. As seen in the tables, herbicide expenses increase from $44/a to $82/a for wheat, and sorghum expenses increase from $56/a to $105/a to control glyphosate-resistant kochia. The question facing producers dealing with glyphosate-resistant kochia is whether the higher yields associated with no-till will outweigh the higher kochia-related herbicide costs. Figure 1 indicates that although the higher kochia-related herbicide costs decrease the profitability of the WSF rotation by nearly $30/a, the no-till rotation is still more profitable by nearly $50/a vs. the reduced-till rotation, and $55/a more than the conventional-till rotation.

Table 3. No-till wheat herbicide program (glyphosate-based) in wheat-sorghum-fallow rotation[1]

Treatment	Rate	Price	Cost	Timing
Glyposate(RT3)(+AMS)	16.5	$0.12/oz	$1.98	After sorghum
2,4-D	1	$3.12/pt	$3.12	harvest (fallow)
Total			$5.10	
Glyphosate (+AMS)	32	$0.09/oz	$2.88	Fallow
Glyphosate (+AMS)	32	$0.09/oz	$2.88	Fallow
Glyphosate (+AMS)	32	$0.09/oz	$2.88	Fallow
Metsulfuron (+NIS)	0.1	$13.93/oz	$1.39	In-crop
Dicamba	4	$0.33/oz	$1.32	
Total			$2.71	
Applications	5	$5.47	$27.35	
Total cost			$43.90	

[1] Surfactants and additives such as AMS and NIS can vary significantly in price and carrier volume and thus are excluded in cost estimates. Typical AMS costs range from $0.40/a to $0.80/a with glyphosate applications, whereas typical NIS applications range from $0.60/a to $2.30/a.

Table 4. No-till sorghum herbicide program (glyphosate-based) in wheat-sorghum-fallow rotation

Treatment	Rate	Price	Cost	Timing
Glyphosate (+AMS)	32	$0.09/oz	$2.88	After wheat harvest (fallow)
Glyhosate(RT3)(+AMS)	22	$0.12/oz	$2.64	Fallow
2,4-D	2	$3.12/pt	$6.24	
Atrazine	1.6	$3.51/oz	$5.62	
Total			$14.50	
Glyphosate (+AMS)	32	$0.09/oz	$2.88	Preplant
S-metolachlor +atrazine	1.5	$13.28/qt	$19.92	
Total			$22.80	
Applications	3	$5.47	$16.41	
Total cost			$56.59	

Table 5. No-till wheat herbicide program for glyphosate-resistant kochia control in wheat-sorghum-fallow rotation.

Treatment	Rate	Price	Cost	Timing
Dicamba	16	$0.33/oz	$5.28	After sorghum harvest (fallow)
Metribuzin	0.5	$14.50/lb	$7.25	
Total			$12.53	
paraquat (+NIS)	48	$0.23/oz	$11.04	Fallow
Glyphosate (+AMS)	32	$0.09/oz	$2.88	Fallow
2,4-D	1	$3.12/pt	$3.12	
Dicamba	16	$0.33/oz	$5.28	
Total			$11.28	
Glyphosate (+AMS)	32	$0.09/oz	$2.88	Fallow
2,4-D	1	$3.12/pt	$3.12	
Dicamba	8	$0.33/oz	$2.64	
Total			$8.64	
Glyphosate (+AMS)	32	$0.09/oz	$2.88	Fallow
Ally (+NIS)	0.1	$13.93/oz	$1.39	In-crop
Dicamba	4	$0.33/oz	$1.32	
Total			$2.71	
Applications	6	$5.47	$32.82	
Total cost			$81.90	

Table 6. No-till sorghum herbicide program for glyphosate-resistant kochia control in wheat-sorghum-fallow rotation

Treatment	Rate	Price	Cost	Timing
Glyphosate (+AMS)	32	$0.09/oz	$2.88	After wheat harvest (fallow)
2,4-D	2	$3.12/pt	$6.24	
Dicamba	16	$0.33/oz	$5.28	
Total			$14.56	
Glyphosate (+AMS)	32	$0.09/oz	$2.88	Fallow
2,4-D	1	$3.12/pt	$3.12	
Total			$6.00	
Glyphosate (+AMS)	32	$0.09/oz	$2.88	Fallow
Dicamba	16	$0.33/oz	$5.28	
Atrazine	16	$0.11/oz	$1.76	
Total			$9.92	
S-metolachlor +atrazine	1.66	$14.26/pt	$23.67	Preplant
Atrazine	16	$0.11/oz	$1.76	
Paraquat (+NIS)	48	$0.23/oz	$11.04	
Total			$36.47	
Pyrasulfotole+bromoxynil (+NIS)	13	$0.75/oz	$9.75	In-crop
Atrazine	8	$0.11/oz	$0.88	
Total			$10.63	
Applications	5	$5.47	$27.35	
Total cost			$104.93	

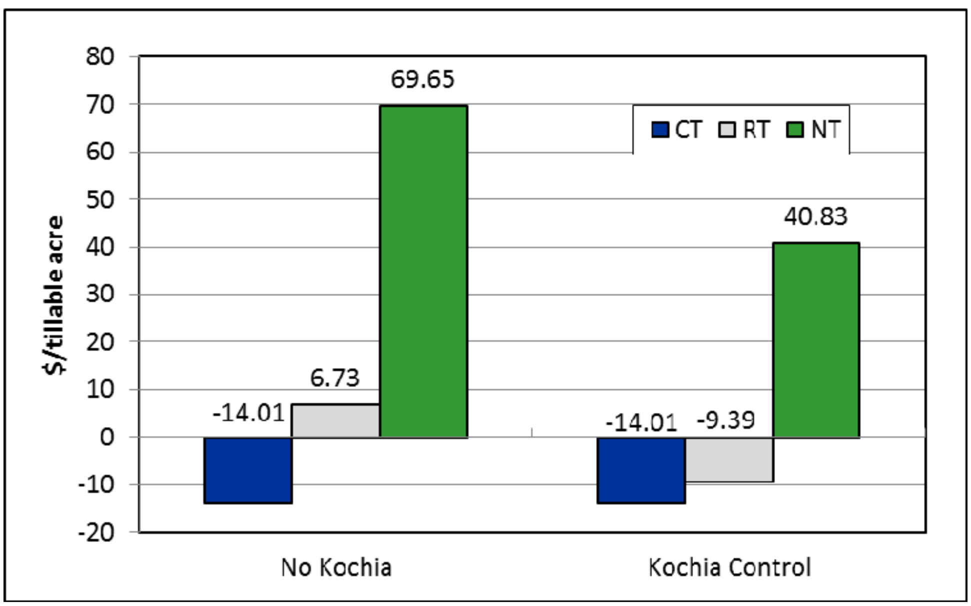

Figure. Average returns in a wheat-sorghum-fallow rotation with and without kochia resistance.

Control of kochia with increasing rates of preemergence dicamba followed by tank-mixes of paraquat. Randall S. Currie, Jennifer Jester, Curtis Thompson, and Phillip Stahlman (K-State Southwest Research-Extension Center, 4500 E Mary Street, Garden City, KS 67846) In 2010, in response to an emerging threat of glyhposate-resistant kochia, a regional task force tested 9 preemergence and 14 postemergence non-glyphosate herbicide tank mixes for kochia control at six to nine locations (Stahlman et al., 2012). None of these tank mixes consistently provided 100% control of kochia, but preemergence applications of dicamba provided the best and most consistent control. It was unclear, however, what rate would provide the optimal level and duration of control. Among the postemergence herbicides, paraquat and atrazine tank-mixes provided the highest and most consistent level of kochia control. Therefore, the objective of this study was to measure the dose-response relationship of several preemergence dicamba rates followed by postemergence tank mixes of Paraquat and Atrazine.

Within the first week of March, a split-plot experiment with 0, 0.25, 0.5, 0.75, and 1 lb/a of dicamba as the main plot was established. During May, the main plot treatments began to fail. Subplots of Paraquat and Atrazine at 0.75 and 1 lb/a were then applied. To reduce the possible interference of grassy weeds, 2 lb/a of S-metolachlor was included. These treatments were repeated at Hays and Tribune, KS. To expand the inference of this experiment to a wheat-fallow-wheat rotation at the Tribune location, an additional set of subplots were included as a tank-mix of paraquat + metribuzin at 0.75 and 0.5 lb/a.

Control 30 days after treatment (DAT) ranged from 100 to 94% with 1 lb/a dicamba across all locations (Figures 1, 2 and 3). At this rate, control declined at 60 DAT from 94 to 83% across all locations. With 0.5 lb/a dicamba, control declined from 85 to 70% across all locations. At all but the Garden City location, a log-logistic model explained the dose response relationship with R-squares greater than 0.90 at all rating dates from 33 to 94 DAT. At the Garden City location, this was true until 47 DAT; however, from 68 to 110 DAT the rate of control at the Garden City location was best described by simple linear models with R-square values greater than 0.90 at all rating dates. At all rating dates, the rate of diminishing returns was seen at 0.5 lb/a dicamba. At this rate (0.5 lb/a), control declined linearly with time at all three locations with R-squares ranging from 0.90 to 0.97. (Figures 4, 5 and 6). The slopes of these lines predicted a 0.56 to 0.86% decline in control per day during the first 60 days. At the Tribune and Hays locations, tank mixes with Paraquat and Atrazine or Metribuzin augmented control of dicamba treated plots elevating control from 93 to 100% for more than 88 DAT. Record heat and drought conditions during herbicide application at Garden City, coupled with poor coverage due to initial high kochia densities greater than 250 plants/in.^{2} led to atypically poor control compared with previous work. There was substantial kochia mortality in the control plots due to drought, and remaining plants were stunted and failed to reach a height of 12 in. at the end of the growing season. This limits inference from the late-season postemergence treatments at this location. Early-season control of kochia with pre-emergence application of dicamba (in March) was consistent across locations; however, additional postemergence treatments were needed to achieve season-long control. At two of the three locations, preemergence dicamba treatments followed by postemergence applications of paraquat and atrazine or metribuzin provided excellent season-long kochia control.

Stahlman, P.W., P.W. Geier, S.S. Reddy, R.S Currie, B.L. Olson , C.R. Thompson , J.L. Jester, A. Helm, P. Westra, R.G. Wilson, G.M. Sbatella, P. Jha, A.R. Kniss, and J.M. Tichota. 2012. Regional studies on managing kochia without glyphosate. Weed Sci. Soc. Am. Abst. 52:376. Weed Sci. Soc. Am., Lawrence, KS.

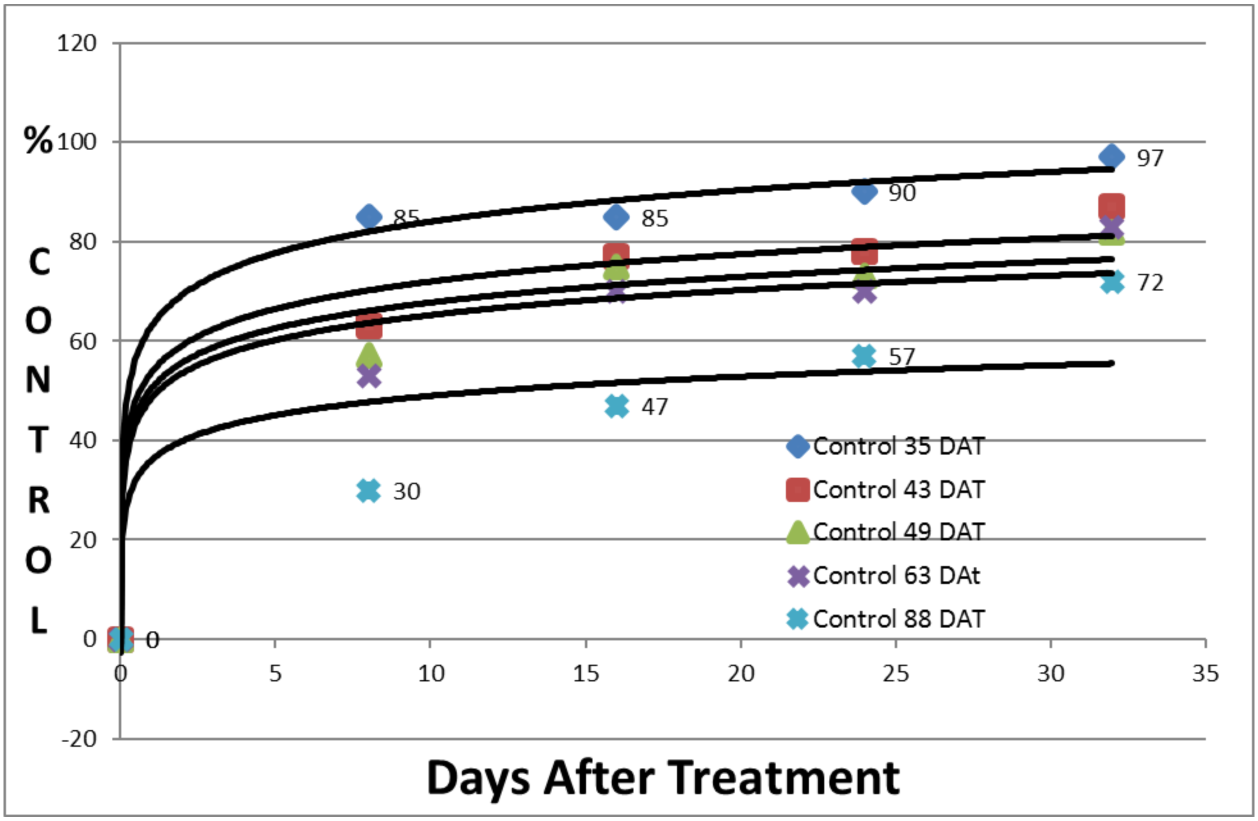

Figure 1. Dose response of dicamba at Tribune

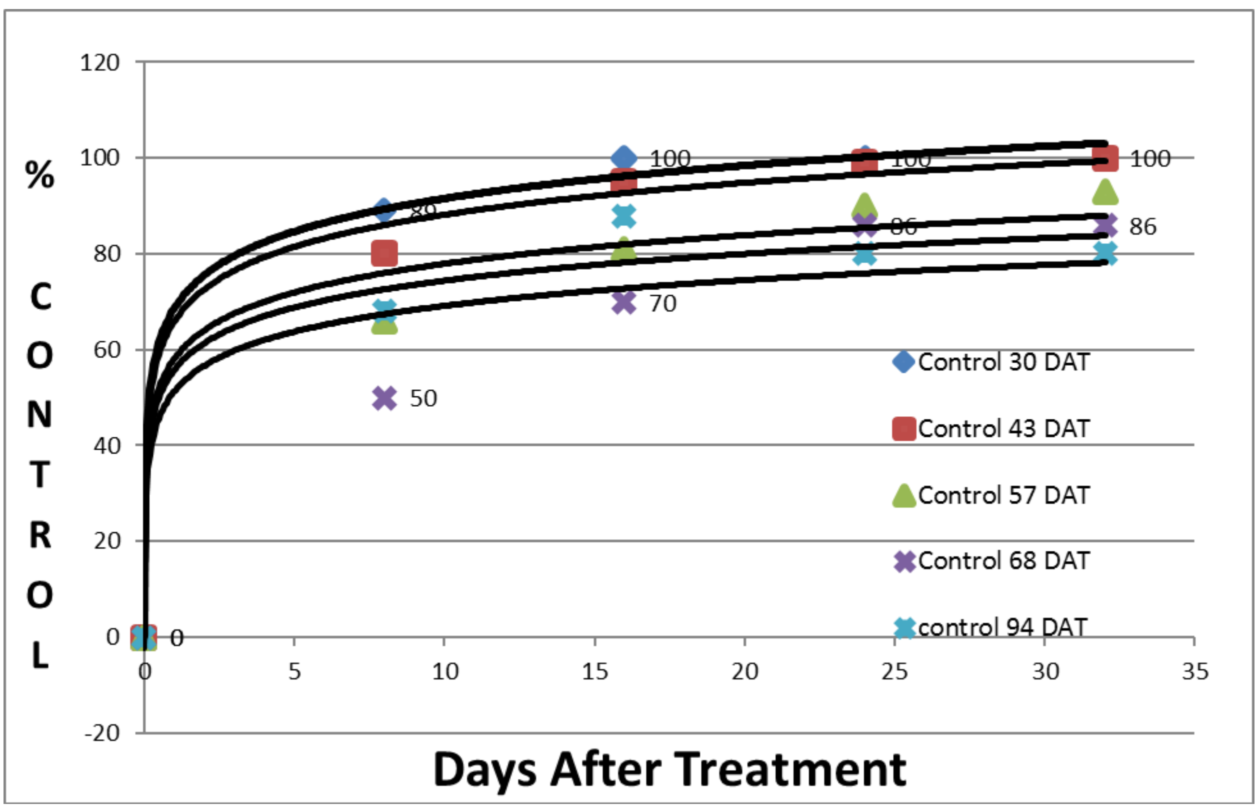

Figure 2. Dose response of dicamba at Hays

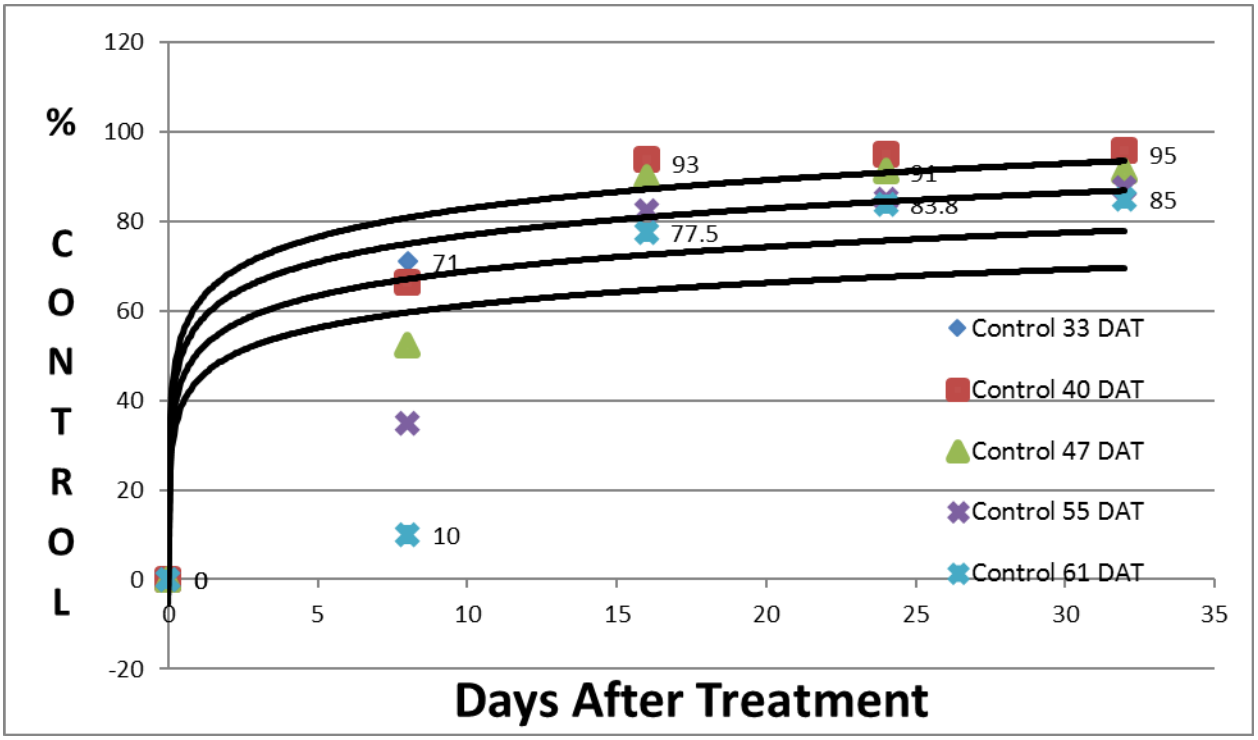

Figure 3. Dose response of dicamba at Garden City

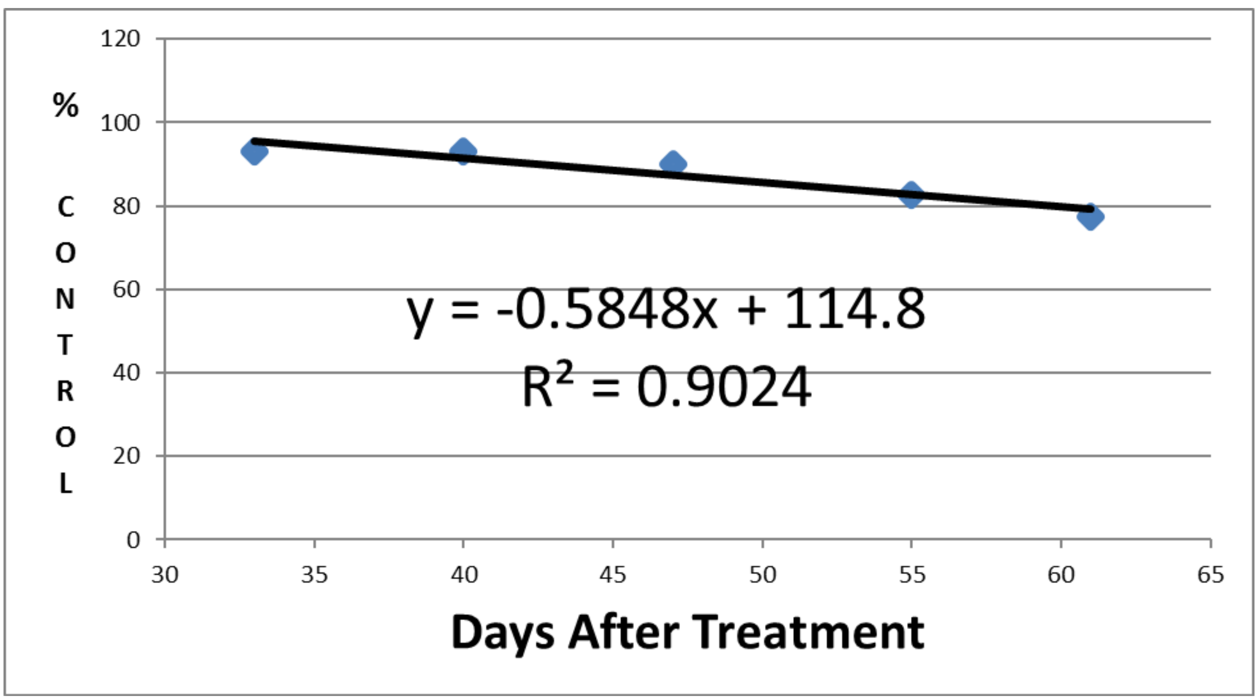

Figure 4. Decline in control of a pint of dicamba at Garden City

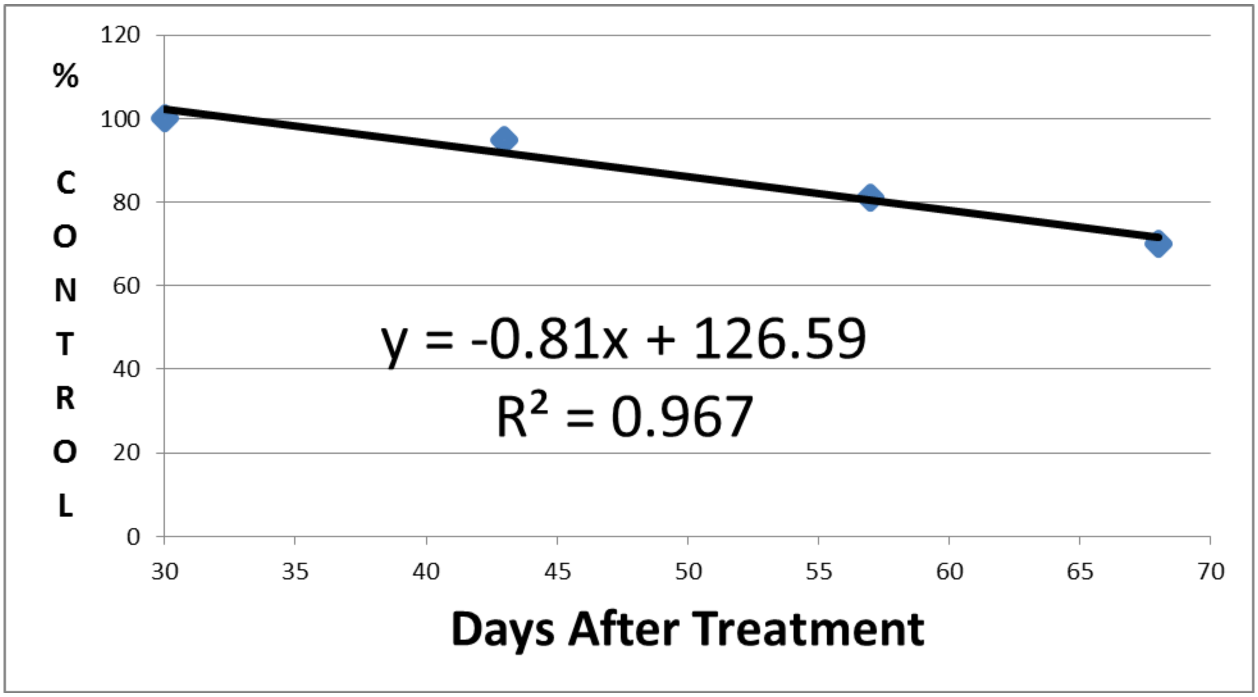

Figure 5. Decline in control of a pint of dicamba at Hays

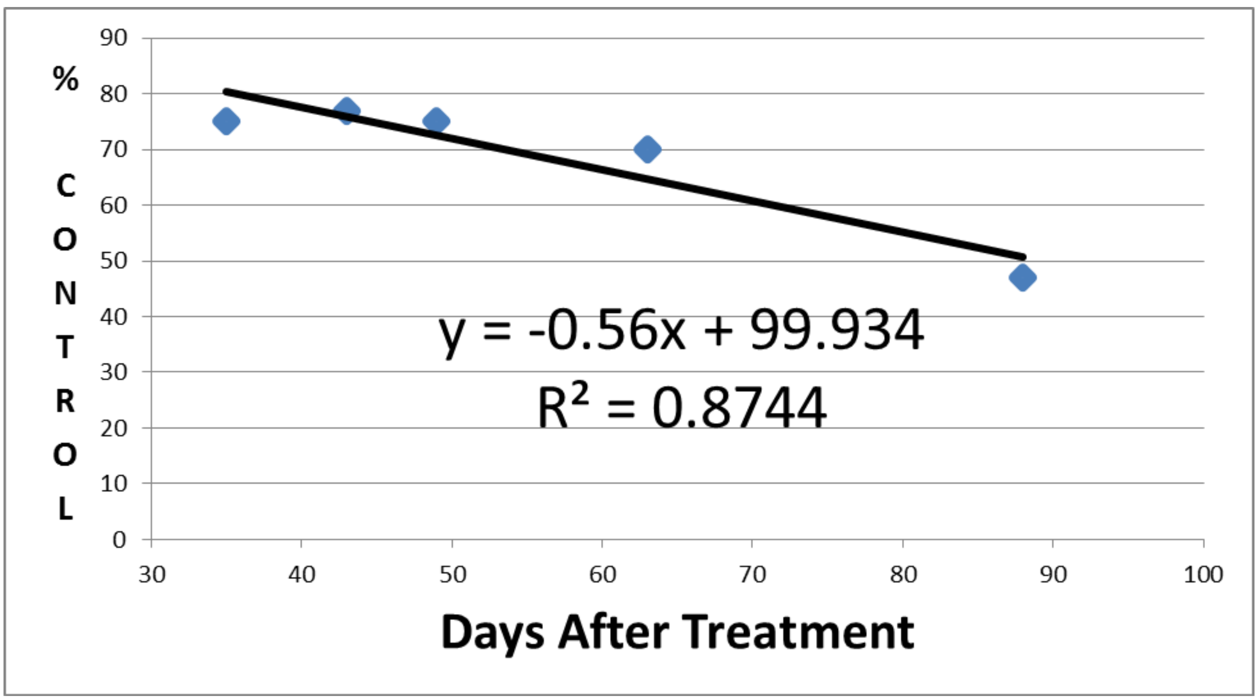

Figure 6. Decline in control of a pint of dicamba at Tribune.

Pyroxasulfone and flumioxazin use on dormant peppermint. Kyle C. Roerig, Daniel W. Curtis, Andrew G. Hulting, and Carol A. Mallory-Smith. (Department of Crop and Soil Science, Oregon State University, Corvallis OR 97331) Pyroxasulfone (Zidua), pyroxasulfone + flumioxazin (Fierce), carfentrazone (Aim) and carfentrazone + pyroxasulfone were applied to dormant peppermint to assess crop safety and weed control efficacy. Treatments were applied to dormant peppermint in Polk County, Oregon in mid-January. All treatments were applied with a single bicycle wheeled sprayer at 20 gallons per acre. Non-ionic surfactant was added at 0.25% v/v to both treatments containing carfentrazone. Harvest of 22.5 square foot samples was conducted by hand on June 28, 2013. Following drying, oil was extracted from samples by distillation.

One month following application plots treated with pyroxasulfone + flumioxazin were injured 65-75% (Table). At harvest the injury in these plots was no longer visible. Injury was not observed in other treatments. None of the treatments caused a reduction in oil yield. The highest rate of pyroxasulfone + flumioxazin provided 100% control of all weeds present including sharppoint fluvellin, prickly lettuce, willowherb, and common groundsel. The lower rates also provided 96-100% control of these weeds except for common groundsel. Pyroxasulfone applied either alone or in combination with carfentrazone did not provide adequate control of these weeds.

Table. Pyroxasulfone and flumioxazin in dormant peppermint, Independence, OR.

Treatment	Rate	Applied	Sharp-point fluvellin	Prickly lettuce	Willowherb	Common groundsel	Peppermint Injury[1]	Peppermint Injury[2]	Oil yield
			---- Control ----						
	lb ai/a		---- % ----						lb/a
check			0	0	0	0	0	0	53
pyroxasulfone	1.7	1/18/2013	50	0	19	17	0	0	53
pyroxasulfone	3.4	1/18/2013	32	25	13	27	0	0	57
pyroxasulfone	1.5	1/18/2013	100	100	100	47	68	0	59
+ flumioxazin	2	1/18/2013							
pyroxasulfone	1.88	1/18/2013	96	100	100	63	65	0	55
+ flumioxazin	2.5	1/18/2013							
pyroxasulfone	3	1/18/2013	100	100	100	100	75	0	60
+ flumioxazin	4	1/18/2013							
carfentrazone	1.01	1/18/2013	37	0	13	0	0	0	54
pyroxasulfone	1.7	1/18/2013	77	75	75	60	0	0	60
+ carfentrazone	1.01	1/18/2013							
pyroxasulfone	1.7	4/11/2013	58	0	0	33		0	51
LSD (P=.05)			57.8	33.7	33.3	59	5	0	13.6

[1]Evaluated 2/19/13
[2]Evaluated 6/10/13

Post-harvest redroot pigweed control with pyroxasulfone and flumioxazin in double-cut mint. Kyle C. Roerig, Daniel W. Curtis, Andrew G. Hulting, and Carol A. Mallory-Smith. (Department of Crop and Soil Science, Oregon State University, Corvallis OR 97331) Removal of the crop canopy at harvest provides a competitive advantage to weeds in double-cut mint. Controlling the post-harvest flush of weeds after the first cutting in double-cut mint can be challenging, and is important to reduce competition and contamination of the mint oil. This trial was designed to evaluate options for the control of redroot pigweed. Injury data are not shown because injury, if present, could not be distinguished from verticillium wilt symptoms. Pyroxasulfone (Zidua) and pyroxasulfone + flumioxazin (Fierce) were compared to a number of registered herbicides. Treatments were applied to peppermint in Polk County, Oregon, on July 12, 2013, immediately following harvest. Treatments were applied with a single bicycle wheeled sprayer at 20 gallons per acre. Harvest samples, 22.5 square feet, were cut by hand on September 18, 2013. Following drying, oil was extracted from samples by distillation.

Pyroxasulfone, pyroxasulfone + flumioxazin, sulfentrazone (Spartan 4L), flumioxazin (Chateau), terbacil (Sinbar WDG), and oxyfluorfen (Goal 2XL) controlled 92% or more of the redroot pigweed (Table). Pendimethalin (Prowl H_2O) only controlled 50% of the redroot pigweed. The highest rates of pyroxasulfone and pyroxasulfone + flumioxazin controlled 100% of the redroot pigweed.

Table. Post-harvest redroot pigweed control in double cut mint, near Independence OR.

Treatment[1]	Rate	Redroot pigweed Control[2]	Peppermint Oil yield
	lb ai/a	---- % ----	lb/a
check		0	50
pyroxasulfone	0.09	92	29
pyroxasulfone	0.18	100	41
pyroxasulfone	0.08	98	36
+ flumioxazin	0.064		
pyroxasulfone	0.1	100	36
+ flumioxazin	0.08		
sulfentrazone	0.188	92	45
flumioxazin	0.128	99	41
terbacil	1.2	96	37
oxyfluorfen	0.5	98	48
pendimethalin	1.5	50	41
LSD (P=.05)		26.9	21
CV		26.5	35.6

[1]Applied 7/12/13
[2]Evaluated 9/17/13

Diuron alternatives 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, pyroxasulfone/flumioxazin, rimsulfuron, oxyfluorfen and glufosinate in comparison to industry standards of diuron followed by ethofumesate or diuron plus pronamide followed by ethofumesate. Plots were 8 by 36 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 plots. Twenty-four rows of APR2105 perennial ryegrass on twelve inch row spacings were planted in the rear portion of the plots. The perennial ryegrass was planted 0.25 inches deep with a one inch wide band of activated carbon over the rows applied at 300 lbs per acre. Planting was completed on October 8, 2012. Application and soil data are presented in Table 1. Herbicide 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 perennial ryegrass and percent control of planted *Poa* species were evaluated visually on June 10, 2013. The perennial ryegrass was swathed on July 10 and harvested with a small plot combine on July 24. Seed was cleaned and yields quantified (Table 2).

Table 1. Application and soil data, Hyslop Research Farm, Corvallis, OR.

Application date	October 10, 2012		November 15, 2012
Crop growth stage	preemergence		1 tiller
Poa trivialis growth stage	preemergence		1-2 leaves
Poa annua growth stage	preemergence		1-3 leaves
Air temperature (F)	70		45
Relative humidity (%)	42		90
Wind (mph, direction)	2, N		0
Cloud cover (%)	0		95
First rainfall (inches)	October 12, 1.06		November 18, 0.29
Soil temperature at 2 inches (F)	76º		47º
pH		6.1	
OM (%)		2.52	
CEC (meq/100g)		15.4	
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. Crop injury reduced yields in plots with the highest indaziflam rate. The remaining yields were greater than the untreated check. Diuron resistant *Poa annua* control was greater than 93% in treatments with the exceptions of the rimsulfuron and the diuron followed by ethofumesate treatments. *Poa trivialis* was controlled greater than 91% with the exception of the lower rate of pyroxasulfone, the rimsulfuron and the diuron followed by ethofumesate treatments. These diuron resistant *Poa annua* and the *Poa trivialis* populations are resistant to preemergence applications of rimsulfuron, but can be controlled by preemergence applications of indaziflam, pyroxasulfone, pyroxasulfone/flumioxazin and pronamide + diuron followed by ethofumesate.

Table 2. Control of weeds and crop injury with herbicide treatments in carbon-seeded perennial ryegrass, 2012-2013.

Treatment	Rate	Poa annua	*Poa trivialis*	Crop injury	Clean seed Yield
	lb ai/A	----- % control[1] -----		- % -	lb/A
Untreated check	0	0	0	0	815
Indaziflam	0.01	100	100	0	1080
Indaziflam	0.02	100	100	3	1086
Indaziflam	0.04	100	100	40	689
Pyroxasulfone	0.05	96	83	0	1124
Pyroxasulfone	0.09	99	94	3	1064
Pyroxasulfone-flumioxazin	0.1	100	98	0	1193
Pyroxasulfone-flumioxazin	0.14	100	99	1	1273
Rimsulfuron	0.05	0	0	0	1052
Rimsulfuron	0.06	0	0	0	1217
Indaziflam + diuron fb[2] glufosinate + oxyfluorfen	0.02 + 1 0.18 + 0.02	100	100	13	1106
Pyroxasulfone + diuron fb glufosinate + oxyfluorfen	0.05 + 1 0.18 + 0.02	98	97	1	1178
Rimsulfuron + diuron fb glufosinate + oxyfluorfen	0.05 + 1 0.18 + 0.02	66	63	0	1230
Diuron fb ethofumesate	2.4 1	13	48	0	1160
Pronamide + diuron fb ethofumesate	0.25 + 1 1	93	91	0	1172
LSD (P = 0.05)		7	7	4	137
CV		6	7	63	9

[1]% control and crop injury evaluated June 10, 2013.
[2]Abbreviations: fb, followed by.

Broadleaf weed control with 2,4-D formulations in spring wheat. Traci A. Rauch, Joan M. Campbell and Donald C. Thill. (Crop and Weed Science Division, University of Idaho, Moscow, ID 83844-2339) A study was established at the University of Idaho Parker Farm near Moscow, ID to evaluate broadleaf weed control with 2,4-D formulations in spring wheat. Spring wheat 'Louise' was seeded at 120 lb /A on May 5, 2013. A broadleaf seed mixture including; largeseed falseflax, common lambsquarters, and yellow mustard was also seeded on May 5. All plots were 8 by 25 feet arranged in a randomized complete block design with four replications and included an untreated check. Herbicide treatments were applied using a CO_2 pressurized backpack sprayer calibrated to deliver 10 gpa at 32 psi and 3 mph (Table 1). Broadleaf weed control was evaluated visually.

Table 1. Application and soil data.

Application date	May 31, 2013
Growth stage	
Spring wheat	1 tiller
Largeseed falseflax (CAMSA)	3 inch
Common lambsquarters (CHEAL)	1 inch
Yellow mustard (SINAL)	3 leaf
Air temperature (F)	51
Relative humidity (%)	89
Wind (mph, direction)	3, W
Cloud cover (%)	60
Soil moisture	adequate
Soil temperature at 2 inch (F)	40
pH	4.5
OM (%)	4.1
CEC (meq/100g)	18
Texture	silt loam

At 7 days after treatment (DAT), largeseed falseflax (CMASA) control ranged from 86 to 98% (Table 2). Yellow mustard (SINAL) ranged from 87 to 97%. WE-1402-1 and 2,4-D amine at the high rate provided better CMASA and SINAL control than the low rate, but control did not differ between the rates of the ester formulation. Common lambsquarters (CHEAL) control ranged from 88 to 98%. By 14 DAT, all treatments controlled largeseed falseflax, common lambsquarters, and yellow mustard 99% (data not shown).

Table 2. Broadleaf weed control with 2,4-D formulations in spring wheat near Moscow, ID in 2013.

		Weed control – 7 DAT[2]		
Treatment[1]	Rate	CAMSA	CHEAL	SINAL
	lb ae/A	%	%	%
WE-1402-1 +	0.475			
NIS	0.25% v/v	86	88	87
2,4-D amine +	0.475			
NIS	0.25% v/v	88	90	87
2,4-D ester +	0.475			
NIS	0.25% v/v	90	90	89
WE-1402-1 +	0.95			
NIS	0.25% v/v	98	97	97
2,4-D amine +	0.95			
NIS	0.25% v/v	98	98	97
2,4-D ester +	0.69			
NIS	0.25% v/v	91	92	92
LSD (0.05)		7	NS	8
Density (plants/ft^2)		5	5	5

[1]NIS = nonionic surfactant. WE-1402-1 is a 2,4-D formulation from Wilbur Ellis.
[2]CAMSA = largeseed falseflax, CHEAL = common lambsquarters, SINAL = yellow mustard.

Italian ryegrass and rattail fescue control in spring wheat. Traci A. Rauch, Joan M. Campbell and Donald C. Thill. (Crop and Weed Science Division, University of Idaho, Moscow, ID 83844-2339) Studies were established in spring wheat near Potlatch and Genesee, ID to evaluate Italian ryegrass and rattail fescue control, respectively, with flucarbazone alone or plus thifensulfuron/tribenuron and pyroxsulam/florasulam/fluroxypyr. 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). Crop injury and grass weed control were evaluated visually during the growing season.

Table 1. Application and soil data.

Location	Potlatch, ID			Genesee, ID		
S. wheat-variety/seeding date	Wit - 5/8/13			Louise - 5/2/13		
Application date	5/31/13	6/6/13	6/13/13	5/20/13	6/5/13	6/12/13
Growth stage						
Spring wheat	2 lf	1 tiller	2 tiller	1 lf	1 tiller	2 tiller
Italian ryegrass (LOLMU)	1 lf	3 lf	1 tiller	--	--	--
Rattail fescue (VLPMY)	--	--	--	1 lf	3 lf	1 tiller
Air temperature (F)	66	87	58	66	74	67
Relative humidity (%)	56	52	73	58	60	55
Wind (mph, direction)	1, W	1, W	3, W	2, E	0	3, W
Cloud cover (%)	75	60	80	10	0	40
Soil moisture	good	good	dry	dry	good	dry
Soil temperature at 2 inch (F)	53	66	54	54	55	60
pH		4.3			5.2	
OM (%)		4.2			4.1	
CEC (meq/100g)		17.0			18.3	
Texture		silt loam			silt loam	

At Potlatch at 6 DAT, spring wheat was injured 10% with pyroxsulam/florasulam/fluroxypyr applied at the 1 leaf stage (Table 2). By June 13 and July 11, no treatment visually injured spring wheat (data not shown). No treatment at any application time adequately controlled Italian ryegrass likely due to the presence of Group 2 resistant biotypes.

At Genesee, spring wheat was not injured by any treatment at any application time (data not shown). At the 3 leaf application time, flucarbazone alone or combined with thifensulfuron/tribenuron controlled rattail fescue better (87 and 89%) than pyroxsulam/florasulam/fluroxypyr (51%) (Table 2). At the 1 leaf or 1 tiller application time, rattail fescue control did not differ among treatments within each application time.

Table 2. Grass weed control in spring wheat with flucarbazone alone or plus thifensulfuron/tribenuron and pyroxsulam/florasulam/fluroxypyr near Potlatch and Genesee, ID in 2013.

			Potlatch		Genesee
Treatment[1]	Rate	Application timing[2]	Spring wheat injury[3]	Italian ryegrass control[4]	Rattail fescue control[5]
	lb ai/A		%	%	%
Flucarbazone	0.027	1 leaf	0	28	91
Flucarbazone +	0.027				
thifen/triben	0.012	1 leaf	0	52	80
Pyrox/flora/fluro	0.105	1 leaf	10	41	85
Flucarbazone	0.027	3 leaf	NA	38	87
Flucarbazone +	0.027				
thifen/triben	0.012	3 leaf	NA	41	89
Pyrox/flora/fluro	0.105	3 leaf	NA	58	51
Flucarbazone	0.027	1 tiller	NA	55	61
Flucarbazone +	0.027				
thifen/triben	0.012	1 tiller	NA	52	74
Pyrox/flora/fluro	0.105	1 tiller	NA	68	72
LSD (0.10)			1	NS	22
Density (plants/ft^2)				15	5

[1]All treatments were applied with a basic blend adjuvant at 1% v/v. Thifen/triben = thifensulfuron/tribenuron. Pyrox/flora/fluro = pyroxsulam/florasulam/fluroxypyr.
[2]Application timing based on grass weed growth stage.
[3]Evaluation date June 6, 2013. The 3 leaf and 1 tiller applications had not been applied (NA).
[4]Evaluation date July 11, 2013.
[5]Evaluation date June 26, 2013.

Comparing broadleaf herbicides tank mixed with pinoxaden for wild oat and broadleaf weed control in spring wheat. Don W. Morishita, Kyle G. Frandsen, Neyle T. Perdomo (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 the effectiveness of broadleaf herbicides tank mixed with pinoxaden on wild oats and broadleaf weeds in spring wheat. 'Alturas' spring wheat was planted March 29, 2013, at 100 lb/A. Experimental design was a randomized complete block with four replications and individual plots were 7.33 by 30 ft. Soil type was a Portneuf silt loam 20.4% sand, 71% silt, and 8.6% clay with a pH of 8, 1.5% organic matter, and CEC of 17-meq/100 g soil. Herbicides were applied on May 9 with a CO_2-pressurized bicycle-wheel sprayer using 11001 flat fan nozzles calibrated to deliver 15 gpa at 22 psi and 3mph. Application began at 1:30 pm. Air temperature, relative humidity, soil temperature, wind speed, and cloud cover was 76 F, 27%, 71 F, 5 mph, and 25%, respectively. Crop injury and weed control were evaluated visually 15 and 39 days after application (DAA) on May 24 and June 17, respectively. Grain was harvested August 13 with a small-plot combine.

No crop injury was observed among any of the herbicide treatments at 15 and 39 DAA. Common lambsquarters control ranged from 0 to 100% at 15 and 39 DAA. Common lambsquarters control with pinoxaden & fluroxypyr (formulated premixture) at 0.135 lb ae/A averaged 8 and 0% at 15 and 39 DAA, respectively. This was the only treatment that did not control common lambsquarters >75%. Wild oat control 15 DAA ranged from 73 to 78% and there were no differences among the herbicide treatments. At 39 DAA, wild oat control ranged from 56 to 90%. However, pinoxaden & fluroxypyr premixture was the only treatment that controlled wild oats ≥90%, although this may be misleading due to common lambsquarters competition preventing wild oat growth. Wild oat control with all other herbicide treatments ranged from 56 to 73%. Yields ranged from 39 to 99 bu/A with the untreated control and pinoxaden & fluroxypyr with the lowest grain yields at 39 and 42 bu/A, respectively. All of the other herbicide treatments had statistically equal yields ranging from 87 to 99 bu/A.

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

Treatment[3]	Application rate	Crop injury 5/24	Crop injury 6/17	Weed control[2] CHEAL 5/24	CHEAL 6/17	AVEFA 5/24	AVEFA 6/17	Grain yield
	lb ai/A	-----------	-----------	-----------	%	-----------	-----------	bu/A
Untreated control		-	-	-	-	-	-	39 b
Pinoxaden/fluroxypyr + thifensulfuron/tribenuron-1 + picoxystrobin	0.135 lb ae/A + 0.0313 + 0.065	0 a	0 a	97 bc	99 a	74 a	70 b	98 a
Pinoxaden/fluroxypyr + thifensulfuron/tribenuron-2 + picoxystrobin	0.135 lb ae/A + 0.0313 + 0.065	0 a	0 a	96 cd	94 ab	73 a	69 b	95a
Pinoxaden + thifensulfuron/tribenuron-1 + picoxystrobin	0.054 + 0.0313 + 0.065	0 a	0 a	98 abc	99 a	73 a	71 b	87 a
Pinoxaden/fluroxypyr	0.135 lb ae/A	0 a	0 a	8 f	0 c	78 a	90 a	42 b
Pinoxaden/fluroxypyr + florasulam	0.135 lb ae/A + 0.355 lb ae/A	0 a	0 a	75 e	89 ab	75 a	69 b	99 a
Pinoxaden/fluroxypyr + thifensulfuron/tribenuron-1 + MCPA LVE	0.135 lb ae/A + 0.0125 + 0.231 lb ae/A	0 a	0 a	97 bc	99 a	75 a	58 b	90 a
Pinoxaden/fluroxypyr + bromoxynil/MCPA	0.135 lb ae/A + 0.375 lb ae/A	0 a	0 a	99 abc	83 b	75 a	75 b	98 a
Pinoxaden + thifensulfuron/tribenuron-1 + MCPA LVE	0.054 + 0.0125 + 0.231 lb ae/A	0 a	0 a	91 d	86 b	75 a	56 b	96 a
Pinoxaden + bromoxynil/pyrasulfotole	0.054 + 0.217	0 a	0 a	100 a	91 ab	74 a	70 b	92 a
Pinoxaden + bromoxynil/pyrasulfotole	0.054 + 0.241	0 a	0 a	100 a	94 ab	74 a	66 b	91 a
Pinoxaden + bromoxynil/pyrasulfotole + trifloxystrobin/propiconazole	0.054 + 0.217 + 0.081	0 a	0 a	99 ab	92 ab	76 a	73 b	89 a

[1]Means followed by same letter are not significantly different using Fisher's Protected LSD (P=0.05).
[2]Weed species evaluated for control were: common lambsquarters (CHEAL) and wild oat (AVEFA).
[3]Pinoxadin/fluroxypyr is Axial Star. Pinoxaden is sold as Axial XL. Thifensulfuron/tribenuron-1 is a 1:1 formulation sold as Affinity Broadspec. Thifensulfuron/tribenuron-2 is a 4:1 formulation sold as Affinity Tankmix. Picoxystrobin is a fungicide sold as Aproach. Florasulam is sold as Orion. Bromoxynil/MCPA is sold as Bronate Advanced. Bromoxynil/pyrasulfotole is sold as Huskie. Trifloxystrobin/propiconazole is a fungicide sold as Stratego.

Broadleaf weed control with pyraflufen ethyl with and without Kafe adjuvant in spring wheat. Don W. Morishita, Kyle G. Frandsen, and Neyle T. Perdomo (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 crop tolerance and broadleaf weed control with pyraflufen ethyl when used in combination with the adjuvant Kafe. 'Alturas' spring wheat was planted on March 29, 2013, at 100 lb/A. The experimental design was a randomized complete block with four replications. Individual plots were 8 ft by 30 ft. Soil type was a Portneuf silt loam with 8.8% sand, 54% silt and 37.2% clay with a pH of 7.9, 1.45% organic matter, and CEC of 17.5-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 24 psi and 3 mph. Weeds present in this study were common lambsquarters (CHEAL), kochia (KCHSC) and Russian-thistle (SASKR) with densities averaging 26, 8, and 1 plant/ft^2, respectively. Environmental conditions at application were as follows: air temperature 85 F, soil temperature 71 F, relative humidity 24%, wind speed 2 mph, and 30% cloud cover. Application began at 12:10 pm. Crop injury was evaluated visually 4, 7, 9 and 30 days after application (DAA) on May 17, 20, 22, and June 12, respectively. Weed control was evaluated visually at 9 and 30 DAA. Grain was harvested August 12 with a small-plot combine.

Crop injury 4 DAA ranged from 0 to 16%. The highest levels of crop injury were in the treatments with the higher pyraflufen rate (0.007oz ai/A). At 9 and 30 DAA crop injury ranged from 0 to 9%, again with the higher pyraflufen rate. By 30 DAA, no crop injury was observed among any of the treatments. Common lambsquarters control at 9 DAA ranged from 0 to 91%. The treatments with the higher pyraflufen rate had the highest common lambsquarters control ranging from 85 to 91% when combined with any of the three Kafe rates, which ranged from 6 to 12 fl oz/A. Common lambsquarters control with pyraflufen at 0.007oz ai/A without Kafe was lower than treatments that included Kafe, regardless of the rate used. By 30 DAA, common lambsquarters control ranged from 0 to 63%, which was markedly lower overall compared to the earlier evaluation. Kochia control 9 DAA ranged from 13 to 65%. By 30 DAA kochia control ranged from 3 to 40%, with the exception of the treatments containing fluroxypyr at 0.14 lb ae/A. With fluroxypyr added, control was 99 and100%. Unfortnately, these same treatments have virtually no common lambsquarters control at 9 or 30 DAA. Russian-thistle control was evaluated only 9 DAA and ranged from 8 to 98%. The highest levels of Russian-thistle control was with the treatments containing pyraflufen at 0.007oz ai/A. Wheat yields ranged from 90 to 118 bu/A. The lowest yielding treatments were the untreated control and those containing fluroxypyr. The reduction in yield for treatments containing fluroxypyr appears to be caused by an antagonistic relationship between pyraflufen and fluroxypyr, causing poor common lambsquarters control which resulted in reduced yield.

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

						Weed control[2]					
	Application	Crop injury				CHEAL		KCHSC		SASKR	Grain
Treatment[3]	rate	5/17	5/20	5/22	6/12	5/22	6/12	5/22	6/12	5/22	yield
	oz ai/A	--------------------				%				--------------------	bu/A
Untreated control		-	-	-	-	-	-	-	-	-	90 d
Pyraflufen	0.0035	1 d	0 b	0 c	0 a	36 d	2 de	13 c	25 bcd	72 ab	101 bcd
Pyraflufen + Kafe	0.0035 + 6 fl oz/A	6 cd	0 b	1 bc	0 a	59 bc	6 cd	24 c	7 cd	48 bc	104 a-d
Pyraflufen + Kafe	0.0035 + 9 fl oz/A	9 bc	0 b	1 bc	0 a	51 bcd	13 bc	20 c	7 cd	75 ab	104 a-d
Pyraflufen + Kafe	0.0035 + 12 fl oz/A	6 cd	0 b	0 c	0 a	38 cd	3 de	15 c	3 d	29 cd	105 abc
Pyraflufen	0.007	10 abc	0 b	3 abc	0 a	63 b	18 b	36 bc	10 bcd	85 a	110 ab
Pyraflufen + Kafe	0.007 + 6 fl oz/A	16 a	5 a	5 a	0 a	85 a	57 a	64 a	35 bc	96 a	118 a
Pyraflufen + Kafe	0.007 + 9 fl oz/A	14 ab	3 a	4 ab	0 a	86 a	45 a	51 ab	17 bcd	98 a	111 ab
Pyraflufen + Kafe	0.007 + 12 fl oz/A	16 a	6 a	5 a	0 a	91 a	63 a	63 a	40 b	89 a	116 a
Pyraflufen + fluroxypyr	0.0035 + 0.14 lb ae/A	0 d	0 b	1bc	0 a	4 e	0 e	60 ab	100 a	8 d	92 cd
Pyraflufen + zinc + fluroxypyr	0.0035 + 12 fl oz/A + 0.14 lb ae/A	0 d	0 b	0 c	0 a	0 e	0 e	65 a	99 a	40 bcd	90 d

[1]Means followed by same letter do not significantly differ (P=0.05, LSD).
[2]Weed species evaluated for control were: common lambsquarter (CHEAL), kochia (KCHSC), and russian thistle (SASKR).
[3]Pyraflufen is Vida. Fluroxypyr is Starane Ultra.

Post-harvest control of Russian-thistle following spring wheat. Drew Lyon, Brianna Cowan, and Rod Rood. (Crop and Soil Sciences Department, Washington State University, PO Box 646420, Pullman, WA 99164-646420) A field study was conducted at the Lind Dryland Research Station near Lind, WA to evaluate the effect that herbicide application time has on Russian-thistle control. Spring wheat was harvested on July 29, 2013. Post-harvest herbicide applications were made on August 9. The first application time was at dawn, when Russian-thistle plants should have recovered from the previous day's drought stress to the maximum extent possible. The air temperature was 61 F, the soil surface temperature was 53 F and the relative humidity was 60%. The second application time was at mid-afternoon, when the air temperature was near the maximum for the day and plants would have been shutting down as a result of drought stress. The air temperature was 91 F, the soil surface temperature was 84 F, and the relative humidity was 17%. All treatments were applied with a CO_2 backpack sprayer set to deliver 15 gpa at 35 psi and 3 mph. Russian-thistle plants were 6 to 12 inches tall.

The time of day at which herbicide applications were made did not appear to affect the level of control achieved by any particular treatment (Table). The greatest difference in control between early morning and mid-afternoon application occurred for the treatment of glyphosate at 64 ounces per acre, although the difference was not statistically different. These data do not support the recommendations by some to apply herbicides at night for better control, although this is just one site and one year. The results will need to be verified with further research. The treatments containing paraquat provided the best control of Russian-thistle, particularly two weeks after application. The bromoxynil + dicamba treatment was a very close second. Glyphosate at 64 ounces per acre provided good to very good control of Russian-thistle four weeks after application, but a reduced rate of glyphosate, with or without saflufenacil, provided only fair control of Russian-thistle four weeks after application. The glyphosate + saflufenacil treatment did provide better control than glyphosate at 64ounces per acre at two weeks after application, but not at four weeks after application.

Table. Post-harvest control of Russian–thistle following spring wheat.

Treatment	Rate	Timing	22-Aug-13 Russian-thistle control	4-Sep-13 Russian-thistle control
	oz ai/a		--------%--------	
Paraquat +	15.1	AM	95	93
NIS	0.5% v/v			
Paraquat +	10.1	AM	95	90
Diuron +	4			
NIS	0.5% v/v			
Bromoxynil +	6	AM	91	89
Dicamba	4			
Glyphosate +	16	AM	18	56
AMS	17 lb/100 gal			
Glyphosate +	32	AM	53	89
AMS	17 lb/100 gal			
Glyphosate +	16	AM	69	71
Saflufenacil +	0.303			
MSO +	1.0% v/v			
AMS	17 lb/100 gal			
Paraquat +	15.1	PM	99	95
NIS	0.5% v/v			
Paraquat +	10.1	PM	98	93
Diuron +	4			
NIS	0.5% v/v			
Bromoxynil +	6	PM	86	83
Dicamba	4			
Glyphosate +	16	PM	25	55
AMS	17 lb/100 gal			
Glyphosate +	32	PM	45	80
AMS	17 lb/100 gal			
Glyphosate +	16	PM	73	73
Saflufenacil +	0.303			
MSO +	1.0% v/v			
AMS	17 lb/100 gal			
Untreated check			0	0
LSD (5%)			10	10

Ventenata and bulbous bluegrass control in winter wheat following CRP takeout. Drew Lyon, Stephen Van Vleet, Brianna Cowan, and Rod Rood. (Crop and Soil Sciences Department, Washington State University, PO Box 646420, Pullman, WA, 99164-646420) A field study was conducted near Anatone, WA to evaluate several grass herbicides for the control of ventenata and bulbous bluegrass in winter wheat. The winter wheat was direct-seeded into ground that had been in CRP. Glyphosate was applied twice to the CRP grass in the fall at a rate of 2 lb ai/acre each time. A wheat mix containing 'Xerpha' and 'WB528' winter wheat was planted on November 6, 2012 at 82 pounds per acre, using a drill set-up with 12-inch row spacing. Herbicide treatments were applied on April 9, 2013 when the wheat was tillering and about 4 to 6 inches tall. A CO_2 backpack sprayer was used and set to deliver 10 gpa at 30 psi and 3 mph. Heavy infestations of bulbous bluegrass and ventenata were present. Bulbous bluegrass and ventenata were 1 to 2 inches tall and in the 2- to 3-leaf stage. Winter wheat stands were poor, so this trial was not taken to yield.

Pinoxaden, clodinafop, and pyroxsulam provided excellent control of ventenata and bulbous bluegrass in this study. Propoxycarbazone and mesosulfuron provided very good control of bulbous bluegrass, but poor control of ventenata. We failed to add an ammonium nitrate fertilizer to the mesosulfuron treatment, which may have reduced its efficacy on ventenata. It appears that there are several herbicides, including both Group 1 and Group 2 mechanisms of action, which provide effective control of ventenata and bulbous bluegrass in winter wheat. Both of these weeds can be problematic in wheat that is direct-seeded into CRP ground.

Table. Ventenata and bulbous bluegrass control in winter wheat following CRP takeout.

		9-May-13	3-Jun-13		17-Jun-13
Treatment	Rate	Bulbous bluegrass control	Ventenata control	Bulbous bluegrass control	Ventenata control
	oz ai/a	----------	---------- %	----------	----------
Pyroxsulam +	0.263	85	86	89	90
NIS	0.25% v/v				
Propoxycarbazone +	0.121	70	15	90	44
NIS	0.25% v/v				
Mesosulfuron +	0.214	80	15	86	56
NIS	0.25% v/v				
Pinoxaden	2.36	89	99	99	96
Diclofop +	16	25	0	10	9
COC	16				
Fenoxaprop	0.0825	5	0	0	5
Clodinafop +	1	86	94	98	95
MSO	0.25% v/v				
Flucarbazone +	0.438	48	18	69	64
NIS	0.25% v/v				
Nontreated check		0	0	0	0
LSD (5%)		19	24	28	23

<u>Mayweed chamomile control in winter wheat</u>. Traci A. Rauch, Joan M. Campbell, and Donald C. Thill. (Crop and Weed Science Division, University of Idaho, Moscow, ID 83844-2339) Two studies were established in 'ORCF 102' winter wheat near Kendrick, ID to evaluate winter wheat response and mayweed chamomile control with pyraflufen/2,4-D and clopyralid and fluroxypyr combinations. 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). Both studies were oversprayed on May 10, 2013 with pinoxaden at 0.054 lb ai/A to control Italian ryegrass and azoxystrobin/propiconazole at 0.18 lb ai/A to control stripe rust. Wheat response and weed control were evaluated visually.

Table 1. Application and soil data.

	Pyraflufen/2,4-D study	Clopyralid and fluroxypyr study
Application date	4/24/13	4/25/2013
Growth stage		
Winter wheat	2 tiller	2 tiller
Mayweed chamomile	1 inch tall	1 inch tall
Air temperature (F)	63	49
Relative humidity (%)	51	77
Wind (mph), direction	2, W	2, E
Dew present?	no	yes
Cloud cover (%)	0	0
Soil moisture	wet	wet
Soil temperature at 2 inch (F)	60	40
pH	5.0	
OM (%)	5.2	
CEC (meq/100g)	30.6	
Texture	silt loam	

In the pyraflufen/2,4-D study at 13 DAT, pyraflufen/2,4-D injured winter wheat 7% (Table 2). By 40 DAT, no winter wheat injury was visible (data not shown). Clopyralid/fluroxypyr controlled mayweed chamomile 96%. Mayweed chamomile was not controlled by any other treatment.

In the clopyralid and fluroxypyr study at 15 DAT, pyraflufen/2,4-D injured winter wheat 7% (Table 3). By 40 DAT, no visible winter wheat injury was present (data not shown). Thifensulfuron/tribenuron plus 2,4-D and treatments containing clopyralid controlled mayweed chamomile 86% and greater. All other treatments suppressed mayweed chamomile 58 to 74%.

Table 2. Winter wheat injury and mayweed chamomile control with pyraflufen/2,4-D near Kendrick, ID in 2013.

		Winter wheat injury	Mayweed chamomile control
Treatment	Rate[1]	13 DAT	40 DAT
	lb ai/A	%	%
Pyraflufen/2,4-D ester	0.33	7	52
2,4-D ester	0.356	0	50
Clopyralid/fluroxypyr	0.188	0	96
Pyrasulfotole/bromoxynil	0.21	0	64
LSD (0.05)		1	15
Density (plants/ft^2)			10

[1]Rate is in lb ae/A for all treatments containing fluroxypyr or 2,4-D ester.

Table 3. Mayweed chamomile control with clopyralid and fluroxypyr combinations near Kendrick, ID in 2013.

Treatment[1]	Rate[2]	Winter wheat injury	Mayweed chamomile control
		15 DAT	40 DAT
	lb ai/A	%	%
Clopyralid/fluroxypyr	0.187	0	90
Clopyralid/2,4-D	0.594	0	88
Florasulam/fluroxypyr	0.093	0	58
Florasulam/fluroxypyr +	0.093		
2,4-D ester	0.344	0	74
Pyrasulfotole/bromoxynil +	0.178		
AMS +	1		
NIS	0.25% v/v	0	66
Thifensulfuron/tribenuron +	0.0125		
2,4-D ester +	0.344		
NIS	0.25% v/v	0	86
Pyraflufen/2,4-D	0.33	7	58
GF-2686	0.0089	0	69
LSD (0.05)		1	23
Density (plants/ft^2)			10

[1]AMS is ammonium sulfate. NIS is nonionic surfactant.
[2]Rate is in lb ae/A for treatments containing clopyralid, fluroxypyr or 2,4-D.

Mayweed chamomile control in winter wheat. Drew Lyon, Brianna Cowan, and Rod Rood. (Crop and Soil Sciences Department, Washington State University, PO Box 646420, Pullman, WA 99164-6420) A field study was conducted at the Cook farm near Pullman, WA to determine the efficacy of clopyralid/fluroxypyr for the control of mayweed chamomile in winter wheat. 'Brundage 96' was direct seeded on October 18, 2012 into lentil residue using a Horsch drill set-up with 12-inch row spacing. The soil was a silt loam with a pH of 4.8 and 2.8% organic matter. Herbicide treatments were applied on April 16, 2013 when the wheat had two tillers and was 8 to10 inches tall. Herbicides were applied with a CO_2 backpack sprayer set to deliver 10 gpa at 30 psi and 3 mph. Prickly lettuce and mayweed chamomile were the most prevalent and uniformly distributed weeds in this study. Prickly lettuce was about 4 inches tall and mayweed chamomile was a 1- to 2-inch rosette at the time of application. Other weeds present, but not rated due to uneven distribution or low plant densities were volunteer lentil, henbit, panicle willowweed, and catchweed bedstraw. The trial was harvested for grain yield on August 19, 2013.

Herbicides containing clopyralid provide excellent control of mayweed chamomile and prickly lettuce. The decision on which of these products to use will come down to differences in price, application windows, and recrop restrictions. Florasulam/fluroxypyr/pyroxsulam plus pyrasulfotole/bromoxynil provided very good to excellent control of these two weeds and may be a good choice if the control of certain grass weeds is needed in addition to these broadleaf weeds. Thifensulfuron/tribenuron plus 2,4-D ester provided good control of both mayweed chamomile and prickly lettuce. Resistance to Group 2 herbicides have been reported for both of these weeds, so this level of control with thifensulfuron/tribenuron may not be achievable if this resistance is present in a particular field.

Table. Mayweed chamomile control in winter wheat.

Treatment	Rate	31-May-13 Mayweed chamomile control	31-May-13 Prickly lettuce control	24-Jul-13 Wheat senescence	19-Aug-13 Grain yield
	oz ai/a	-------------------------	--%	-------------------------	bu/a
Clopyralid/fluroxypyr	3	96	96	94	87.2
Clopyralid/2,4-D amine	9.5	96	100	95	87.3
Florasulam/fluroxypyr	1.49	51	61	95	93.8
Florasulam/fluroxypyr +	1.49	63	84	95	99.1
2,4-D ester	5.5				
Pyrasulfotole/bromoxynil +	2.84	63	79	94	104.7
NIS +	0.25% v/v				
AMS	1 lb/a				
Thifensulfuron/tribenuron +	0.2	86	85	91	91.3
2,4-D ester +	5.5				
NIS	0.25% v/v				
GF-2686 +	0.14	76	70	94	102.3
NIS	0.25% v/v				
Florasulam/MCPA +	4.97	69	71	96	97.2
Pyrasulfotole/bromoxynil +	5.06	69	70	96	100.3
Florasulam/fluroxypyr	1.49				
Florasulam/fluroxypyr/pyroxsulam +	4.67	88	95	94	109.5
Pyrasulfotole/bromoxynil	5.06				
Clopyralid/MCPA ester	10	99	98	94	89.0
Nontreated check		0	0	94	87.2
LSD (5%)		21	24	4	21.3

Italian ryegrass and mayweed chamomile control in winter wheat. Traci A. Rauch, Joan M. Campbell and Donald C. Thill. (Crop and Weed Science Division, University of Idaho, Moscow, ID 83844-2339) Studies were established in winter wheat to evaluate 1) Italian ryegrass (LOLMU) control with flufenacet/metribuzin and propoxycarbazone combinations near Troy, ID; and Italian ryegrass and mayweed chamomile (ANTCO) control with 2) flumioxazin or flumioxazin/pyroxasulfone applied at two application times near Moscow, ID and 3) pinoxaden, pinoxaden/fluroxypyr, and flucarbazone combined with broadleaf herbicides near Kendrick, 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). At Moscow, all plots, excluding the check, were oversprayed 10 days before planting or postplant preemergence with glyphosate at 0.77 lb ae/A. Troy and Moscow sites were oversprayed with pyrasulfotole/bromoxynil at 0.21 lb ai/A and clopyralid/fluroxypyr at 0.25 lb ae/A for broadleaf weed control on May 15, 2013. Winter wheat injury, Italian ryegrass and mayweed chamomile control were evaluated visually during the growing season.

Table 1. Application and soil data.

Location	Troy, ID			Moscow, ID			Kendrick, ID
Wheat variety – seeding date	Boundary – 9/30/12			Madsen/WB 528 blend – 10/18/12			ORCF 102 – 10/12/12
Application date	10/10/12	4/2/13	5/1/13	10/8/12	10/21/12	5/6/13	4/24/13
Growth stage							
Winter wheat	pre	1 tiller	3 tiller	preplant	pre	3 tiller	2 tiller
Mayweed chamomile (ANTCO)	--	--	--	pre	pre	2 inch	1 inch
Italian ryegrass (LOLMU)	pre	2 leaf	2 tiller	pre	pre	1 tiller	2 tiller
Air temperature (F)	65	73	51	65	46	68	60
Relative humidity (%)	42	50	72	33	61	53	54
Wind (mph, direction)	2, E	1, W	0	5, SW	0	4, NE	2, W
Cloud cover (%)	0	100	0	0	0	0	0
Soil moisture	very dry	dry	adequate	very dry	dry	dry	wet
Soil temperature at 2 inch (F)	58	55	55	61	50	48	60
Next rain occurred	10/13/12	4/5/13	5/22/13	10/13/12	10/23/12	5/22/13	4/29/13
pH	4.4			4.5			5.2
OM (%)	4.8			3.4			5.5
CEC (meq/100g)	25.5			15.9			19.5
Texture	silt loam			silt loam			silt loam

At Troy, propoxycarbazone applied at the 1 tiller stage injured winter wheat 7% (Table 2). By May 15, visible winter wheat injury was not present (data not shown). Pyroxasulfone and all treatments containing flufenacet/metribuzin controlled Italian ryegrass 90 to 96%. Propoxycarbazone alone or combined with pyrasulfotole/bromoxynil did not control Italian ryegrass.

At Moscow, winter wheat injury on May 15, 2013 was 32 to 36% with all treatments containing postplant preemergence applications (Table 3). Flumioxazin/pyroxasulfone and flumioxazin applied postplant preemergence injured wheat 41 and 50% more, respectively, than the preplant timing of the same herbicides. By July 18, the post-plant preemergence timings of flumioxazin/pyroxasulfone and flumioxazin, both combined with pyroxsulam and thifensulfuron, injured wheat 22 and 26%, but did not differ from flufenacet/metribuzin plus pyroxsulam and thifensulfuron (19%). Flumioxazin/pyroxasulfone treatments controlled Italian ryegrass 95 and 97%.

At Kendrick, no treatment visibly injured winter wheat (data not shown). All treatments containing pinoxaden controlled Italian ryegrass control 91 to 98% (Table 4). Mayweed chamomile control tended to be greater than 90% with florasulam/MCPA but was not differ among all treatments.

Table 2. Winter wheat injury and Italian ryegrass control with flufenacet/metribuzin and propoxycarbazone combinations near Troy, ID in 2013.

Treatment[1]	Rate	Application timing[2]	Wheat injury May 7	LOLMU control July 26
	lb ai/A		%	%
Flufenacet/metribuzin	0.425	preemergence	0	94
Pyroxasulfone	0.08	preemergence	0	96
Flufenacet/metribuzin +	0.425	preemergence		
propoxycarbazone +	0.026	preemergence		
propoxycarbazone +	0.026	2 tiller		
pyrasulfotole/bromoxynil	0.217	2 tiller	0	90
Flufenacet/metribuzin +	0.425	preemergence		
propoxycarbazone +	0.04	2 tiller		
pyrasulfotole/bromoxynil	0.217	2 tiller	0	93
Propoxycarbazone +	0.04	2 tiller		
pyrasulfotole/bromoxynil	0.217	2 tiller	0	68
Propoxycarbazone	0.04	1 tiller	6	61
LSD (0.05)			1	22
Density (plants/ft^2)				5

[1]A 90% nonionic surfactant at 0.5% v/v was applied with propoxycarbazone at the 1 and 2 tiller timing.
[2]Application timing based on Italian ryegrass growth stage.

Table 3. Winter wheat injury, mayweed chamomile and Italian ryegrass control with flumioxazin and flumioxazin/pyroxasulfone combined with pyroxsulam and thifensulfuron at two application times near Moscow, ID in 2013.

Treatment[1]	Rate	Application timing[2]	Wheat injury May 15	Wheat injury June 18	ANTCO control[3]	LOLMU control[4]
	lb ai/A		%	%	%	%
Flumioxazin +	0.064	preplant				
pyroxsulam +	0.016	3 tiller				
thifensulfuron	0.014	3 tiller	18	4	50	68
Flumioxazin/pyroxasulfone +	0.143	preplant				
pyroxsulam +	0.016	3 tiller				
thifensulfuron	0.014	3 tiller	19	10	73	97
Flumioxazin +	0.064	postplant pre				
pyroxsulam +	0.016	3 tiller				
thifensulfuron	0.014	3 tiller	36	26	92	86
Flumioxazin/pyroxasulfone +	0.143	postplant pre				
pyroxsulam +	0.016	3 tiller				
thifensulfuron	0.014	3 tiller	32	22	93	95
Flufenacet/metribuzin +	0.425	postplant pre				
pyroxsulam +	0.016	3 tiller				
thifensulfuron	0.014	3 tiller	34	19	40	86
LSD (0.05)			9	11	39	11
Density (plants/ft^2)					5	15

[1]All treatments, excluding the check, were oversprayed with glyphosate at 0.77 lb ae/A plus ammonium sulfate at 2.5 lb ai/A at preplant or post plant preemergence. A 90% nonionic surfactant at 0.25% v/v and ammonium sulfate at 2.5 lb ai/A was applied with pyroxsulam and thifensulfuron.
[2]Application timing based on winter wheat growth stage. Preplant = 10 days before planting. Postplant pre = post-plant preemergence wheat that was germinated.
[3]ANTCO = Mayweed chamomile. Evaluation date May 15, 2013. Three replication analyzed due to non-uniform stand.
[4]LOLMU = Italian ryegrass. Evaluation date June 18, 2013.

Table 4. Italian ryegrass and mayweed chamomile control with pinoxaden, pinoxaden/fluroxypyr, and flucarbazone combined with broadleaf herbicides near Kendrick, ID in 2013.

Treatment[1]	Rate	Weed control LOLMU[2]	Weed control ANTCO[2]
	lb ai/A	%	%
Pinoxaden +	0.054		
florasulam/MCPA	0.315	95	93
Pinoxaden +	0.054		
dicamba/fluroxypyr	0.108		
MCPA ester	0.27	91	76
Pinoxaden/fluroxypyr +	0.147		
florasulam/MCPA	0.315	95	96
Pinoxaden/fluroxypyr +	0.147		
dicamba/fluroxypyr	0.108		
MCPA ester	0.27	95	86
Pinoxaden/fluroxypyr +	0.147		
bromoxynil/MCPA	0.375	98	81
Flucarbazone +	0.021		
florasulam/MCPA	0.315	33	93
Flucarbazone +	0.021		
dicamba/fluroxypyr	0.108		
MCPA ester	0.27	35	80
Pyroxsulam +	0.016		
pyrasulfotole/bromoxynil	0.217	67	85
LSD (0.05)		38	NS
Density (plants/ft^2)		8	5

[1]Basic blend at 1% v/v was applied with flucarbazone. A 90% nonionic surfactant at 0.25% v/v and ammonium sulfate at 1.5 lb ai/A were applied with pyroxsulam.

[2]Evaluation date = June 4, 2013. Three replications analyzed due to non-uniform weed population.

Rattail fescue control in winter wheat. Traci A. Rauch, Joan M. Campbell and Donald C. Thill. (Crop and Weed Science Division, University of Idaho, Moscow, ID 83844-2339) Studies were established in 'Brundage 96' winter wheat to evaluate rattail fescue control with flucarbazone, flufenacet/metribuzin and pyroxasulfone combinations near Colton, WA and with pyroxasulfone containing herbicides alone or in combination near Genesee, 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). Crop injury and rattail fescue control were evaluated visually during the growing season.

Table 1. Application and soil data.

Location	Colton, WA			Genesee, ID	
Winter wheat seeding date		10/7/12		10/13/12	
Application date	10/11/12	4/2/13	4/26/13	10/17/12	5/3/13
Growth stage					
Winter wheat	pre (no germ)	1 tiller	2 tiller	pre (germ)	3 tiller
Rattail fescue (VLPMY)	pre	1 tiller	3 tiller	pre	2 tiller
Air temperature (F)	68	56	59	53	66
Relative humidity (%)	40	72	68	54	55
Wind (mph, direction)	5, E	1, W	2, E	3, NW	1, E
Cloud cover (%)	0	0	20	60	50
Soil moisture	very dry	dry	good	dry	good
Soil temperature at 2 inch (F)	55	45	45	45	50
pH		5.4		4.7	
OM (%)		7.0		5.0	
CEC (meq/100g)		26.5		21.3	
Texture		silt loam		silt loam	

At the Colton, WA site, no treatment visually injured winter wheat (data not shown). Flufenacet/metribuzin at the high rate alone or combined with flucarbazone and pyroxasulfone plus flucarbazone, at both rates, controlled rattail fescue 93 to 96% (Table 2). Winter wheat yield was greater than the untreated check in treatments containing flufenacet/metribuzin and pyroxasulfone applied preemergence, except pyroxasulfone combined with the low rate of flucarbazone. Grain yield in postemergence treatments alone did not differ from the untreated check. Test weight was 62 lb/bu for all treatments.

At the Genesee, ID site, all pyroxasulfone/flumioxazin treatments injured winter wheat 12 to 15%, but injury was not different from flufenacet/metribuzin plus pyroxsulam and pyroxasulfone combined with pyroxsulam or sulfosulfuron (10 to 12%) (Table 3). All treatments containing flufenacet/metribuzin or pyroxasulfone controlled rattail fescue 98 to 99%. Flucarbazone was the best postemergence herbicide with 81% rattail fescue control.

Table 2. Rattail fescue control in winter wheat with flucarbazone, flufenacet/metribuzin, and pyroxasulfone combinations near Colton, WA in 2013.

Treatment[1]	Rate	Application timing[2]	Rattail fescue control[3]	Winter wheat Yield	Winter wheat Test weight
	lb ai/A		%	lb/A	lb/bu
Flufenacet/metribuzin	0.425	pre	97	5705	62
Pyroxasulfone	0.08	pre	86	5356	62
Flufenacet/metribuzin +	0.213	pre			
flucarbazone	0.021	1 tiller	78	5418	62
Pyroxasulfone +	0.04	pre			
flucarbazone	0.021	1 tiller	95	5246	62
Flufenacet/metribuzin +	0.213	pre			
flucarbazone	0.027	1 tiller	84	5365	62
Pyroxasulfone +	0.04	pre			
flucarbazone	0.027	1 tiller	93	5395	62
Flucarbazone	0.027	1 tiller	56	5287	62
Flucarbazone +	0.027	1 tiller			
thifensulfuron	0.008	1 tiller	76	5236	62
Pyroxsulam	0.016	1 tiller	68	5284	62
Flucarbazone	0.027	3 tiller	79	4987	62
Flucarbazone +	0.027	3 tiller			
thifensulfuron	0.008	3 tiller	69	4910	62
Pyroxsulam	0.016	3 tiller	32	5055	62
Flufenacet/metribuzin +	0.425	pre			
flucarbazone	0.027	3 tiller	94	5578	62
Untreated check	--	--	--	4881	62
LSD (0.05)			27	408	NS
Density (plants/ft^2)			10		

[1]Glyphosate at 0.75 lb ae/A and ammonium sulfate at 1 lb ai/A were applied to the entire study at the preemergence timing. A non-ionic surfactant at 0.25% v/v and ammonium sulfate at 1 lb ai/A were applied with flucarbazone and pyroxsulam postemergence treatments.
[2]Application timing based on rattail fescue growth stage.
[3]Evaluation date June 28, 2013.

Table 3. Rattail fescue control in winter wheat with pyroxasulfone combinations near Genesee, ID in 2013.

Treatment[1]	Rate	Application timing[2]	Winter wheat injury[3]	Rattail fescue control[4]
	lb ai/A		%	%
Flufenacet/metribuzin	0.425	pre	2	98
Pyroxasulfone	0.08	pre	0	98
Pyroxasulfone/fluthiacet	0.091	pre	1	98
Pyroxasulfone/flumioxazin	0.143	pre	12	98
Flucarbazone	0.027	2 tiller	0	81
Pyroxsulam	0.016	2 tiller	0	71
Sulfosulfuron	0.031	2 tiller	0	61
Flufenacet/metribuzin +	0.425	pre		
flucarbazone	0.027	2 tiller	4	98
Flufenacet/metribuzin +	0.425	pre		
pyroxsulam	0.016	2 tiller	10	98
Flufenacet/metribuzin +	0.425	pre		
sulfosulfuron	0.031	2 tiller	3	98
Pyroxasulfone +	0.08	pre		
flucarbazone	0.027	2 tiller	6	99
Pyroxasulfone +	0.08	pre		
pyroxsulam	0.016	2 tiller	10	98
Pyroxasulfone +	0.08	pre		
sulfosulfuron	0.031	2 tiller	12	98
Pyroxasulfone/fluthiacet +	0.091	pre		
flucarbazone	0.027	2 tiller	8	98
Pyroxasulfone/fluthiacet +	0.091	pre		
pyroxsulam	0.016	2 tiller	9	99
Pyroxasulfone/fluthiacet +	0.091	pre		
sulfosulfuron	0.031	2 tiller	4	99
Pyroxasulfone/flumioxazin +	0.143	pre		
flucarbazone	0.027	2 tiller	13	98
Pyroxasulfone/flumioxazin +	0.143	pre		
pyroxsulam	0.016	2 tiller	15	99
Pyroxasulfone/flumioxazin +	0.143	pre		
sulfosulfuron	0.031	2 tiller	14	99
LSD (0.05)			6	6
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 May 8, 2013.

[4]Evaluation date June 28, 2013.

Rattail fescue control in winter wheat with pyroxasulfone/fluthiacet. Drew Lyon, Brianna Cowan, and Rod Rood. (Crop and Soil Sciences Department, Washington State University, PO Box 646420, Pullman, WA, 99164-6420) Field studies were conducted at the Palouse Conservation Field Station near Pullman, WA to evaluate rattail fescue control in winter wheat with pyroxasulfone/fluthiacet. One of the study sites had heavy rattail fescue populations, but the wheat stand was very inconsistent. The other site had a nice, uniform stand of winter wheat, but very light rattail fescue populations. Both sites received the same treatments on the same day. Rattail fescue control was evaluated at the site with heavy rattail fescue populations and winter wheat response to the treatments was evaluated at the site with a uniform wheat stand. On October 22, 2012 the PPI treatment was applied with a CO_2 backpack sprayer set to deliver 10 gpa at 30 psi and 3 mph. The treatment was immediately incorporated using a spike-tooth harrow operated in two directions. 'AP-700' winter wheat was planted at a rate of 117 pounds per acre on October 23, 2012 using a Horsch drill with 12-inch row spacing. The following day, the PRE treatments were applied with the previously used CO_2 backpack sprayer. Fall POST treatment were applied on November 16, 2012 and spring POST treatments were applied on May 3, 2013 using the same equipment and settings. The soil at both sites was a silt loam with 4.2% organic matter and a pH of 5.0. The trial was harvest for grain yield on August 20, 2013.

Pyroxasulfone/fluthiacet provided excellent control of rattail fescue at all rates and application times used in the study. Pyroxsulam, which served as the competitive standard, provided poor control of rattail fescue. The only crop injury observed in the study was necrotic leaf spotting caused by the spring POST application of fluthiacet. Wheat plants quickly recovered from this injury. Grain yields, however, did appear to be negatively affected by all but one of the pyroxasulfone/fluthiacet treatments. This suggests that further work is needed to refine rates and application times with pyroxasulfone/fluthiacet to reduce the risk of grain yield loss in winter wheat. The level of rattail fescue control provided by pyroxasulfone/fluthiacet is encouraging.

Table. Rattail fescue control in winter wheat with pyroxasulfone/fluthiacet.

			13-May-13		10-Jun-13	20-Aug-13
Treatment	Rate	Timing	Crop injury	Rattail fescue control	Rattail fescue control	Grain yield
	oz ai/a		------------------- % -------------------			bu/a
Pyroxasulfone/fluthiacet	1.34	PRE	0	100	98	92.1
Pyroxasulfone/fluthiacet	1.74	PRE	0	98	97	93.0
Pyroxasulfone/fluthiacet	2.14	PRE	0	100	100	97.5
Pyroxasulfone/fluthiacet	1.74	PPI	0	90	93	97.4
Pyroxasulfone/fluthiacet	1.34	PRE	0	95	97	100.2
Pyroxsulam +	0.187	fallPOST				
NIS +	0.25% v/v	fallPOST				
AMS	17 lb/100 gal	fallPOST				
Pyroxasulfone/fluthiacet +	1.74	PRE	10	100	100	90.1
Fluthiacet +	0.085	spPOST				
2,4-D amine +	6	spPOST				
Dicamba +	1	spPOST				
NIS +	0.25% v/v	spPOST				
AMS	17 lb/100 gal	spPOST				
Pyroxsulam +	0.262	fallPOST	0	60	48	106.4
NIS +	0.25% v/v	fallPOST				
AMS	17 lb/100 gal	fallPOST				
Nontreated check			0	0	0	107.4
LSD (5%)			0	23	27	9.3

Italian ryegrass control and winter wheat tolerance with pyroxasulfone. Traci A. Rauch, Joan M. Campbell and Donald C. Thill. (Crop and Weed Science Division, University of Idaho, Moscow, ID 83844-2339) Studies were established to evaluate 1) winter wheat response at the University of Idaho Research Moscow Farm and 2) Italian ryegrass (LOLMU) control near Moscow, Idaho with preemergence pyroxasulfone alone and plus fluthiacet or flumioxazin combined with postemergence mesosulfuron or pyroxsulam. 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). Studies were oversprayed for broadleaf weeds at the University of Idaho with thifensulfuron/tribenuron at 0.025 lb ai/A and pyrasulfotole/bromoxynil at 0.193 lb ai/A on May 24; and at Moscow with pyrasulfotole/bromoxynil at 0.209 lb ai/A and clopyralid/fluroxypyr at 0.25 lb ae/A on May 15, 2013. University of Idaho site was sprayed with azoxystrobin/propiconazole at 0.09 lb ai/A for stripe rust control on May 24. Winter wheat injury and Italian ryegrass control were evaluated visually during the growing season. At University of Idaho site, grain was harvested with a small plot combine on August 9, 2013.

Table 1. Application and soil data.

Location	University of Idaho Farm		Moscow, ID	
Wheat variety – seeding date	Brundage 96 – 10/12/12		Madsen/WB 528 blend – 10/18/12	
Application date	10/17/12	4/26/13	10/21/12	4/26/13
Growth stage				
Winter wheat	pre	5 tiller	pre	3 tiller
Italian ryegrass (LOLMU)	--	--	pre	2 tiller
Air temperature (F)	50	64	46	64
Relative humidity (%)	57	65	61	67
Wind (mph, direction)	2, W	3, SW	0	2, SW
Cloud cover (%)	10	0	0	0
Soil moisture	dry	wet	dry	good
Soil temperature at 2 inch (F)	50	60	50	65
Next rain occurred	10/23/12	4/29/13	10/23/12	4/29/13
Soil pH	4.8		4.5	
OM (%)	4.7		3.4	
CEC (meq/100g)	23.0		15.9	
Texture	silt loam		silt loam	

At the University of Idaho site, visible wheat injury ranged from 10 to 13% with pyroxasulfone/flumioxazin, flufenacet/metribuzin + pyroxsulam and pyroxasulfone + mesosulfuron compared to the untreated check. Wheat injury was highest with pyroxasulfone/flumioxazin followed by applications of mesosulfuron (29%) or pyroxsulam (24%). Injury from all other treatments ranged from 1 to 8%. Wheat yield was lower than the untreated check (6877 lb/a) with only pyroxasulfone and pyroxasulfone/flumioxazin followed by applications of mesosulfuron (5971 and 5396 lb/a, respectively).

At the Moscow site, flufenacet/metribuzin alone or plus mesosulfuron and pyroxasulfone/flumioxazin combined with mesosulfuron or pyroxsulam injured winter wheat 9 to 16% (Table 2). Pyroxasulfone/flumioxazin alone or followed by either postemergence herbicide, pyroxasulfone alone or followed by pyroxsulam, and pyroxasulfone/ fluthiacet + pyroxsulam controlled Italian ryegrass 89 to 99%. Mesosulfuron and pyroxsulam did not control Italian ryegrass most likely due to ALS resistant biotypes.

Table 2. Winter wheat response and Italian ryegrass control with pyroxasulfone combinations at the University of Idaho Research Farm and near Moscow, ID in 2013.

			University of Idaho Farm			Moscow, ID	
			Wheat				
Treatment[1]	Rate	Application timing[2]	Injury[3]	Yield	Test weight	Wheat injury[4]	LOLMU control[4]
	lb ai/A		%	bu/A	lb/bu	%	%
Flufenacet/metribuzin	0.34	pre	3	6974	57	9	76
Pyroxasulfone	0.08	pre	1	6797	57	1	92
Pyroxasulfone/fluthiacet	0.091	pre	5	6361	57	0	88
Pyroxasulfone/flumioxazin	0.143	pre	11	6699	57	6	94
Mesosulfuron	0.013	post	4	6883	57	0	0
Pyroxsulam	0.016	post	1	6596	57	0	0
Flufenacet/metribuzin +	0.34	pre					
mesosulfuron	0.013	post	8	6936	57	10	80
Flufenacet/metribuzin +	0.34	pre					
pyroxsulam	0.016	post	13	6410	58	6	86
Pyroxasulfone +	0.08	pre					
mesosulfuron	0.013	post	10	5971	56	6	87
Pyroxasulfone +	0.34	pre					
pyroxsulam	0.016	post	3	6915	57	3	89
Pyroxasulfone/fluthiacet +	0.091	pre					
mesosulfuron	0.013	post	8	6876	55	0	88
Pyroxasulfone/fluthiacet +	0.091	pre					
pyroxsulam	0.016	post	3	7189	57	0	94
Pyroxasulfone/flumioxazin +	0.143	pre					
mesosulfuron	0.013	post	29	5396	57	15	99
Pyroxasulfone/flumioxazin +	0.143	pre					
pyroxsulam	0.016	post	24	6128	57	16	94
Untreated check			-	6877	58		
LSD (0.05)			6	810	NS	8	10
Density (plants/ft^2)			-	-	-		20

[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 germinated). Post= U of I site winter wheat 5 tiller and Moscow site winter wheat 3 tiller and Italian ryegrass 2 tiller.
[3]Evaluation date was June 3, 2013.
[4]Evaluation date was June 18, 2013.

Chickpea response to saflufenacil. Traci A. Rauch, Joan M. Campbell and Donald C. Thill. (Crop and Weed Science Division, University of Idaho, Moscow, ID 83844-2339) Studies were established near Genesee, ID on the University of Idaho Plant Science Farm in direct-seed and conventional 'Dwelley' chickpea to evaluate crop response with higher than labeled rates of saflufenacil. Chickpea may be treated with saflufenacil at 0.044 lb ai/A per application with a total of 0.089 lb ai/A per cropping season. 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 40 psi and 3 mph (Table 1). Crop injury was evaluated during the growing season and seed was harvested with a small plot combine on September 11, 2013.

Table 1. Application and soil data.

	Conventional	Direct seed
Seeding date	April 26, 2013	April 27, 2013
Application date	May 5, 2013	May 5, 2013
Winter wheat growth stage	post plant preemergence	post plant preemergence
Air temperature (F)	46	47
Relative humidity (%)	73	75
Wind (mph, direction)	2, NE	3, NE
Cloud cover (%)	0	0
Soil moisture	dry	dry
Soil temperature at 2 inch (F)	45	44
pH	5.6	5.5
OM (%)	4.4	3.9
CEC (meq/100g)	20.7	19.3
Texture	silt loam	silt loam

At the conventional site, chickpea injury ranged 0 to 4% on May 16 and did not differ among treatments (Table 2). At the direct seed site and by June 3 at the conventional site, chickpea was not injured by any treatment. At the both sites, seed yield did not differ among treatments including the untreated check. Overall, chickpea seed yield at the direct seed site, compared to the conventional site, was reduced due to a drill malfunction that decreased the seeding rate.

Table 2. Chickpea response to saflufenacil near Genesee, Idaho in 2013.

		Conventional chickpea			Direct seed chickpea		
		Injury			Injury		
Treatment	Rate	May 16	June 3	Yield[1]	May 16	June 3	Yield
	lb ai/A	%	%	lb/A	%	%	lb/A
Saflufenacil	0.044	0	0	2846	0	0	1595
Saflufenacil	0.056	0	0	3014	0	0	1773
Saflufenacil	0.067	0	0	3015	0	0	1683
Saflufenacil	0.089	0	0	3150	0	0	1444
Saflufenacil	0.111	0	0	3077	0	0	1598
Saflufenacil	0.134	1	0	2980	0	0	1282
Saflufenacil	0.167	3	0	2959	0	0	1744
Saflufenacil	0.2	4	0	2836	0	0	1641
Untreated check	--	--	--	2925			1765
LSD (0.05)		NS	NS	NS	NS	NS	NS

[1]Three replications analyzed due to a weed infestation.

Flucarbazone and pyroxsulam carryover to legume crops. Campbell, Joan, Traci Rauch, and Donn Thill (University of Idaho, Crop and Weed Science Division, Moscow, ID 83844-2339). A study was established near Moscow to evaluate pea, chickpea, lentil and imazamox-tolerant lentil response to soil persistence of flucarbazone and pyroxsulam. Flucarbazone was applied at 1x (0.43 lb ai/a), 1.5x and 2x rate and pyroxsulam at 1x (0.26 lb ai/a) and 2x rate in winter wheat in 2012. Herbicides were applied on May 8, 2012 with a CO_2 pressurized backpack sprayer in 10 gal/a spray solution and at 32 psi. No winter wheat injury was visible during the growing season. 'Banner' pea, 'Sierra' chickpea, 'Pardina' lentil and 'Maxim' imidazolinone-tolerant lentil were direct seeded May 6, 2013 to evaluate crop injury from potential herbicide carryover in the soil. The experimental design was a randomized complete block, split block with four replications. Plot size was 10 by 16 feet. Linuron at 1.5 lb/a was applied post-plant pre-emergence for broadleaf weed control and the plots were hand weeded throughout the growing season. Soil pH, organic matter, CEC, and texture were 4.6, 4%, 17.5 meq/100 g, and silt loam, respectively. Total rainfall from May 2012 through April 2013 was 25 inches and from May 2012 through August 2013 was 29 inches.

Crop injury from flucarbazone ranged from 2 to 5% of the untreated and means did not differ among rates within a variety (Table). 'Maxim' imidazolinone-tolerant lentil injury ranged from 0 to 5% across all treatments, but means were not statistically different. 'Pardina' lentil, pea, and chickpea injury was higher with the 2x pyroxsulam rate compared to flucarbazone treatments. 'Pardina' lentil and pea injury at the 1x pyroxsulam rate was different from the flucarbazone and the 2x pyroxsulam rates. Pea seed yield was the same for all treatments, including the untreated check. 'Pardina' lentil and chickpea seed yield were reduced by both pyroxsulam rates compared to the untreated check. 'Maxim' lentil was not reduced by any treatment. 'Maxim' lentil yield was low due to delayed maturity compared to 'Pardina'.

Table. Legume injury and seed yield in 2013 following winter wheat treated with flucarbazone and pyroxsulam in 2012 near Moscow, Idaho.

		Visual injury				Seed yield			
Treatment	Rate	'Pardina'	'Maxim'	Pea	Chickpea	'Pardina'	'Maxim'	Pea	Chickpea
	oz ai/a	--------------- % -----------------				----------------- lb/a -------------			
Untreated		-	-	-	-	853 a	258 a	902 a	2003 a
Flucarbazone	0.43	2 c[1]	5 a	4 c	4 b	724 a	214 a	891 a	1827 a
Flucarbazone	0.64	2 c	0 a	1 c	0 b	657 ab	245 a	823 a	1898 a
Flucarbazone	0.86	4 c	0 a	4 c	1 b	664 ab	221 a	777 a	1824 a
Pyroxsulam	0.26	24 b	5 a	11 b	14 ab	416 bc	220 a	662 a	1371 b
Pyroxsulam	0.52	35 a	0 a	20 a	24 a	315 c	218 a	705 a	1264 b

[1]Means followed by the same letter within a column are not statistically different P<0.05.

Mustard response to pyroxasulfone. Traci A. Rauch, Joan M. Campbell and Donald C. Thill. (Crop and Weed Science Division, University of Idaho, Moscow, ID 83844-2339) A study was established near Moscow, ID in 'Westbred 523/Westbred 528' winter wheat blend to evaluate crop response in 2012 and yellow mustard soil carryover response in 2013 with pyroxasulfone. 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). Winter wheat was planted on October 4, 2011. Crop injury was evaluated during the growing season and grain was harvested with a small plot combine on August 13, 2012. In spring 2013, 'IdaGold' mustard was direct-seeded at 8 lb/A on May 10, 2013. Mustard injury was evaluated visually and seed was harvested with a small plot combine at maturity.

Winter wheat visual injury, yield, and test weight data can be found in the WSWS Research Progress Report 2013 (http://www.wsweedscience.org/wp-content/uploads/research-report-archive/2013%20WSWS%20RPR.pdf) on page 94.

Table 1. Application and soil data.

Application date	10/2/11	10/7/11
Winter wheat growth stage	preplant	post plant preemergence
Air temperature (F)	45	54
Relative humidity (%)	99	88
Wind (mph, direction)	0	1, S
Dew present?	yes	no
Cloud cover (%)	15	100
Soil moisture	dry	adequate
Soil temperature at 2 inch (F)	50	55
pH	5.8	
OM (%)	2.6	
CEC (meq/100g)	13.9	
Texture	silt loam	

No mustard injury was visible on May 17, May 25 and June 10 (data not shown). Mustard yield did not differ among treatments, including the untreated check (Table 2).

Table 2. Winter wheat response to pyroxasulfone near Moscow, Idaho in 2012.

Treatment	Rate	Application timing	Seed yield
	lb ai/A		lb/A
Pyroxasulfone	0.08	preplant	944
Pyroxasulfone	0.093	preplant	954
Pyroxasulfone	0.16	preplant	852
Pyroxasulfone	0.186	preplant	992
Flufenacet/metribuzin	0.425	post plant pre	850
Pyroxasulfone	0.08	post plant pre	1004
Pyroxasulfone	0.093	post plant pre	918
Pyroxasulfone	0.16	post plant pre	950
Pyroxasulfone	0.186	post plant pre	832
Untreated check	--		1001
LSD (0.05)			NS

Winter wheat response to pyroxasulfone and fluthiacet/pyroxasulfone. Traci A. Rauch, Joan M. Campbell and Donald C. Thill. (Crop and Weed Science Division, University of Idaho, Moscow, ID 83844-2339) Two studies were established near Deary, ID in 'WB Ovation' winter wheat to evaluate crop response with 1) pyroxasulfone and 2) fluthiacet/pyroxasulfone. 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). Winter wheat was planted on October 9, 2012. Both studies were sprayed with bromoxynil/pyrasulfotole at 0.209 lb ai/A and clopyralid/fluroxypyr at 0.25 lb ae/A to control broadleaf weeds and azoxystrobin/propiconazole at 0.18 lb ai/A for leaf rust control on May 15, 2013. Crop response was evaluated during the growing season and grain was harvested with a small plot combine on August 7, 2013.

Table 1. Application and soil data.

Location	Pyroxasulfone		Fluthiacet/pyroxasulfone			
Application date	10/8/12	10/12/12	10/8/12	10/12/12	4/25/13	5/2/13
Growth stage						
Winter wheat	preplant	postplant pre	preplant	postplant pre	1 tiller	2 tiller
Air temperature (F)	65	67	67	65	52	69
Relative humidity (%)	34	44	44	34	69	34
Wind (mph, direction)	2, SW	0	0	2, SW	0	1, W
Cloud cover (%)	10	30	30	10	0	10
Soil moisture	very dry	very dry	very dry	very dry	wet	adequate
Soil temperature at 2 inch (F)	60	58	58	60	42	60
Next rain occurred	10/12/12	10/12/12	10/12/12	10/12/12	4/29/13	5/22/13
Soil - pH	5.0					
OM (%)	3.8					
CEC (meq/100g)	21.2					
Texture	silt loam					

No treatment visibly injured winter wheat in either study (data not shown). In the pyroxasulfone study, grain yield ranged from 4085 to 4333 lb/A and test weight was 64 lb/bu (Table 2). In the fluthiacet/pyroxasulfone study, grain yield ranged from 4005 to 4257 lb/A and test weight was 64 lb/bu (Table 3). In both studies, grain yield and test weight did not differ among treatments, including the untreated check.

Table 2. Winter wheat response to pyroxasulfone near Deary, Idaho in 2013.

Treatment	Rate	Application timing	Wheat Yield	Wheat Test weight
	lb ai/A		lb/A	lb/bu
Pyroxasulfone	0.08	preplant	4151	64
Pyroxasulfone	0.093	preplant	4085	64
Pyroxasulfone	0.16	preplant	4090	64
Pyroxasulfone	0.08	postplant pre	4204	64
Pyroxasulfone	0.093	postplant pre	4101	64
Pyroxasulfone	0.16	postplant pre	4095	64
Flufenacet/metribuzin	0.425	postplant pre	4118	64
Pendimethalin	0.71	postplant pre	4333	64
Pendimethalin	1.43	postplant pre	4176	64
Untreated check	--		4142	64
LSD (0.05)			NS	NS

Table 3. Winter wheat response with fluthiacet/pyroxasulfone near Deary, Idaho in 2013.

Treatment[1]	Rate	Application timing[2]	Wheat Yield	Wheat Test weight
	lb ai/A		lb/A	lb/bu
Fluthiacet/pyroxasulfone	0.109	preplant	4098	64
Fluthiacet/pyroxasulfone	0.084	postplant pre	4143	64
Fluthiacet/pyroxasulfone	0.109	postplant pre	4257	64
Fluthiacet/pyroxasulfone	0.134	postplant pre	4025	64
Fluthiacet/pyroxasulfone +	0.084	postplant pre		
pyroxsulam	0.012	1 tiller	4102	64
Fluthiacet/pyroxasulfone +	0.109	postplant pre		
fluthiacet +	0.005	2 tiller		
2,4-D +	0.375	2 tiller		
dicamba	0.063	2 tiller	4005	64
Pyroxsulam	0.016	1 tiller	4170	64
Untreated check			4085	64
LSD (0.05)			NS	NS
Density (plants/ft^2)				

[1]Ammonium sulfate at 17 lb/100 gal of mix and a 90% nonionic surfactant at 0.25% v/v was applied with all post emergence application times.

[2]Application timing based on winter wheat growth stage. Preplant = 1 day before planting and postplant pre = post-plant preemergence to wheat (no germination).

Single gene imidazolinone tolerant wheat response to group 2 herbicides. Campbell, Joan, Traci Rauch, and Donn Thill (University of Idaho, Crop and Weed Science Division, Moscow, ID 83844-2339). A study was established near Genesee, Idaho to evaluate tolerance of single gene imidazolinone-tolerant wheat to multiple acetolactate synthase inhibiting (group 2) herbicides. 'Brundage96 CL' winter wheat was conventionally seeded on October 12, 2012. Herbicides were applied on April 25, 2013 with a CO_2 pressurized backpack sprayer in 10 gal/a spray solution and at 32 psi. Wheat had 6 to 7 tillers and was 5 to 8 inches. The experimental design was a randomized complete block, with four replications. Plot size was 8 by 25 feet. Soil pH, organic matter, CEC, and texture were 5.4, 6%, 21.4 meq/100 g, and silt loam, respectively. Wheat grain was harvested at maturity on August 8.

Wheat was chlorotic on May 3 and stunted on May 9 with all treatments except imazamox and imazamox + clopyralid/fluroxypyr (Table). Winter wheat yield was lower with all imazamox plus 2,4-D + dicamba treatments, with or without group 2 herbicides, compared to the untreated check. Wheat test weight was lower than the untreated check with all imazamox combinations except imazamox alone or imazamox plus clopyralid/fluroxypyr combinations.

Table. Imidazolinone-tolerant winter wheat response to group 2 herbicide combinations near Genesee, Idaho, 2013.

		May 3		May 9			
Treatment[1]	Rate[2]	Chlorosis	Stunt	Chlorosis	Stunt	Grain yield	Test weight
	lb ai/a	%	%	%	%	lb/a	lb/bu
Imazamox	0.047	6	4	4	4	7890	60.8
Thifen/triben/metsulfuron + imazamox	0.0097 0.047	9	8	8	15	7664	60.4
Thifen/triben/metsulfuron + imazamox	0.0162 0.047	10	8	8	12	7622	60.2
Thifen/triben/metsulfuron + imazamox + 2,4-D ester + dicamba	0.0097 0.047 0.475 0.0625	6	9	9	15	7297	60.1
Thifen/triben/metsulfuron + imazamox + 2,4-D ester + dicamba	0.0162 0.047 0.475 0.0625	10	6	10	16	7598	60.3
Thifen/triben + imazamox	0.0188 0.047	10	10	8	11	7612	60.0
Thifen/triben + imazamox	0.025 0.047	11	11	10	16	7573	60.1
Thifen/triben + imazamox + clopyralid/fluroxypyr	0.0188 0.047 0.25	9	9	9	11	7571	60.8
Thifen/triben + imazamox + clopyralid/fluroxypyr	0.025 0.047 0.25	9	8	10	15	7746	60.6
Imazamox + 2,4-D + dicamba	0.047 0.475 0.0625	8	6	5	16	7523	60.3
Imazamox + clopyralid/fluroxypyr	0.047 0.25	2	0	1	0	7902	61.2
Untreated	-	-	-	-	-	8042	61.0
LSD (0.05)		5	NS	NS	6	442	0.5

[1] Thifen is thifensulfuron and triben is tribenuron.

[2] Dicamba and 2,4-D rates are expressed as lb ae/a.

Screening of new OSU winter wheat varieties for tolerance to commonly used herbicides. Kyle C. Roerig, Daniel W. Curtis, Andrew G. Hulting, and Carol A. Mallory-Smith. (Department of Crop and Soil Science, Oregon State University, Corvallis OR 97331) Each year Oregon State University conducts trails to screen new varieties of winter wheat for tolerance to herbicides that are likely to be applied once the variety is released. These efforts are to ensure that no unexpected sensitivities will be discovered after the variety has been released and is in widespread production. Each variety is screened for two years. In 2013, three varieties of soft white winter wheat were screened: Bobtail, Mary and Rosalyn. Bobtail and Mary were screened in 2012. Rosalyn was screened for the first time in 2013 and is being screened in 2014. Treatments were applied with a single bicycle wheeled sprayer at 20 gallons per acre at the date indicated (Table). Harvest was conducted July 31, 2013.

The treatments are generally accepted as safe on winter wheat so no injury was expected. Flufenacet-metribuzin (Axiom), however, did injure Bobtail and reduce yield. The flufenacet-metribuzin treatment lowered yield from 175 bushels per acre to 145. Mary and Rosalyn varieties were not injured by any of the treatments (data not shown). Neither flufenacet nor metribuzin applied separately in the previous year injured Bobtail. Poor planting conditions or other environmental factors may have contributed to the injury observed in 2013. Further work with Bobtail and flufenacet-metribuzin applications is underway in 2014 to determine if Bobtail is sensitive to Axiom.

Table. Bobtail winter wheat herbicide screen, near Corvallis OR.

Treatment	Rate	Unit	Timing	Injury[1]	Yield[2]
				--- % ---	bu/a
check				0	173.3
pyroxasulfone	0.08	lb ai/a	pre	0	170
diuron	1.5	lb ai/a	pre	0	175.1
flufenacet-metribuzin	0.425	lb ai/a	spike	12.5	154.5
metribuzin	0.141	lb ai/a	2 leaf	0	174.4
pendimethalin	1.42	lb ai/a	2 leaf	0	173.7
fenoxaprop	0.083	lb ai/a	3 lf – 1 tiller	0	172.3
pinoxaden	0.0535	lb ai/a	3 lf – 1 tiller	0	170.6
+ NIS	0.25	% v/v	3 lf – 1 tiller		
chlorsulfuron-metsulfuron	0.018	lb ai/a	3 lf – 1 tiller	0	176.6
+ NIS	0.5	% v/v	3 lf – 1 tiller		
sulfosulfuron	0.031	lb ai/a	3 lf – 1 tiller	0	177.3
+ NIS	0.25	% v/v	3 lf – 1 tiller		
pyroxsulam	0.0164	lb ai/a	3 lf – 1 tiller	0	181
+ NIS	0.5	% v/v	3 lf – 1 tiller		
+ AMS	17	lb/100 gal	3 lf – 1 tiller		
florasulam-MCPA	0.315	lb ae/a	3 lf – 1 tiller	0	176.4
carfentrazone	0.012	lb ai/a	3 lf – 1 tiller	0	175.8
+ NIS	0.25	% v/v	3 lf – 1 tiller		
+ AMS	8.5	lb/100 gal	3 lf – 1 tiller		
pyrasulfotole-bromoxynil	0.186	lb ai/a	3 lf – 1 tiller	0	177.1
+ NIS	0.25	% v/v	3 lf – 1 tiller		
+ AMS	8.5	lb/100 gal	3 lf – 1 tiller		
pyraflufen	0.00122	lb ai/a	3 lf – 1 tiller	0	178.1
+ NIS	0.25	% v/v	3 lf – 1 tiller		
fluroxypyr-clopyralid	0.188	lb ae/a	3 lf – 1 tiller	0	179.9
+ NIS	0.25	% v/v	3 lf – 1 tiller		
flucarbazone	0.026	lb ai/a	3 lf – 1 tiller	0	177.3
+ NIS	0.25	% v/v	3 lf – 1 tiller		
+ AMS	15	lb/100 gal	3 lf – 1 tiller		
mesosulfuron	0.0135	lb ai/a	3 lf – 1 tiller	0	166.6
+ NIS	0.5	% v/v	3 lf – 1 tiller		
+ AMS	17	lb/100 gal	3 lf – 1 tiller		
LSD (P=.05)					7.3

[1]Evaluated 5/22/2013
[2]Harvested 7/31/2013

Newly reported exotic species in Idaho for 2013. 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 129 specimens and digital images for identification in 2013 (Figure 1). Seventy-five introduced species were identified. The lab received 9 exotic species that were new county records and no new state record species that were considered weedy (see Table 1 and Figure 2). Ada and Cassia counties sent in *Choloris verticillata*, a new species to Idaho. *Chloris verticillata* (also known as tumble windmillgrass or finger windmill grass) is a North American native bunch grass. It is considered to be an aggressive species when found east of the Rocky Mountains. A total of 25 counties in Idaho submitted samples (Figure 3) and we had on-line photo submissions from western states, Missouri and British Columbia, Canada. Species in Table 1 have not previously been reported from the county or state to the Erickson Weed Diagnostic Laboratory or the USDA Plants Database.

Table 1. Identified introduced species new to county and state based on USDA Plants Database.

COUNTY	FAMILY	*GENUS*	*SPECIES*	COMMON NAME
Adams	Fabaceae	*Lotus*	*corniculatus*	birdsfoot trefoil
Bingham	Lamiaceae	*Nepeta*	*cataria*	catnip
Bonner	Caryophyllaceae	*Cerastium*	*fontanum ssp. vulgare*	common chickweed
Boundary	Brassicaeae	*Rorippa*	*nasturtium-aquaticum*	watercress
Idaho	Euphorbiaceae	*Euphorbia*	*cyparissias*	cypress spurge
Idaho	Iridaceae	*Iris*	*pseudacorus*	yellow flag iris
Latah	Papaveraceae	*Papaver*	*dubium*	field poppy
Latah	Ranunculaceae	*Ranunculus*	*repens*	creeping buttercup
Lewis	Brassicaeae	*Lepidium*	*latifolium*	perennial pepperweed

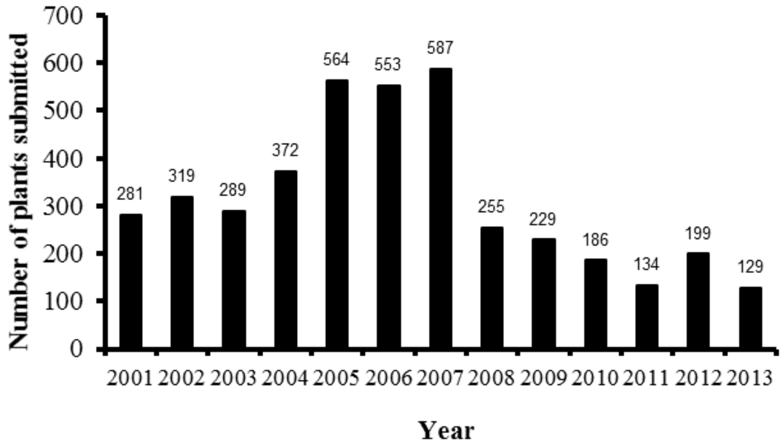

Figure 1. Erickson Weed Diagnostic Laboratory received 129 plants for identification in 2013.

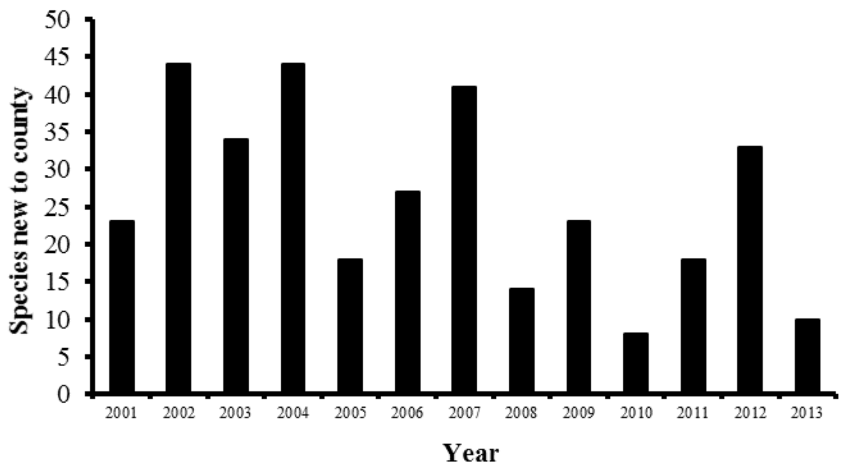

Figure 2. The lab identified 9 exotic species that were new Idaho records in 2013.

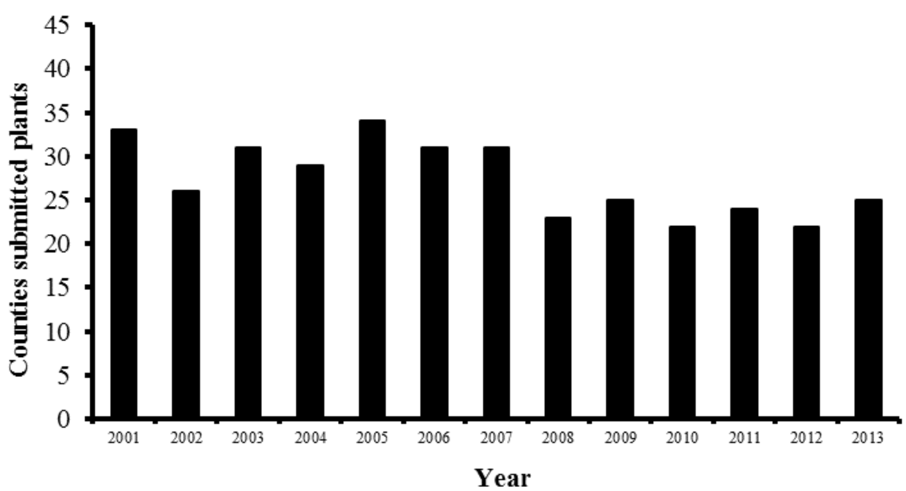

Figure 3. Twenty-five Idaho counties submitted plants in 2013.

Suppression of downy brome by red clover as a cover crop. Randy L. Anderson. (USDA-ARS, Brookings SD 57006). Weeds are one of the primary obstacles to successful organic farming. Organic producers till to control weeds, but soil health is being damaged by the extensive tillage. Therefore, organic producers are interested in reducing the amount of tillage in their production systems.

To help organic producers manage weeds with less tillage, we devised a 9-year rotation that disrupts population dynamics of weeds and reduces weed density across time (*Renewable Agriculture and Food Systems 25:189; 2010*). The rotation is comprised of 3 years of a perennial legume, followed by 2-year sequences of corn-soybean, winter wheat-oat, and soybean-corn. In the winter wheat-oat sequence, we are seeking to control weeds after winter wheat harvest with cover crops. Producers can plant cover crops after winter wheat harvest, or underseed a clover into winter wheat. We are seeking to suppress weeds before oat is planted the following year, thus eliminating the need to till for weed control.

Our objective with this study was to compare downy brome demographics following winter wheat harvest as affected by cover crop choice. Our broader goal is to develop a continuous no-till system for organic farming.

Methodology:

Winter wheat (Darrell) was planted at 1.2 million seeds/acre on September 12, 2011. Red clover (mammoth type: variety not stated) was planted in winter wheat at 12 lbs/ac with a disk drill on April 2, 2012. An oat-dry pea mixture was planted on August 8, 2012, following winter wheat harvest. Oat/pea seeding rate as 660,000 seeds/acre (seed ratio of 1 pea to 1.8 oat). A control consisted of no cover crops. Treatments were arranged as a randomized complete block design with four replications. Oat (Jerry) at 1.4 million seeds/acre was planted in the plots in 2013.

Downy brome demographics were quantified following winter wheat harvest through the oat growing season. Three quadrats (0.33 yd^2 in size) were established in each plot to record downy brome emergence across time. Seedlings were counted and removed by hand weekly, starting on August 1 and continued until May 31. No weed control actions were imposed after wheat harvest.

A second set of quadrats was used to quantify downy brome seedling survival and plant production. Plant density was recorded on September 1 and November 1, 2012, and May 1 and June 15, 2013. The later assessments of downy brome seedlings determined the survival level of downy brome as affected by cover crop competition and winter conditions. Two weeks before maturity, downy brome plants in these quadrats were harvested to determine dry weight and seed production of individual plants.

Downy brome was the most prominent weed at this site, with density ranging from 60 to 90 seedlings per yd^2. Weeds other than downy brome were removed by hand from quadrats weekly.

Results:

Downy brome weekly emergence. Seedling emergence did not vary among treatments in the fall. The figure below shows emergence of downy brome in the control and red clover treatment. Approximately 45 seedlings emerged in both treatments, with 60% of the seedlings emerging in August. A secondary flush of seedlings emerge in the spring (May 8 – May 22). Seedling emergence was delayed 7 to 10 days in the red clover treatment compared with the control, which we attribute to cooler soils resulting from higher quantity of crop residue on the soil surface.

Downy brome seedling survival overwinter. Downy brome survival in red clover was only 2%, compared with 84% survival in the control and 67% survival in the oat-pea treatment (see Table below). We speculate that early canopy development and high resource consumption of red clover favored death of downy brome seedlings, as seedling emergence was not affected by red clover (see Figure).

Plant productivity. Downy brome biomass was only 0.8 gm/plant in the red clover treatment, whereas downy brome produced 9.7 and 4.7 gm/plant in the control and oat/pea mixture, respectively (see Table below). Seed production/plant was reduced similarly. On a quadrat basis, downy brome produced 7370 seeds in the control and 4090 seeds in the oat/pea treatment, but only 78 seeds in the red clover treatment. Red clover reduced seed rain of downy brome more than 98% compared with the control. Most of the plants producing seed in the red clover treatment emerged and established in the spring.

Crop production. Yield of winter wheat was not affected by underseeded red clover. However, oat yield was reduced considerably because red clover survived the winter and infested 45 to 80% of the oat plot area. Oat yield in the control was low because of downy brome interference.

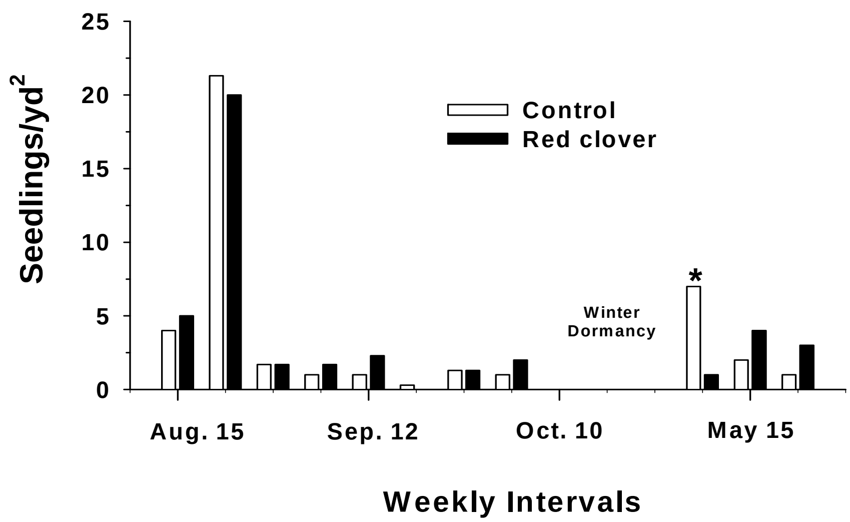

Figure. Seedling emergence of downy brome during 2012-2013, comparing red clover as a cover crop with the control. Asterisk indicates that seedling emergence differed between treatments with emergence on May 8.

Table. Demographics of downy brome as affected by cover crop treatments, compared with a control.

Parameter	Red clover	Oat/dry pea	Control
Density (plants/quadrat)			
September 1	36.0	35.2	32.7
November 1	4.6	24.6	30.1
May 1	0.4	23.5	27.8
June 15	3.1	25.1	28.3
Biomass/plant (gm)	0.8	4.7	9.7
Seeds/plant (no.)	25	163	261
Seeds/quadrat (no.)	78	4090	7370

Management Implications:

Cover crops will be a pivotal tactic if no-till organic farming is to be successful. Red clover underseeded in winter wheat was the most effective in suppressing downy brome growth, reducing seed production 98% compared with the control. The oat/pea cover crop was not effective, as downy brome produced more than 4000 seeds per quadrat. A drawback of red clover, however, is inconsistent winterkill can lead to infestations in oat that reduce grain yield. We plan to test berseem clover as a substitute for red clover, as berseem clover is more susceptible to winter kill.

Winter wheat tolerance to pyroxasulfone and flufenacet/metribuzin. Campbell, Joan, Traci Rauch, and Donn Thill (University of Idaho, Crop and Weed Science Division, Moscow, ID 83844-2339). A study was established near Moscow, Idaho to evaluate tolerance of winter wheat at two seeding depths to pyroxasulfone and flufenacet/metribuzin. 'Brundage96' winter wheat was conventionally seeded on October 11, 2012 at 0.5 and 2 inches. Herbicides were applied with a CO_2 pressurized backpack sprayer in 10 gal/a spray solution at 32 psi (Table 1). Pyroxasulfone and flufenacet combinations were applied preemergence. Post-emergence grass herbicides were applied for comparison at 5 to 6 tiller wheat. The experimental design was a randomized complete split-block with four replications. Plot size was 8 by 20 feet. Soil pH, organic matter, CEC, and texture were 4.4, 4%, 17.7 meq/100 g, and silt loam, respectively. Wheat grain was harvested at maturity on July 25.

Table 1. Application data.

Application date	10/14/12	4/26/13
Winter wheat growth stage	Pre-emergence	5-6 tiller
Air temperature (F)	67	65
Relative humidity (%)	58	63
Wind (mph, direction)	2.5, ESE	3-6, W
Cloud cover (%)	100	0
Soil moisture	dry	wet
Soil temperature at 2 inch (F)	60	61
Next rain occurred	10/14/12	4/29/13

Wheat was seeded into dry, powdery soil. Rainfall (0.4 inch) one day later moistened soil about 1 inch from the surface and the shallow seeded wheat began to germinate within days. Wheat seeded deeper did not germinate until after additional rain events 3 days later. Wheat was not visibly injured after emergence in the fall. Pyroxasulfone/flumioxazin visibly stunted wheat in the spring and throughout the growing season (data not shown). Injury was not evident with any other treatment. Grain yield was not affected by seeding depth (7002 vs 7013 lb/a for the 0.5 and 2 inch depth, respectively). Averaged over seeding depth, grain yield was lowest with pyroxasulfone/flumioxazin (6091 lb/a) and highest with pyroxsulam (7585 lb/a) (Table 2). Grain yield from other treatments was not different from the nontreated control. Test weight was higher with the shallow compared to the deeper seeding depth for pyroxasulfone/flumioxazin and pyroxasulfone/fluthiacet.

Table 2. Grass herbicide and seeding depth effects on winter wheat near Moscow, Idaho in 2013.

Herbicide	Rate	Seeding depth	Grain yield mean[4]	Test weight
	lb ai/a	inch	lb/a	bu/a
Nontreated	--	0.5		61.1 d-g
Nontreated	--	2	7160 bc[5]	61.1 d-g
Flufenacet/metribuzin[1]	0.34	0.5		61.3 e-g
Flufenacet/metribuzin	0.34	2	7011 bc	60.7 c-f
Pyroxasulfone [1]	0.08	0.5		61.4 g
Pyroxasulfone	0.08	2	7099 bc	60.7 c-g
Pyroxasulfone/fluthiacet[1]	0.091	0.5		60.8 d-g
Pyroxasulfone/fluthiacet	0.091	2	6824 b	59.9 bc
Pyroxasulfone/flumioxazin [1]	0.143	0.5		59.8 b
Pyroxasulfone/flumioxazin	0.143	2	6091 a	57.6 a
Mesosulfuron[2]	0.0134	0.5		61.0 d-g
Mesosulfuron	0.0134	2	7224 c	60.4 bcd
Pyroxsulam [2]	0.0164	0.5		61.3 fg
Pyroxsulam	0.0164	2	7585 d	60.9 d-g
Pinoxaden[3]	0.054	0.5		61.3 fg
Pinoxaden	0.054	2	7066 bc	60.6 c-f

[1] Applied post-plant pre-emergence.
[2] Applied postemergence with urea ammonium nitrate at 2 qt/a + nonionic surfactant at 0.5% v/v.
[3] Applied postemergence.
[4] Grain yield was averaged over seeding depth because depth by herbicide interaction was not statistically significant ($P<0.05$)
[5] Means followed by the same letter within a column are not statistically different ($P<0.05$)

Winter barley tolerance to two grass herbicides affected by application time and seeding depth. Campbell, Joan, Traci Rauch, and Donn Thill (University of Idaho, Crop and Weed Science Division, Moscow, ID 83844-2339). A study was established near Moscow, Idaho to evaluate tolerance of winter barley at two seeding depths and two application times to pyroxasulfone and flufenacet/ metribuzin. Eight-Twelve winter barley was conventionally planted October 11, 2012 at 0.5 and 2 inch on the University of Idaho Parker Farm east of Moscow. The soil was dry and powdery at the time of seeding. Rainfall (0.4 inch) one day later moistened soil about 1 inch from the surface and the shallow seeded barley began to germinate within days. Barley seeded deeper did not germinate until after additional rain events 3 days later and emerged 7 days later than the shallower seeded barley. Rainfall also caused some collapse of the soil in the rows and some seeds were 2.5 inches below the surface. The experimental design was a randomized complete split-block with four replications. Plot size was 8 by 20 feet. Soil pH, organic matter, CEC, and texture were 4.2, 3.8%, 17.3 meq/100 g, and loam, respectively. Pyroxasulfone and flufenacet/metribuzin were applied October 14 and 21 with a CO_2 pressurized backpack sprayer in 10 gal/a spray solution at 32 psi (Table 1). Barley was not germinated on October 14. On October 21, the shallow seeded barley had 0.5 inch roots and the deeper seeded barley was just beginning to germinate. Wheat grain was harvested at maturity on July 25.

Table 1. Application data.

Application date	10/14/2012	10/21/2012
Winter barley growth stage	Seed not germinated	germinated
Air temperature (F)	67	49
Relative humidity (%)	58	63
Wind (mph, direction)	2.5, ESE	0
Cloud cover (%)	100	10
Soil moisture	dry	moist
Soil temperature at 2 inch (F)	60	40
Next rain occurred	10/14/2012	10/23/2012

Fall emergence and stand throughout the season was reduced and variable with the deeper compared to the shallow seeded barley, even in the non-herbicide treated plots. Barley grain yield was 4383 and 3475 lb/a, plump kernels were 82 and 75%, and thin kernels were 4 and 6% with shallow seeded barley compared to deeper seeded barley, respectively, averaged over application time and herbicide treatment. Due to the variability of the deep seeding, data was analyzed for the shallow depth (Table 2). Grain yield was lower with flufenacet/metribuzin (3820 lb/a) compared to the untreated check (5097 lb/a), but pyroxasulfone (4230 lb/a) was not statistically different from either treatment averaged over application time. Test weight, plump and thin kernels were not different among treatment. Application timing did not affect any measured variables at either depth.

Table 2. Barley grain yield, test weight, plumps and thins at 0.5 inch seeding depth averaged over application timing.

Herbicide	Grain yield	Test weight	Plumps	Thins
	lb/a	lb/bu	%	%
Untreated	5097 a	52 a	75 a	6 a
Pyroxasulfone	4230 ab	52 a	77 a	5 a
Flufenacet/metribuzin	3820 b	52 a	73 a	6 a

[1] Means followed by the same letter within a column are not statistically different (P<0.5).

Winter wheat tolerance following flumioxazin pre-harvest treatments in dry pea. Campbell, Joan, Traci Rauch, and Donn Thill (University of Idaho, Crop and Weed Science Division, Moscow, ID 83844-2339). A study was established at the University of Idaho experiment station near Moscow, Idaho to examine winter wheat tolerance to harvest aid applications of flumioxazin in spring dry pea. Three rates of flumioxazin were applied near pea maturity August 9, 2012 with a CO_2 pressurized backpack sprayer calibrated to deliver 20 gal/a at 35 psi. The experimental design was a randomized complete block, with four replications. Plot size was 16 by 25 feet. Relative humidity, air and soil temperatures were 38%, 85 and 78 F, respectively. Soil pH, organic matter, CEC, and texture were 4.8, 4.7%, 23 meq/100 g, and silt loam, respectively. Brundage96 winter wheat was direct-seeded in October 2012. Wheat grain was harvested at maturity on August 8, 2013.

Common lambsquarters desiccation was around 70% with flumioxazin treatments and 55% with saflufenacil treatments (Table). Common lambsquarters desiccation was lower with paraquat (29%) and glyphosate alone (13%). In 2013, winter wheat crop response, grain yield and test weight were not different from the untreated check.

Table. Common lambsquarters desiccation and winter wheat tolerance to dry pea pre-harvest flumioxazin applications in 2012 near Moscow, Idaho.

Treatment	Rate	Common lambsquarters desiccation August 17, 2012	Wheat injury June 19, 2013	Wheat grain yield	Wheat grain test weight
	lb ai/a	%	%	lb/a	lb/bu
Untreated	--	--	--	5097	56.6
Flumioxazin + Glyphosate[1]	0.0313 0.75	70	0.0	5108	57.3
Flumioxazin + Glyphosate[1]	0.0625 0.75	71	2.5	4805	56.7
Flumioxazin + glyphosate[1]	0.094 0.75	70	0.0	4856	56.8
Paraquat	0.3	29	0.0	4815	55.9
Saflufenacil[2]	0.0223	55	0.0	4955	56.0
Saflufenacil + glyphosate[2]	0.0445 0.75	55	0.0	4909	56.5
Glyphosate[1]	0.75	13	0.0	4738	55.7
$LSD_{(0.05)}$		20	NS	NS	NS

[1]Applied with methylated seed oil at 1 qt/a.
[2]Applied with methylated seed oil at 1 qt/a and ammonium sulfate at 2.5 lb ai/a.

Evaluation of herbicide mixtures for leafy spurge control under trees or in an open field. Rodney G. Lym. (Department of Plant Sciences, North Dakota State University, Fargo, ND 58108-6050). Leafy spurge generally is well controlled with herbicide mixtures such as picloram plus 2,4-D, picloram plus imazapic, or quinclorac plus dicamba plus diflufenzopyr. These treatments are labeled for use in pasture and rangeland but not near trees or wooded areas. The biological control agents such as *Aphthona* spp. also control leafy spurge in open areas unless the soil is extremely sandy, but will not reduce the weed in shaded areas. The purpose of this research was to evaluate leafy spurge control under trees and open areas with various herbicide mixtures.

The first experiment to evaluate leafy spurge control under trees was established in a pasture at the NDSU Albert Ekre Grassland Preserve near Walcott, ND. The site was a natural wooded area of bur oak (*Quercus macrocarpa* Michx.) on the perimeter of a grazed pasture. Treatments were applied on May 30, 2012 when leafy spurge was in the vegetative to flowering stage and 18 to 30 inches tall. Herbicides were applied using a hand-held boom sprayer delivering 17 gpa at 35 psi. Experimental plots were 10 by 25 feet and replicated three times in a randomized complete block design with care taken to ensure the plots were generally shaded. The second experiment was established in an open pasture immediately across a county road from the wooded area. Treatment date and application methods were the same but the plot size was 10 by 30 feet with four replications. Leafy spurge control was evaluated visually using percent stand reduction compared to the untreated control.

The herbicides evaluated for leafy spurge control in the shaded area are generally considered safe to apply under most tree species (Table 1). Quinclorac applied at 12 oz/A provided 78 and 81% leafy spurge control 3 and 12 months after treatment (MAT), respectively. However, aminopyralid, fluroxypyr, and 2,4-D applied alone only provided an average of 64% control 3 MAT. Leafy spurge control averaged 73% 13 MAT with 2,4-D applied at 30 oz/A. Aminopyralid or fluroxypyr applied alone did not control leafy spurge. Aminopyralid applied with dicamba plus diflufenzopyr averaged 60% control 13 MAT which was similar to quinclorac applied alone (62%). Dicamba plus diflufenzopyr appeared to provide the most consistent increase in leafy spurge control when that combination was added to other herbicide mixtures, but was not applied alone in this study for direct comparison.

All herbicide treatments applied alone or in combination in the open pasture area provided excellent long-term leafy spurge control (93%) regardless of application rate (Table 2). During the study, *Aphthona* spp. flea beetles became widely established in the study area and aided in the long-term reduction of leafy spurge.

In summary, quinclorac applied alone or herbicide combinations that contained dicamba plus diflufenzopyr provided good leafy spurge control in shaded area under trees. These treatments could safely be used under many tree species to reduce leafy spurge. Unfortunately, *Aphthona* spp. flea beetles greatly reduced leafy spurge in the open pasture study site so no treatment differences were observed.

Table 1. Leafy spurge control under trees with aminopyralid applied alone or various herbicide mixtures on May 30, 2012 near Walcott, ND.

Treatment[a]	Rate	Evaluation date 2012 28 Aug	2013 28 June	2013 21 Aug
	——— oz/A ———	——— % control ———		
Aminopyralid	1.75	60	10	0
Fluroxypyr	8	74	12	0
Quinclorac[b]	12	78	81	62
2,4-D	30	58	73	32
Aminopyralid + 2,4-D[c]	1.7 + 14	76	25	10
Aminopyralid + 2,4-D + dicamba + diflufenzopyr[d]	1.7 + 14 + 2 + 0.8	89	78	62
Aminopyralid+ 2,4-D + fluroxypyr[e]	1.7 + 14 + 8	92	9	7
Aminopyralid + 2,4-D + fluroxypyr + dicamba + diflufenzopyr	1.7 + 14 + 8 + 2 + 0.8	97	85	80
Aminopyralid + fluroxypr	1.75 + 8	80	25	5
Aminopyralid + fluroxypr	2.5 + 8	83	67	22
Aminopyralid + dicamba + diflufenzopyr	1.75 + 2 + 0.8	90	82	71
Aminopyralid + fluroxypyr + dicamba + diflufenzopyr	1.75 + 8 + 2 + 0.8	93	52	28
LSD (0.05)		9	33	23

[a]NIS at 0.25% was added to all treatments and was Activator 90 by United Agri Products 7251 W. 4th St. Greeley, CO 80634.
[b]Commercial formulation - Paramount and [d]Overdrive by BASF Corporation, 100 Campus Drive, Florham Park, NC 07932.
[c]Commercial formulation - ForeFront HL and [e]Vista XRT by Dow AgroSciences LLC, 9330 Zionsville Road, Indianapolis, IN 46268-1189.

Table 2. Leafy spurge control with picloram mixtures applied on May 30, 2012, in an open field near Walcott, ND.

		Evaluation date		
		2012	2013	
Treatment[a]	Rate	28 Aug	28 June	21 Aug
	—— oz/A ——	——	% control	——
Picloram	8	92	96	86
Picloram	12	98	98	95
Picloram	16	97	96	96
Picloram + MSO	8 + 1 qt	97	96	95
Picloram + dicamba + diflufenzopyr[b]	8 + 2 + 0.8	94	97	95
Picloram + dicamba + diflufenzopyr	8 + 1 + 0.4 + 0.25	96	98	92
Picloram + 2,4-D[c]	8.7 + 32	95	94	93
Picloram + 2,4-D + dicamba + diflufenzopyr	8.7 + 32 + 2 + 0.8	95	98	92
Picloram + fluroxypyr[d]	8 + 8 + 7.2	95	96	95
Picloram + fluroxypyr + dicamba + diflufenzopyr	8 + 8 + 2 + 0.8	95	99	95
AMCP + chlorsulfuron[e]	0.8 + 0.3	94	93	91
AMCP + chlorsulfuron	1.9 + 0.75	96	98	94
AMCP + chlorsulfuron + picloram	0.8 + 0.3 + 4	94	99	93
AMCP + chlorsulfuron + aminopyralid	0.8 + 0.3 + 1.75	89	92	87
LSD (0.05)		4	7	8

[a]NIS at 0.25% was added to all treatments (except when MSO was used) and was Activator 90 by United Agri Products 7251 W. 4th St. Greeley, CO 80634.
[b]Commercial formulation - Overdrive by BASF Corporation, 100 Campus Drive, Florham Park, NC 07932.
[c]Commercial formulations - Grazon P+D and [d]Surmount by Dow AgroSciences LLC, 9330 Zionsville Road, Indianapolis, IN 46268-1189.
[e]AMCP=aminocyclopyrachlor, commercial formulation - Perspective by E.I. duPont de Nemours and Company, 1007 Market Street, Wilmington, DE 19898.

Aminocyclopyrachlor applied with various herbicides for leafy spurge and yellow toadflax control. Rodney G. Lym (Department of Plant Sciences, North Dakota State University, Fargo, ND 58108-6050). Aminocyclopyrachlor (AMCP) applied with chlorsulfuron has provided very good long-term leafy spurge control when applied in the spring or fall. Research at North Dakota State University has shown that leafy spurge control is improved when AMCP is applied with 2,4-D rather than chlorsulfuron. AMCP has generally provided inconsistent yellow toadflax control when applied with chlorsulfuron. The purpose of this research was to evaluate long-term control of leafy spurge or yellow toadflax with AMCP applied with various other herbicides.

The leafy spurge control experiment was established near Walcott, ND in an ungrazed area of pasture with a dense stand of leafy spurge. Treatments were applied May 30, 2012 when leafy spurge was in the true-flower growth stage 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. The yellow toadflax experiment was established on a wildlife production area near Valley City, ND. Treatments were applied as previously described on July 25, 2012 when yellow toadflax was beginning to flower and 8 to 24 inches tall. Leafy spurge and yellow toadflax control was evaluated visually using percent stand reduction compared to the untreated control.

Long-term leafy spurge control was similar when applied with chlorsulfuron or 2,4-D and tended to be higher when AMCP was applied at 1.8 or 2 oz/A compared to 1 oz/A (Table 1). For example, leafy spurge control in August 2013 averaged 80% 15 months after treatment (MAT) when applied at 1 oz/A with chlorsulfuron or 2,4-D but control increased to an average of 94% when the AMCP application rate increased to 2 oz/A. The current standard treatment of picloram plus imazapic plus 2,4-D at 4 + 1 + 16 oz/A only provided 63% leafy spurge control 15 MAT.

AMCP applied with chlorsulfuron, 2,4-D, or metsulfuron provided excellent long-term yellow toadflax control regardless of application rate (Table 2). Yellow toadflax control averaged 93% 14 MAT the same as the standard treatment of picloram plus dicamba plus diflufenzopyr at 16 + 4 + 1.6 oz/A. Yellow toadflax was slowly controlled in this study. Average control in September 2012 was only 66% averaged over all treatments, but increased to 98% by June 2013.

AMCP provided excellent long-term leafy spurge and yellow toadflax control when applied with chlorsulfuron, 2,4-D, or metsulfuron (yellow toadflax only). Unlike previous studies, leafy spurge control was similar when AMCP was applied with chlorsulfuron or 2,4-D and control increased as AMCP application rate increased. In contrast, yellow toadflax control was similar regardless of AMCP application rate.

Table 1. Evaluation of aminocyclopyrachlor applied with chlorsulfuron or 2,4-D on May 30, 2012 for leafy spurge control near Walcott, ND.

		Evaluation date			
		2012		2013	
Treatment[a]	Rate	27 July	28 Aug	28 June	21 Aug
	oz/A	% control			
Aminocyclopyrachlor + chlorsulfuron[b]	1 + 0.4	97	94	92	83
Aminocyclopyrachlor + chlorsulfuron	1.8 + 0.7	100	99	97	94
Aminocyclopyrachlor + 2,4-D	1 + 7.6	97	93	92	77
Aminocyclopyrachlor+ 2,4-D	2 + 15.2	99	95	98	93
Picloram + imazapic + 2,4-D + MSO	4 + 1 + 16 + 1 qt	97	96	92	63
Untreated	...	0	0	0	0
LSD (0.05)		3	5	5	13

[a]Surfactant applied at 0.25% with all AMCP treatments, Induce by Helena Chemical Co., 225 Schilling Blvd, Collierville, TN 38017.
[b]Formulation - Perspective by E.I. duPont de Nemours and Company, 1007 Market Street, Wilmington, DE 19898.

Table 2. Evaluation of aminocyclopyrachlor applied with various herbicides on July 25, 2012 for yellow toadflax control near Valley City, ND.

		Evaluation date		
		2012	2013	
Treatment[a]	Rate	13 Sept	11 June	13 Sept
	—— oz/A ——	—— % control ——		
Aminocyclopyrachlor + chlorsulfuron[b]	1.8 + 0.7	66	99	94
Aminocyclopyrachlor + chlorsulfuron	2.4 + 0.95	63	99	99
Aminocyclopyrachlor + 2,4-D	2 + 15.2	67	96	93
Aminocyclopyrachlor + 2,4-D	2.5 + 19	65	97	94
Aminocyclopyrachlor + metsulfuron[c]	1.8 + 0.3	62	94	81
Aminocyclopyrachlor + metsulfuron	2.4 + 0.4	65	99	94
Picloram + dicamba + diflufenzopyr[d]	16 + 4 + 1.6	71	100	99
Untreated	•••	0	0	0
LSD (0.05)		13	4	9

[a]All treatments applied with surfactant Induce by Helena Chemical Co., 225 Schilling Blvd, Collierville, TN 38017.

[b]Formulation - Perspective by E.I. duPont de Nemours and Company, 1007 Market Street, Wilmington, DE 19898.

[c]DPX-RDQ98 formulation Rejuvra by E.I. duPont de Nemours and Company, 1007 Market Street, Wilmington, DE 19898.

[d]Commercial formulation - Overdrive by BASF, 100 Campus Drive, Florham Park, NC 07932.

Aminopyralid applied alone or in combination with clopyralid in the spring or fall for Canada thistle and absinth wormwood control. Rodney G. Lym. (Department of Plant Sciences, North Dakota State University, Fargo, ND 58108-6050). Aminopyralid is generally applied at 1.25 to 1.75 oz/A for Canada thistle and absinth wormwood control in North Dakota. Prior to the release of aminopyralid, clopyralid was commonly used to control these weeds. 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 aminopyralid applied alone or at reduced rates with clopyralid for long-term Canada thistle and absinth wormwood control.

The Canada thistle study was established on an abandoned crop field that had become heavily infested with the weed on the North Dakota State University Agricultural Experiment Station in Fargo. The treatments were applied June 30 or September 26, 2011. June treatments were applied to Canada thistle in the bolted to early bud growth stage and 30 to 48 inches tall while plants were post-flower with woody stems and 36 to 48 inches tall when herbicides were applied in the fall.

The absinth wormwood study was established on an active gravel quarry near Valley City, ND that was heavily infested. The treatments were applied on May 26 or September 15, 2011. Absinth wormwood was in the vegetative growth stage and 11 to 18 inches tall when treatments were applied in May. Because absinth wormwood grows 4 to 6 feet tall, the plot area was mowed in late-July 2011. The plants were 6 to 8 inches tall when the fall treatments were applied.

Herbicides 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. Canada thistle and absinth wormwood control was evaluated visually using percent stand reduction compared to the untreated control.

Canada thistle control was similar whether aminopyralid was applied alone or with clopyralid (Table 1). For instance, aminopyralid applied at 1.25 oz/A in June, provided 99 and 77% control 12 and 24 months after treatment (MAT), respectively, while aminopyralid plus clopyralid at 1.25 + 5.8 oz/A averaged 99 and 85% control, respectively. In general, there was little difference in long-term Canada thistle control when the treatments were applied in June compared to September. The most cost-effective treatment was aminopyralid plus clopyralid at 0.5 + 2.4 oz/A which provided 70% Canada thistle control 26 MAT and cost $11.05/A.

All treatments that contained aminopyralid or clopyralid provided 90% or better absinth wormwood control 26 MAT whether applied in June or September (Table 2). The most cost-effective treatment again was aminopyralid plus clopyralid at 0.5 + 2.4 oz/A which provided 95% absinth wormwood control 26 MAT. The least effective treatment was dicamba applied at 16 oz/A in the spring which provided 71% absinth wormwood control by the end of the study. In summary, the combination of aminopyralid plus clopyralid at reduced rates generally provided similar weed control to aminopyralid applied alone with only a slight reduction in herbicide cost.

Table 1. Aminopyralid plus clopyralid for Canada thistle control applied on June 30 or September 26, 2011 at Fargo, ND.

		Evaluation date					
		2011	2012		2013		
Treatment[a]	Rate	13 Sept	1 June	17 Aug	17 June	21 Aug	Cost[b]
	— oz/A —	—	—	% control	—	—	$/A
June application							
Aminopyralid[c]	1.25	100	99	94	77	69	15.65
Aminopyralid	1.75	100	100	97	84	80	21.90
Clopyralid[d]	6	100	96	94	78	75	23.70
Dicamba	16	99	100	98	73	81	14.50
Aminopyralid + clopyralid	0.5 + 2.4	100	100	90	69	70	11.05
Aminopyralid + clopyralid	0.75 + 3.4	100	99	95	75	66	15.75
Aminopyralid + clopyralid	1 + 4.6	100	100	99	97	95	21.30
Aminopyralid + clopyralid	1.25 + 5.8	100	99	99	85	82	26.95
Aminopyralid + clopyralid	1.5 + 7	100	99	94	84	86	32.35
September application							
Aminopyralid	1.25		91	91	90	81	15.65
Dicamba	16		91	84	68	60	14.50
Aminopyralid + clopyralid	0.75 + 3.4		100	99	86	84	15.75
Aminopyralid + clopyralid	1 + 4.6		100	99	85	86	21.30
Aminopyralid + clopyralid	1.25 + 5.8		100	100	91	81	26.95
LSD (0.05)		NS	6	10	20	20	

[a]All treatments applied with NIS Activator 90 at 0.25%. Activator 90 from United Agri Products, 7251 W. 4th St. Greeley, CO 80634.
[b]Based on Milestone at $400/gal and Transline at $190/gal and does not include surfactant or application costs.
[c]Commercial formulation - Milestone and [d]Transline, from Dow AgroSciences LLC, 9330 Zionsville Road, Indianapolis, IN 46268-1189.

Table 2. Aminopyralid plus clopyralid for absinth wormwood control applied May 26 or September 15, 2011, near Valley City, ND.

		Evaluation date					
		2011	2012		2013		
Treatment[a]	Rate	15 Sept	17 May	22 Aug	3 June	14 Aug	Cost[b]
	— oz/A —			% control			$/A
June application							
Aminopyralid[c]	1.25	95	94	93	91	90	15.65
Aminopyralid	1.75	99	96	96	99	96	21.90
Clopyralid[d]	6	99	97	99	99	97	23.70
Dicamba	16	80	65	75	73	71	14.50
Aminopyralid + clopyralid	0.5 + 2.4	96	97	96	99	95	11.05
Aminopyralid + clopyralid	0.75 + 3.4	99	99	99	100	99	15.75
Aminopyralid + clopyralid	1 + 4.6	99	99	97	100	99	21.30
Aminopyralid + clopyralid	1.3 + 5.8	99	100	99	99	97	26.95
Aminopyralid + clopyralid	1.5 + 7	100	100	99	100	99	32.35
September application							
Aminopyralid	1.25		99	99	100	96	15.65
Dicamba	16		91	96	79	84	14.50
Aminopyralid + clopyralid	0.75 + 3.4		99	100	100	99	15.75
Aminopyralid + clopyralid	1 + 4.6		99	99	100	98	21.30
Aminopyralid + clopyralid	1.3 + 5.8		99	100	100	96	26.95
LSD (0.05)		5	5	9	14	11	

[a]All treatments applied with NIS Activator 90 at 0.25%. Activator 90 from United Agri Products, 7251 W. 4th St. Greeley, CO 80634.
[b]Based on Milestone at $400/gal and Transline at $190/gal and does not include surfactant or application costs.
[c]Commercial formulation - Milestone and [d]Transline, from Dow AgroSciences LLC, 9330 Zionsville Road, Indianapolis, IN 46268-1189.

Yellow toadflax control with aminopyralid and picloram applied alone and with other herbicides. Rodney G. Lym (Department of Plant Sciences, North Dakota State University, Fargo, ND 58108-6050). Yellow toadflax has been much more difficult to control with herbicides than the related species dalmatian toadflax. The most commonly used treatment in North Dakota is picloram applied at 8 to 16 oz/A with dicamba plus diflufenzopyr at 3 to 4 + 1.2 to 1.6 oz/A, respectively. Control has been consistently high, but this treatment costs from $40 to $65/A for the chemical alone. The purpose of this research was to compare picloram and aminopyralid applied alone and with other herbicides for cost-effective yellow toadflax control.

The experiment was established on a wildlife production area near Valley City, ND. Treatments were applied August 5, 2012 when yellow toadflax was 10 to 16 inches tall and beginning to flower. Herbicides 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. Yellow toadflax control was evaluated visually using percent stand reduction compared to the untreated control.

Picloram applied alone at 8 or 16 oz/A provided the most cost-effective yellow toadflax control which averaged 83% 13 months after treatment (MAT) (Table). Control was similar when picloram was applied with chlorsulfuron and/or dicamba plus diflufenzopyr. This is in contrast to previous research conducted at North Dakota State University when the combination treatment of picloram plus dicamba plus diflufenzopyr provided much better long-term yellow toadflax control than picloram alone. Aminopyralid alone averaged 16% control 13 MAT, but control increased to 76% when aminopyralid was applied with chlorsulfuron. Control was not improved when dicamba plus diflufenzopyr was applied with aminopyralid. Aminocyclopyrachlor plus chlorsulfuron at 1.9 + 0.73 oz/A provided 83% yellow toadflax control 13 MAT and control was unchanged when aminopyralid was added to the mixture.

In summary, picloram alone at 8 oz/A provided the most cost-effective yellow toadflax control in this study. However, previous research has shown that dicamba plus diflufenzopyr should be added with picloram to obtain consistent long-term control. Aminocyclopyrachlor also provided excellent yellow toadflax control and will likely be used more widely once the herbicide is labeled for areas that are grazed and hayed.

Table. Yellow toadflax control with aminopyralid and picloram applied with various herbicides on August 5, 2012 near Valley City, ND.

		Evaluation date		
		2012	2013	
Treatment[a]	Rate	13 Sept	11 July	13 Sept
	—— oz/A ——	—— % control ——		
Aminopyralid	2.5	49	36	23
Aminopyralid	3.5	50	15	9
Chlorsulfuron	0.75	29	62	51
Aminopyralid + chlorsulfuron	1.75 + 0.75	39	92	89
Aminopyralid + chlorsulfuron	2.5 + 0.75	43	53	63
Aminopyralid + chlorsulfuron + dicamba + diflufenzopyr[b]	1.75 + 0.75 + 3 + 1.2	63	77	63
Picloram	8	44	88	81
Picloram	16	51	62	84
Picloram + chlorsulfturon	8 + 0.75	62	84	82
Picloram + chlorsulfuron + dicamba + diflufenzopyr	8 + 0.75 + 3 + 1.2	58	90	91
Aminocylopyrachlor + chlorsulfuron[c]	1.9 + 0.73	68	84	83
Aminocylopyrachlor + chlorsulfuron + aminopyralid	0.8 + 0.3 + 1.75	64	67	71
Picloram + dicamba + difulfenzopyr	8 + 3 + 1.2	68	89	90
Picloram + dicamba + diflufenzopyr	16 + 4 + 1.6	73	86	84
LSD (0.05)		10	25	22

[a]All treatment applied with surfactant at 0.25%. Activator 90 by United Agri Products 7251 W. 4th St. Greeley, CO 80634.
[b]Commercial formulation - Overdrive by BASF Corporation, 100 Campus Drive, Florham Park, NC 07932.
[c]Formulation - Perspective by E.I. duPont de Nemours and Company, 1007 Market Street, Wilmington, DE 19898.

Evaluation of aminocyclopyrachlor applied with various herbicides for absinth wormwood control. Rodney G. Lym (Department of Plant Sciences, North Dakota State University, Fargo, ND 58108-6050). Aminocyclopyrachlor (AMCP) is generally applied with chlorsulfuron for control of a variety of invasive species. AMCP has provided excellent long-term control of leafy spurge, Canada thistle, and spotted knapweed but has been less effective when applied on woody species such as absinth wormwood. Previous research at North Dakota State University found AMCP plus chlorsulfuron applied in the fall provided much better long-term absinth wormwood control than the same treatment applied in early spring. The purpose of this research was to evaluate absinth wormwood control with AMCP plus chlorsulfuron applied with commonly used brush herbicides.

The experiment was established in Valley City, ND in an abandoned feed lot area. Treatments were applied May 23, 2012 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. A methylated seed oil adjuvant at 1 qt/A was applied with all treatments that contained AMCP while aminopyralid was applied with a non-ionic surfactant at 0.25%. The site had an extremely dense stand of absinth wormwood with many seedlings and rosettes that were beginning to bolt and averaged 18 inches tall. Control was evaluated visually using percent stand reduction compared to the untreated control.

Absinth wormwood control was 96% when averaged over all treatments 15 months after application (Table). Absinth wormwood control was similar when AMCP plus chlorsulfuron was applied with imazapyr, triclopyr ester, triclopyr amine, or metsulfuron. No antagonism was observed with any of the herbicide combinations. Thus, application of AMCP with commonly used brush herbicides likely would provide a wider spectrum of brush control than AMCP plus chlorsulfuron used alone.

Table. Evaluation of AMCP applied with a variety of herbicides for absinth wormwood control applied on May 23, 2012, near Valley City, ND.

		Evaluation date			
		2012		2013	
Treatment[a]	Rate	9 July	22 Aug	3 June	19 Aug
	oz/A	% control			
AMCP + chlorsulfuron[b] + imazapyr	2 + 2.8	97	98	100	89
AMCP + chlorsulfuron + imazapyr	4 + 5.6	100	99	100	91
AMCP + chlorsulfuron + triclopyr ester	2 + 2	92	96	99	97
AMCP + chlorsulfuron + triclopyr ester	4 + 4	98	99	100	100
AMCP + chlorsulfuron + triclopyr amine	2 + 2	95	97	100	100
AMCP + chlorsulfuron + triclopyr amine	4 + 4	98	99	100	98
AMCP + chlorsulfuron + triclopyr amine	2 + 4	96	99	99	100
AMCP + chlorsulfuron + triclopyr amine	4 + 8	97	100	100	99
AMCP + chlorsulfuron + imazapyr + triclopyr amine	2 + 2.8 + 2	97	99	100	89
AMCP + chlorsulfuron + imazapyr + triclopyr amine	4 + 5.6 + 4	100	100	100	90
AMCP + chlorsulfuron + metsulfuron	4 + 1.3	99	100	100	98
AMCP + chlorsulfuron + metsulfuron + imazapyr	4 + 1.3 + 5.6	100	100	100	94
AMCP + chlorsulfuron + metsulfuron	2 + 0.6	95	100	100	99
Aminopyralid[c] + NIS[d]	1.75 + 0.25%	94	99	100	100
LSD (0.05)		5	2	1	9

[a]MSO at 1 qt/A was applied with all treatments that contained AMCP. Dyne-Amic by Helena Chemical Co., 225 Schilling Blvd, Collierville, TN 38017.
[b]AMCP = aminocyclopyrachlor. Commercial formulation - Perspective by E.I. duPont de Nemours and Company, 1007 Market Street, Wilmington, DE 19898.
[c]Commercial formulation - Milestone by Dow AgroSciences LLC, 9330 Zionsville Road, Indianapolis, IN 46268-1189.
[d]NIS Activator 90 by United Agri Products 7251 W. 4th St. Greeley, CO 80634.

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