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FOREWORD

The 2013 Research Progress Report of the Western Society of Weed Science (WSWS) is a compilation of research investigations contributed by weed scientists in the western United States of America. The objective of the Research Progress Report is to provide an avenue for presentation and exchange of on-going research to the weed science community. The information in this report is preliminary; therefore, it is not for the development of endorsements or recommendations.

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

Traci Rauch
Research Progress Report Editor
Western Society of Weed Science
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Annual glyphosate treatments to control downy brome and promote perennial grass recovery on Colorado Rangeland. 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 is often unacceptable BROTE control 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 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 will be used to compare BROTE control and effect of treatments on soil seed longevity. 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.

BROTE seedlings started emerging in October 2010 and continued emerging in April 2011. Some BROTE emerged after the March 15, 2011 glyphosate application, which led to less than 100% BROTE control in year one. Western wheatgrass was the only perennial grass species that was breaking dormancy and up to 1 to 2" tall at the March 15, 2011 application.

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. Seedling BROTE and all other species that emerged from seed were counted to determine germination of seed that remained in the soil each year. A total of five soil cores collected from a 2" depth were pooled for each plot. All seedlings that emerged in the field when soil cores were collected were identified and counted. Soil cores were placed into flats, watered, and allowed to germinate in the greenhouse. All seedlings were counted daily when they first emerged and two to three times weekly after the first week for 4 weeks. All seedlings were removed to avoid double counting. Seed is being processed and these data were not included in this report. Visual evaluations for BROTE control, biomass, and canopy cover were conducted on October 21, 2011 and again on July 12 and November 29, 2012.

Glyphosate (16 oz ai/a) sprayed in year 1 of this study controlled 82% of BROTE 7 months after treatment (MAT; Table 2). BROTE control was slightly lower than BROTE control in previous studies conducted by CSU due to late spring moisture that promoted BROTE emergence after the March 15, 2011 application. Glyphosate has no soil activity and all BROTE that emerged after the early spring glyphosate treatments were sprayed were not controlled. There was 20% BROTE control 1 year after treatment (YAT) with the first year glyphosate treatment and 100% BROTE control with 2 annual glyphosate treatments in October 2012.

BROTE and perennial grass biomass were collected at the end of the growing season in October 2011 and November 2012. Western wheatgrass (*Pascopyrum smithii*, PASSM), 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 in year 1 and BOUGR biomass in 2 year (Table 3). BOUGR populations increased with 2 glyphosate treatments while PASSM and SPOCR biomass remained similar to checks. 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 with the single glyphosate treatment in 2 year compared to the check. 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 checks and 25% in first year treated plots in year 1. In year 2 there was 63 or 78% BROTE canopy cover in year 1 or checks. Year 2 glyphosate treatments had 100% BROTE control and 0% and BROTE canopy cover.

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. Three to five year treatments will be re-applied in spring 2013 over the original treated plots to compare untreated, 1, 2, and 3 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

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

		Years of	BROTE[3]	
Herbicide[1,2]	Rate	Treatment	2011	2012[4]
	oz ai/A		-----------(% Control)--------------	
Untreated			0	0
Glyphosate	16	1	82	21
Glyphosate	16	1 + 2	-	100
LSD (0.05)			8	2

[1] Methylated seed oil added to all treatments at 1 pint/A.
[2] Roundup Weathermax
[3] Visual ratings of BROTE control compared to the untreated checks was conducted on October 21, 2011 and July 12, 2012.
[4] There were fewer but larger BROTE plants in first year treated plots compared to untreated checks.

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	BOUGR 2012	SPOCR 2012	Total Grass 2011	Total Grass 2012	BROTE[3] 2011	BROTE[3] 2012
	oz ai/A		(Biomass lb/A)						
Untreated			Trace	114	75	100	214	779	98
Glyphosate	16	1	Trace	253	11	850	264	18	334
Glyphosate	16	1 + 2	Trace	620	112	-	732	-	0
LSD (0.05)			-	255	87	228	254	78	110

1 Methylated seed oil added to all treatments at 1 pint/A.
2 Roundup Weathermax
3 There were fewer but larger BROTE plants in first year treated plots compared to untreated checks.

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[3] 2011	AGRSM[3] 2012	BOUGR 2011	BOUGR 2012	SPOCR 2011	SPOCR 2012	BROTE 2011	BROTE 2012
	oz ai/A		(Canopy Cover %)							
Untreated			10	16	21	48	18	16	83	63
Glyphosate	16	1	25	13	71	56	19	14	33	78
Glyphosate	16	1 + 2	-	15	-	63	-	23	-	0
LSD (0.05)			15	8	20	14	13	11	22	3

1 Methylated seed oil added to all treatments at 1 pint/A.
2 Roundup Weathermax
3 Perennial grass and BROTE cover data was collected on October 20, 2011 and November 29, 2012.
4 There were fewer but larger BROTE plants in first year treated plots compared to untreated checks.

Effect of aminocyclopyarachlor applied with chlorsulfuron or 2,4-D on broadleaf and grass production in non-cropland. Rodney G. Lym (Department of Plant Sciences, North Dakota State University, Fargo, ND 58108-6050). Aminocyclopyrachlor (AMCP) has generally been applied with chlorsulfuron for control of a variety of invasive weeds. AMCP plus chlorsulfuron is marketed as a dispersible granule (DG) formulation but could also become available mixed with 2,4-D as a soluble liquid (SL) formulation . The purpose of this research was to compare AMCP applied with chlorsulfuron as a DG or with 2,4-D as a LS formulation on long-term broadleaf and grass production in non-cropland.

The experiment was established on June 9, 2011 in an ungrazed non-cropped area in north Fargo. The area had previously been heavily infested with leafy spurge, but the *Aphthona* spp. biological control agents had reduced the weed to a minor component of the vegetation. Treatments 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. The area contained a wide variety of broadleaf species, but the major grass species present was Kentucky bluegrass. AMCP efficacy was visually evaluated on native and weedy species that were commonly present in all plots using percent stand or height reduction compared to the untreated control. Biomass was harvested in mid-September of 2011 and 2012 by clipping three 0.25-m^2 quadrats per plot and separated into broadleaf or grass species content. Harvested plant material was dried at 120 F for at least 72 hr and weighed to estimate yield.

AMCP provided an average of 81 and 94% leafy spurge control applied with chlorsulfuron or 2,4-D, respectively, 3 months after treatment (MAT) in August 2011 (Table1). Control declined to an average of 51% 23 MAT when AMCP was applied with chlorsulfuron, but averaged 72% when applied with
2,4-D. Previous research at North Dakota State University has shown that long-term leafy spurge control is better when AMCP is applied with 2,4-D, compared to application with chlorsulfuron. Canada thistle control averaged 98% 3 MAT regardless of AMCP application rate or formulation, but declined rapidly to less than 50% by 23 MAT. Buckbrush or western snowberry (*Symphoricarpos occidentalis* Hook.) height was initially reduced when treated with AMCP, but gradually recovered with no injury observed by 23 MAT on this native species. However, Canada goldenrod (*Solidago canadensis* L.) was nearly eliminated and had not returned by the end of the study. Wild licorice (*Glycyrrhiza lepidota* Pursh) was tolerant of all AMCP treatments.

AMCP applied with chlorsulfuron or 2,4-D reduced grass production the year of treatment (2011) even though no grass injury had been observed (Tables 1 and 2). Grass biomass averaged 1760 and 1250 lb/A when AMCP was applied with chlorsulfuron or 2,4-D, respectively, compared to 2235 lb/A in the untreated control. Grass production was similar regardless of treatment in 2012 but was much less than in 2011, likely due to drought conditions that occurred in 2012. Broadleaf plant production following AMCP application averaged 270 lb/A in 2011 compared to 1940 lb/A in the untreated control. Similar to the reduced grass production in 2012, broadleaf biomass in the untreated control only averaged 790 lb/A, but was still more than the average biomass in treated plots which again averaged 270 lb/A.

In summary, AMCP reduced many of the broadleaf species in this study, including leafy spurge, Canada thistle, Canada goldenrod. Buckbrush growth was reduced the year of treatment, but the species recovered by the year after treatment and wild licorice was very tolerant. Grass production was also reduced the year of treatment but not the following growing season. AMCP should maintain long-term control of many broadleaf species but may temporarily reduce grass production.

Table 1. Control of various wildland grass, weed, and native species with aminocyclopyrachlor applied either with chlorsulfuron or 2,4-D near Fargo, ND.

		Evaluation date/plant species											
		3 August 11						30 July 12					
Treatment	Rate	Grass	Leafy spurge	Canada thistle	Buck brush	Wild licorice	Golden rod	Grass	Leafy spurge	Canada thistle	Buck brush	Wild licorice	Golden rod
	oz/A	% control											
AMCP + chlorsulfuron[a] + NIS[b]	1 + 0.4 + 0.25%	0	80	100	29	3	74	0	37	27	0	0	93
AMCP + chlorsulfuron + NIS	1.8 + 0.7 + 0.25%	0	82	98	33	0	89	0	64	69	4	0	95
AMCP + 2,4-D[c] + NIS	1 + 7.6 + 0.25%	0	93	95	18	0	85	0	64	62	0	0	92
AMCP + 2,4-D + NIS	2 + 15.2 + 0.25%	0	98	99	13	5	93	0	82	10	5	0	92
Untreated	•••	0	0	0	0	0	0	0	0	0	0	0	0
LSD (0.05)		NS	16	2	NS	NS	20	NS	32	4	15	NS	9

[a]Dispersible granular formulation - Perspective by E.I. duPont de Nemours and Company, 1007 Market Street, Wilmington, DE 19898.
[b]Surfactant Induce by Helena Chemical Co., 225 Schilling Blvd, Collierville, TN 38017.
[c]Soluble liquid formulation, by E.I. duPont de Nemours and Company.

Table 2. Effect of aminocyclopyrachlor applied either with chlorsulfuron or 2,4-D on grass and broadleaf species near Fargo, ND.

		Harvest date			
		15 Sept 11		20 Sept 12	
Treatment	Rate	Grass	Broadleaf	Grass	Broadleaf
	oz/A	lb/A			
AMCP + chlorsulfuron[a] + NIS[b]	1 + 0.4 + 0.25%	1810	240	1275	350
AMCP + chlorsulfuron + NIS	1.8 + 0.7 + 0.2%	1710	295	1365	250
AMCP + 2,4-D[c] + NIS	1 + 7.6 + 0.25%	1415	285	970	170
AMCP + 2,4-D + NIS	2 + 15.2 + 0.25%	1085	265	1000	310
Untreated	•••	2234	1940	990	790
LSD (0.05)		665	625	NS	260

[a]Dispersible granular formulation - Perspective by E.I. duPont de Nemours and Company, 1007 Market Street, Wilmington, DE 19898.
[b]Surfactant Induce by Helena Chemical Co., 225 Schilling Blvd, Collierville, TN 38017.
[c]Soluble liquid formulation, by E.I. duPont de Nemours and Company.

Control of buckhorn plantain in irrigated pasture. Allan Sulser, Ralph E. Whitesides, and Corey V. Ransom. (Utah State University Extension, Wasatch County, Heber City, UT 84032 and Department of Plants Soils and Climate, Utah State University, Logan, UT 84322-4820) Buckhorn plantain (*Plantago lanceolata* L.) is a weed with increasing significance in Wasatch County, Utah. It competes for soil nutrients, water, and light and crowds out desirable plant species. Reduction of desirable plants species decreases forage yield and increases management costs for livestock producers. Initial observations in 2011, using spring applications of herbicides where buckhorn plantain is listed as controlled on the label demonstrated control of 35% with chlorsulfuron, 65% control with metsulfuron, 35% control with triclopyr, 95% control with a tank mixture of 2,4-D amine and dicamba, and 90% control with 2,4-D amine. Control estimates were completed using a random sampling technique of tossing a quarter square yard quadrat, 10 times in each treated section on monthly intervals for three months following application.

In 2012 a field trial was conducted to evaluate chemical control of buckhorn plantain with chlorsulfuron, metsulfuron, 2,4-D amine, dimethylamine salt of dicamba, chlorsulfuron + dicamba, metsulfuron + dicamba, chlorsulfuron + 2,4-D amine, and metsulfuron + 2,4-D amine. The experiment was designed as a randomized complete block with individual plots measuring 10 by 30 feet. Treatments were replicated four times. Herbicides were applied on May 14, 2012, when buckhorn plantain was in the early rosette stage, approximately 1-2 inches in diameter. All treatments were applied using a CO_2-pressurized backpack sprayer calibrated to deliver 18 gpa at 35 psi. The objective of the trial was to determine which herbicide would be most effective in controlling buckhorn plantain and which would be most economical.

Visual ratings showed metsulfuron and metsulfuron mixtures to be most effective in controlling buckhorn plantain in irrigated pasture (Table 1). No significant visual symptoms were observed on the pasture grasses in this study from any treatment. Buckhorn plantain populations were reduced most significantly by metsulfuron and metsulfuron combinations. However, significant reductions in weed populations were not observed until 59 days after treatment and weed populations in treated plots were increasing by 92 days after treatment (Table 2). Metsulfuron and metsulfuron mixtures were the least expensive herbicide treatments evaluated in this study. The current per acre cost for metsulfuron alone was only 33% ($5.29) of the average cost per acre ($15.36) of all herbicide treatments evaluated. Metsulfuron + dicamba cost was $9.00 per acre or 59% of the average herbicide treatment in this study.

Table 1. Visual control of buckhorn plantain in irrigated pasture.[1]

		Control		
Treatment[2]	Rate	35 DAT	59 DAT	92 DAT
	oz ai or ae/A		%	
Chlorsulfuron	0.75	18 bc	14 c	14 bc
Metsulfuron	0.66	68 a	57 ab	57 a
2,4-D amine	30.4	32 b	22 c	35 ab
Dicamba	16.0	8 c	7 c	12 bc
Chlorsulfuron + dicamba	0.75 + 4.0	27 bc	12 c	12 bc
Metsulfuron + dicamba	0.6 + 4.0	67 a	48 b	47 a
Chlorsulfuron +2,4-D amine	0.75 + 30.4	31 b	14 c	34 ab
Metsulfuron +2,4-D amine	0.6 + 30.4	66 a	68 a	58 a
Untreated		0 c	0 c	0 c

[1]Treatment means within a column followed by the same letter are not significant according to LSD at P=0.05.
[2]Chlorsulfuron and metsulfuron rates are in oz ai/acre and 2,4-D amine and dicamba rates are in oz ae/acre. All treatments were applied with 90% non-ionic surfactant (R-11) at 0.25% v/v.

Table 2. Buckhorn plantain densities in response to herbicide treatments.[1]

Treatment[2]	Rate	Density 35 DAT	59 DAT	92 DAT
	oz ai or ae/A	plants/0.25 yd^2		
Chlorsulfuron	0.75	26 ab	44 a	41 ab
Metsulfuron	0.66	15 b	8 c	14 d
2,4-D amine	30.4	24 ab	30 b	30 bcd
Dicamba	16.0	41 a	47 a	45 ab
Chlorsulfuron + dicamba	0.75 + 4.0	43 a	53 a	55 a
Metsulfuron + dicamba	0.6 + 4.0	23 ab	9 c	20 cd
Chlorsulfuron +2,4-D amine	0.75 + 30.4	22 ab	28 b	27 bcd
Metsulfuron +2,4-D amine	0.6 + 30.4	9 b	8 c	16 d
Untreated		27 ab	51 a	38 abc

[1]Treatment means within a column followed by the same letter are not significant according to LSD at P=0.05.
[2]Chlorsulfuron and metsulfuron rates are in oz ai/acre and 2,4-D amine and dicamba rates are in oz ae/acre. All treatments were applied with 90% non-ionic surfactant (R-11) at 0.25% v/v.

Comparison of aminocyclopyarachlor applied with chlorsulfuron or 2,4-D for invasive weed control. Rodney G. Lym (Department of Plant Sciences, North Dakota State University, Fargo, ND 58108-6050). Aminocyclopyrachlor (AMCP) has generally been applied with chlorsulfuron for control of a variety of invasive weeds. AMCP plus chlorsulfuron is marketed as a dispersible granule (DG) formulation which may be more difficult to adapt to direct injection application often used in roadside weed control compared to soluble liquid (SL) formulations. The purpose of this research was to compare AMCP applied with chlorsulfuron as a DG or with 2,4-D as a SL formulation for long-term control of three invasive weed species.

Studies were established for leafy spurge, Canada thistle, or spotted knapweed control near Walcott, ND in an ungrazed area of pasture, on the campus of North Dakota State University, or near Hawley, MN, respectively. Treatments 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 at all locations. The leafy spurge study was established on June 6, 2011 when the plants were in the true-flower growth stage and 12 to 24 inches tall. Spotted knapweed was treated when in the rosette stage on June 9, 2011. The Canada thistle experiment was established on July 18, 2011 when the plants were 4 to 6 inches tall and beginning to bolt. A herbicide treatment considered the current standard for control of each weed species was included in each trial. Weed control was evaluated visually using percent stand reduction compared to the untreated control.

Long-term leafy spurge control was better when AMCP was applied as a liquid formulation with 2,4-D compared to application with chlorsulfuron as a DG or the standard treatment of picloram plus imazapic, plus 2,4-D (Table 1). For instance, leafy spurge control averaged 82% with AMCP plus 2,4-D applied at 1 + 7.6 oz /A, respectively, 14 months after treatment (MAT) (August 12, 2012) compared to only 41% with AMCP plus chlorsulfuron at 1 + 0.4 oz/A, respectively. Control increased to 90% 14 MAT with the liquid formulation, but only averaged 62% with AMCP applied in the DG treatment or the standard picloram plus imazapic plus 2,4-D.
In contrast to the leafy spurge study, spotted knapweed control from AMCP was excellent whether applied with chlorsulfuron or 2,4-D and averaged 98% 14 MAT which was the same control observed with the standard treatment of aminopyralid at 1.25 oz/A (Table 2). Similarly, Canada thistle control was excellent regardless of treatment or formulation and averaged 100% 13 MAT (Table 3). AMCP applied with chlorsulfuron suppressed annual foxtail species (*Setaria* spp.) nearly 90% averaged over application rate, compared to 66% when AMCP was applied with 2,4-D as an SL. All treatments provided excellent control of common ragweed (*Ambrosia artemisiifolia* L.) except AMCP + 2,4-D. As reported in previous studies, AMCP will suppress some annual grass species. The increased control when AMCP was applied as a DG compared to a SL was likely due to the chlorsulfuron in the DG mixture which is known to control many annual grass species. AMCP plus chlorsulfuron and aminopyralid provided nearly 100% ragweed control 11 MAT, compared to no control when AMCP was applied with 2,4-D.

In summary, leafy spurge control was better when AMCP was applied with 2,4-D compared to AMCP applied with chlorsulfuron, but control of Canada thistle and spotted knapweed was similar regardless of formulation. Suppression of annual grass species is likely when AMCP is used to control various invasive weed species.

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

		Evaluation date		
		2011	2012	
Treatment	Rate	4 Aug	24 May	28 Aug
	—— oz/A ——	——	% control	——
Aminocyclopyrachlor + chlorsulfuron[a] + NIS[b]	1 + 0.4 + 0.25%	89	55	41
Aminocyclopyrachlor + chlorsulfuron + NIS	1.8 + 0.7 + 0.25%	95	73	64
Aminocyclopyrachlor + 2,4-D[c] + NIS	1 + 7.6 + 0.25%	98	89	82
Aminocyclopyrachlor + 2,4-D + NIS	2 + 15.2 + 0.25%	99	95	90
Picloram + imazapic + 2,4-D + MSO	4 + 1 + 16 + 1 qt	99	76	61
Untreated	● ● ●	0	0	0
LSD (0.05)		6	22	28

[a]Dispersible granule formulation - Perspective by E.I. duPont de Nemours and Company, 1007 Market Street, Wilmington, DE 19898.
[b]Surfactant Induce by Helena Chemical Co., 225 Schilling Blvd, Collierville, TN 38017.
[c]Soluble liquid formulation, by E.I. duPont de Nemours and Company.

Table 2. Evaluation of aminocyclopyrachlor applied with chlorsulfuron or 2,4-D for spotted knapweed control near Hawley, MN.

		Evaluation date		
		2011	2012	
Treatment	Rate	2 Aug	24 May	17 Aug
	—— oz/A ——	——	% control	——
Aminocyclpyrachlor + chlorsulfuron[a] + NIS[b]	1 + 0.4 + 0.25%	92	96	96
Aminocyclpyrachlor + chlorsulfuron + NIS	1.8 + 0.7 + 0.25%	100	100	100
Aminocyclpyrachlor + 2,4-D[c] + NIS	1 + 7.6 + 0.25%	96	97	98
Aminocyclpyrachlor + 2,4-D + NIS	2 + 15.2 + 0.25%	100	100	100
Aminopyralid[d] + NIS	1.25 + 0.25%	100	98	98
Untreated	● ● ●	0	0	0
LSD (0.05)		3	5	3

[a]Dispersible granule formulation - Perspective by E.I. duPont de Nemours and Company, 1007 Market Street, Wilmington, DE 19898.
[b]Surfactant Induce by Helena Chemical Co., 225 Schilling Blvd, Collierville, TN 38017.
[c]Soluble liquid formulation, by E.I. duPont de Nemours and Company.
[d]Commercial formulation - Milestone by Dow AgroSciences LLC, 9330 Zionsville Road, Indianapolis, IN 46268-1189.

Table 3. Evaluation of aminocyclopyrachlor applied with chlorsulfuron or 2,4-D for Canada thistle control, Fargo, ND.

		Evaluation date					
		13 Sept 2011			12 June 12		16 Aug 12
Treatment	Rate	Canada thistle	Rag-weed	Foxtail spp.	Canada thistle	Rag-weed	Canada thistle
	oz/A	% control					
Aminocyclpyrachlor + chlorsulfuron[a]+ NIS[b]	0.987 + 0.394 + 0.25%	100	100	82	99	99	100
Aminocyclpyrachlor + chlorsulfuron+ NIS	1.777 + 0.709 + 0.25%	100	100	94	100	99	100
Aminocyclpyrachlor + 2,4-D[c] + NIS	1 + 7.6 + 0.25%	100	100	55	100	0	100
Aminocyclpyrachlor + 2,4-D + NIS	2 + 15.2 + 0.25%	100	100	76	100	0	100
Aminopyralid[d] + NIS	1.25 + 0.25%	100	99	0	100	97	100
Untreated	• • •	0	0	0	38	20	0
LSD (0.05)		1	1	16	28	24	1

[a]Dispersible granule formulation - Perspective by E.I. duPont de Nemours and Company, 1007 Market Street, Wilmington, DE 19898.
[b]Surfactant Induce by Helena Chemical Co., 225 Schilling Blvd, Collierville, TN 38017.
[c]Soluble liquid formulation, by E.I. duPont de Nemours and Company.
[d]Commercial formulation - Milestone by Dow AgroSciences LLC, 9330 Zionsville Road, Indianapolis, IN 46268-1189.

Meadow hawkweed control using various rates of aminopyralid and clopyralid combinations. John Wallace and Tim Prather. (Plant Science Divison, University of Idaho, Moscow, ID 83844-2339). An experiment was established near Santa, Idaho in 2011 to evaluate meadow hawkweed (HIECA) control with aminopyralid and clopyralid applications timed to the spring rosette growth stage. The experiment was replicated at two sites and designed as a randomized complete block with three replications and repeated at two different sites. Plot size was 10 by 30 feet. All treatments were applied with a CO_2-pressurized backpack sprayer (Table 1).

Table 1. Application data.

Site	Zenner	Davidson
Weed growth stage	rosette to bolt	rosette to bolt
Application date	June 6, 2011	June 9, 2011
Air Temp (F)	68	48
Relative humidity (%)	57	38
Wind (mph, direction)	1 to 2, NE	1 to 4, NE
Cloud cover (%)	100	85
Soil temp at 2 inches (F)	61	60
Gallons per Acre (gpa)	20	20

Evaluations were conducted on 20 July 2012, approximately 13 month after treatment (MAT). Cover (%) estimates were conducted in two 1 m^2 quadrats per plot and pooled within plot. No site differences were detected, thus data was pooled for analysis. Each treatment resulted in significantly lower meadow hawkweed cover and higher perennial grass cover in comparison to the untreated check. No differences were detected between aminopyralid + clopyralid rates or between aminopyralid and clopyralid used in combination or alone. Each treatment resulted in a significant shift towards perennial grass stands. Idaho fescue (*Festuca idahoensis* Elmer) is the predominant perennial grass at both sites.

Table 2. Meadow hawkweed (HIECA) and perennial grass cover 13 MAT in pasture near Santa, ID.

		Pre-treatment		13 MAT	
Treatment[1]	Rate	HIECA	Perennial grass[2]	HIECA	Perennial grass
	oz ae/A	----- % cover -----		----- % cover -----	
Aminopyralid + clopyralid	0.50 + 2.30	35	35	1	85
Aminopyralid + clopyralid	0.75 + 3.45	28	33	6	78
Aminopyralid + clopyralid	1.00 + 4.60	36	31	0	87
Aminopyralid + clopyralid	1.25 + 5.75	28	37	0	88
Aminopyralid + clopyralid	1.50 + 6.90	33	38	0	88
Aminopyralid	1.25	26	39	0	90
Aminopyralid	1.75	36	34	0	92
Clopyralid	6	30	43	6	82
Untreated check	--	27	38	36	44
Tukey's Studentized Range HSD (0.05)		31	14	13	26

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

[2] Perennial grass cover was predominantly *Festuca idahoensis* Elmer (FESID)

Meadow hawkweed control at various timings using aminopyralid. John Wallace and Tim Prather. (Plant Science Divison, University of Idaho, Moscow, ID 83844-2339). An experiment was established near Santa, Idaho in 2009 to evaluate meadow hawkweed (HIECA) control with aminopyralid at multiple growth stages; early fall senescence, fall rosette, spring rosette and bolting stage. The experiment was designed as a randomized complete block with four replications at two sites. Plot size was 10 by 30 feet. All treatments were applied with a CO_2-pressurized backpack sprayer (Table 1).

Table 1. Application data for meadow hawkweed control.

Weed growth stage	senescence	fall rosette	spring rosette	bolt
Application date	16-Sept-2009	4-Nov-2009	13-May-2010	2-June-2010
Air Temp (F)	86	63	61	53
Relative humidity (%)	24	35	34	41
Wind (mph, direction)	W, 0 to 5	W, 0 to 2	SE, 1 to 4	W, 2 to 6
Cloud cover (%)	0	20	0	40
Soil temp at 2 inches (F)	67	38	60	58
Gallons per Acre (gpa)	15.1	14.8	16.9	14.8

Evaluations were conducted on August 20 2012, two growing seasons after treatment. Cover (%) estimates were conducted in two 1 m^2 quadrats that were established at the initiation of the study. High levels of meadow hawkweed control that occurred in spring timed treatments during the 2010 growing season have resulted in a shift in plant community composition. Idaho fescue (FESID) is the dominant species across spring-timed treated plots, ranging from 77 to 82%, which is significantly greater than the untreated control. Meadow hawkweed cover is negligible (<5%) in spring-timed treatments. Aminopyralid applications timed to the meadow hawkweed senescence stage have resulted in lower meadow hawkweed cover (14 to 32%) in comparison to untreated plots. Applications timed to the fall rosette stage resulted in similar plant community compositions to the untreated control 2 years after treatment.

Table 2. Cover estimates of meadow hawkweed and perennial grass in the 2012 growing season.

Treatment[1]	Rate	Application timing	HIECA[2]	FESID[3]	Other perennial grass[4]
	oz ae/A	---	--------------------	% cover	--------------------
Aminopyralid	1.25	senescence	32	48	5
Aminopyralid	1.75	senescence	14	53	14
Aminopyralid	1.25	fall rosette	61	23	5
Aminopyralid	1.75	fall rosette	51	36	3
Aminopyralid	1.25	spring rosette	0	77	11
Aminopyralid	1.75	spring rosette	0	82	9
Aminopyralid	1.25	bolting	1	78	7
Aminopyralid	1.75	bolting	0	79	7
Untreated check			52	28	7
Tukey's Studentized Range HSD (0.05)			16	33	13

[1] 90% non-ionic surfactant (R-11) at 0.25% v/v was applied with all treatments
[2] HIECA = meadow hawkweed
[3] FESID = Idaho fescue
[4] Perennial grasses other than Idaho fescue

Houndstongue control in Colorado. James R. Sebastian, K.G. Beck, and Derek Sebastian (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.

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. 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 19, 2012 (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 16 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. Several other treatments controlled rosettes similarly but did not eliminate all rosettes, which would be important if eradication was the goal. It also appears that aminocyclopyrachlor has far less activity on houndstongue than chlorsulfuron, metsulfuron, and 2,4,D.

Drought conditions made it impossible to evaluate perennial grass injury in 2012. Evaluations will continue in 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	Houndstongue Bolted
	oz ai/A		-------------------------(% Control)----------------------	
-				
Aminocyclopyrachlor	1	Spring	16	21
	2	Spring	48	45
	3	Spring	35	35
Aminocyclopyrachlor + chlorsulfuron	1.8 + 0.7	Spring	100	100
Aminocyclopyrachlor (liquid) + 2,4-D amine	2 + 15	Spring	87	100
Metsulfuron + chlorsulfuron	0.3 + 0.1	Spring	99	100
Aminocyclopyrachlor + metsulfuron + 2,4-D	2 + 0.6 + 15	Spring	100	100
Aminocyclopyrachlor	1	Fall	20	25
	2	Fall	20	20
	3	Fall	24	45
Aminocyclopyrachlor + chlorsulfuron	1.8 + 0.7	Fall	99	100
Aminocyclopyrachlor (liquid) + 2,4-D amine	2 + 15	Fall	98	100
Metsulfuron + chlorsulfuron	0.3 + 0.1	Fall	99	100
Aminocyclopyrachlor + metsulfuron + 2,4-D	2 + 0.6 + 15	Fall	100	100
LSD (0.05)			15	16

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

Comparison of aminocyclopyarachlor applied with chlorsulfuron or 2,4-D for plumeless thistle and houndstongue control. Rodney G. Lym (Department of Plant Sciences, North Dakota State University, Fargo, ND 58108-6050). Aminocyclopyrachlor (AMCP) has generally been applied with chlorsulfuron for control of many invasive weeds. However, previous research at North Dakota State University (NDSU) has shown that long-term control of leafy spurge is improved when AMCP is applied with 2,4-D compared to application with chlorsulfuron but control of Canada thistle and yellow toadflax was similar regardless of AMCP treatment. The purpose of this research was to evaluate control of the invasive biennial species plumeless thistle (*Carduus acanthoides* L.) and houndstongue (*Cynoglossum officinale* L.) with AMCP applied alone or with chlorsulfuron or other herbicides.

The plumeless thistle study was established on May 26, 2011 on unused pasture near the NDSU campus. The plants were in the rosette to bolt growth stage and 6 to 14 inches tall. The plots were 10 by 30 ft and replicated four times. The houndstongue experiment was established on private pasture near McLeod, ND on June 16, 2011. The houndstongue plants were either in the rosette stage (first yr) or starting to flower (second yr) and 4 to 42 inches tall. The plots were 9 by 9 ft in the first two reps and 8 by 9 feet in reps three and four. Treatments were applied using a hand-held boom sprayer delivering 17 gpa at 35 psi. Weed control was evaluated visually using percent stand reduction compared to the untreated control.

AMCP applied with either chlorsulfuron or 2,4-D provided rapid and complete control of plumeless thistle regardless of application rate (Table 1). Control averaged 100% the year of treatment and nearly 100% 13 MAT which was similar to the current standard treatment of aminopyralid alone at 1.25 oz/A. Houndstongue control with AMCP alone averaged 89 and 83% 3 and 12 months after treatment (MAT), respectively (Table 2). However, there was a trend for houndstongue control to decline as AMCP application rate increased. Control averaged 100% 12 MAT when AMCP was applied with chlorsulfuron and 94% when applied with 2,4-D, which was similar to metsulfuron plus chlorsulfuron applied at 0.3 plus 0.1 oz/A, a current standard for houndstongue control.

In summary, AMCP applied with chlorsulfuron or 2,4-D provided excellent plumeless thistle and houndstongue control. AMCP applied alone provided satisfactory houndstongue control, but might be best used in combination with an ALS herbicide for consistent control of this weed.

Table 1. Efficacy of aminocyclopyrachlor applied with chlorsulfuron or 2,4-D for plumeless thistle control at Fargo, ND.

Treatment	Rate	Evaluation date	
		20 July 11	25 June 12
	——— oz/A ———	——— % control ———	
Aminocyclpyrachlor + chlorsulfuron[a]+ NIS[b]	0.6 + 0.24 + 0.25%	100	99
Aminocyclpyrachlor + chlorsulfuron + NIS	1 + 0.4 + 0.25%	100	100
Aminocyclpyrachlor + 2,4-D[c] + NIS	0.6 + 4.75 + 0.25%	100	100
Aminocyclpyrachlor + 2,4-D + NIS	1 + 7.6 + 0.25%	100	100
Aminopyralid[d] + NIS	1.25 + 0.25%	100	100
Untreated	• • •	0	0
LSD (0.05)		1	0.6

[a]Dispersible granule formulation - Perspective by E.I. duPont de Nemours and Company, 1007 Market Street, Wilmington, DE 19898.
[b]Surfactant Induce by Helena Chemical Co., 225 Schilling Blvd, Collierville, TN 38017.
[c]Soluble liquid formulation - E.I. duPont de Nemours and Company.
[d]Commercial formulation - Milestone by Dow AgroSciences LLC, 9330 Zionsville Road, Indianapolis, IN 46268.

Table 2. Efficacy of aminocyclopyrachlor herbicide for houndstongue control near McLeod, ND.

Treatment	Rate	Evaluation date			
		2011			2012
		19 July	17 Aug	8 Sept	18 May
	—— oz/A ——	——— % control ———			
Aminocyclpyrachlor + NIS[a]	1 + 0.25%	68	75	90	90
Aminocyclpyrachlor + NIS	2 + 0.25%	83	88	97	87
Aminocyclpyrachlor + NIS	3 + 0.25%	79	80	80	73
Aminocyclpyrachlor + chlorsulfuron[b] + NIS	1.8 + 0.7 + 0.25%	98	100	100	100
Aminocyclpyrachlor + 2,4-D[c] + NIS	2 + 15 + 0.25%	93	80	95	94
Metsulfuron + chlorsulfuron[d] + NIS	0.3 + 0.1 + 0.25%	85	88	100	100
Untreated	• • •	0	0	0	0
LSD (0.05)		23	34	14	18

[a]Surfactant Induce by Helena Chemical Co., 225 Schilling Blvd, Collierville, TN 38017.
[b]Dispersible granule formulation - Perspective by E.I. duPont de Nemours and Company, 1007 Market Street, Wilmington, DE 19898.
[c]Soluble liquid formulation - E.I. duPont de Nemours and Company.
[d]Commercial formulation - Cimarron Plus, by E.I. duPont de Nemours and Company.

Diffuse knapweed control with aminocyclopyrachlor in Colorado. James R. Sebastian, K.G. Beck, and Derek Sebastian (Department of Bioagricultural Sciences and Pest Management, Colorado State University, Fort Collins, CO 80523) Diffuse knapweed (*Centaurea diffusa*, CENDI) is a short-lived perennial, a biennial, or occasionally an annual that reproduces and spreads from seed. CENDI seedlings emerge in fall or early spring with adequate moisture. Rosettes over-winter and then bolt, flower, and set seed. A single CENDI plant can produce as many as 700 seeds. CENDI plants often break off at the soil surface then tumble with winds and spread seed long distance from their origin. CENDI favors disturbed areas such as roadsides, overgrazed pastures and rangeland.

Two experiments were established with similar treatments near Greenland (Site 1) and Louisville, Colorado (Site 2). The Greenland site is at 7,300 feet elevation with 22 average annual inches of precipitation. The Louisville site is at 5,300 feet with 16 inches of annual precipitation. Herbicides were applied when CENDI was bolting (spring 2010) or in the rosette growth stage (fall 2010; Table 1). There was very little moisture in fall and winter 2010, especially at the Louisville site and this may have influenced recruitment and plant density. CENDI density was 100 to 600 or 2 to 20 plants/m^2 at the Greenland or Louisville sites, respectively in 2010. Good fall moisture existed in 2011 followed by extremely hot, dry conditions during the 2012 growing season at both locations. The experiments were designed as randomized complete blocks 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 in the fall of 2011 and 2012 (Table 2).

All treatments at the Louisville site controlled 88 to 100% of CENDI in 2011 and 2012 regardless of application timing. The Greenland site is at 2,000 ft higher elevation with better growing conditions and 30 to 60 times greater CENDI density than the Louisville site. Spring applied MAT28 (1 oz ai/A) or MAT28 + metsulfuron (1.3 + 0.2 oz ai/A) controlled 49 or 39% CENDI at the Greenland site and 90 or 96% CENDI at the Louisville site. More favorable conditions at the Greenland site likely increased CENDI recruitment there. Although we did not statistically compare the two sites, the lower rates of MAT28 spring-applied at the Greenland site tended to lose CENDI control quicker than similar treatments at the Louisville site.

All spring-applied aminocyclopyrachlor (MAT28) treatments that were sprayed alone regardless of application timing controlled 49 to 83% of CENDI at the Greenland site and 90 to 98% CENDI at the Louisville site 2 years after treatment (YAT). All fall-applied MAT28 tank mix treatments controlled 89 to 100% of CENDI approximately 2 YAT at both locations. Spring or fall-applied aminopyralid treatments controlled 89 to 100% of CENDI 2 YAT. It appears that 1.5 oz ai/A of MAT28 may be a rate threshold to effect consistent and acceptable CENDI control. Also, fall application timings may produce more consistent and effective CENDI control than spring timings. Long term CENDI control may be extended in drier years and drier locations in response to a decrease in CENDI recruitment.

Table 1. Application data for diffuse knapweed control in Colorado.

	Site 1 - Greenland, CO	
Application date	June 7, 2010	October 5, 2010
Air temperature, F	81	61
Relative humidity, %	25	62
Wind speed, mph	6	0
	Site 2 - Louisville, CO	
Application date	May 27, 2010	November 5, 2010
Air temperature, F	78	55
Relative humidity, %	41	62
Wind speed, mph	3 to 8	0

Table 2. Diffuse knapweed control in Colorado.

Herbicide[1]	Rate	Timing	Diffuse knapweed Site 1		Site 2	
	(oz ai/a)		Greenland, Colorado		Louisville, Colorado	
			2011	2012	2011	2012
			------------------------(% Control)--------------------------			
Aminocyclopyrachlor	1	Spring	62	49	98	90
	1.5	Spring	93	81	99	98
	2	Spring	85	83	99	98
Aminocyclopyrachlor + chlorsulfuron	1.6 + 0.6	Spring	93	81	95	88
Aminocyclopyrachlor (liquid) + 2,4-D amine	1.4 + 11	Spring	85	83	100	100
Aminocyclopyrachlor + metsulfuron	1.3 + 0.2	Spring	54	39	100	96
Aminopyralid	1.3	Spring	95	93	100	100
Aminocyclopyrachlor + chlorsulfuron	1.6 + 0.6	Fall	100	93	100	100
Aminocyclopyrachlor (liquid) + 2,4-D amine	1.4 + 11	Fall	100	100	100	98
Aminocyclopyrachlor + metsulfuron	1.3 + 0.2	Fall	100	90	100	100
Aminopyralid	1.3	Fall	100	89	98	96
LSD (0.05)			18	31	5	9

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

<u>Spotted knapweed control with aminocyclopyrachlor combinations</u>. John Wallace and Tim Prather. (Crop & Weed Science Division, University of Idaho, Moscow, ID 83844-2339). An experiment was established near Athol, ID in Farragut State Park to evaluate spotted knapweed (CENMA) 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	June 1, 2011
Weed growth stage	spring rosette
Air temp (F)	64
Relative humidity (%)	51
Wind (mph, direction)	2 to 4,W
Cloud cover (%)	80
Soil temp at 2 inches (F)	68
Soil type	sandy loam
Delivery rate (gpa)	15.3

Spotted knapweed control was visually evaluated in comparison to the untreated check on August 16 2012, approximately 14 month after treatment (MAT). High levels of spotted knapweed control (>90%) were observed across treatments, which did not differ in comparisons among treatments. Spotted knapweed foliar cover was significantly lower across all treatments (1 to 3%) in comparison to the untreated check (42%).

Table 2. Spotted knapweed control approximately 14 months after treatment (MAT)

		Spotted knapweed	
Treatment [1]	Rate	Cover	Control
	oz ai /A	-----------------%	-----------------
Aminocyclopyrachlor + chlorsulfuron	1.00 + 0.40	1	95
Aminocyclopyrachlor + chlorsulfuron	1.78 + 0.70	3	95
Aminocyclopyrachlor + 2,4-D DMA	1.00 + 7.60	3	92
Aminocyclopyrachlor + 2,4-D DMA	2.00 + 15.2	2	95
Aminopyralid	2.00	2	97
Untreated check	--	42	0
Tukey's HSD		20	12

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

Yellow starthistle control and forage response following aminocyclopyrachlor applications. 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

Yellow starthistle (CENSO) control and bluebunch wheatgrass (PSESP) injury were visually evaluated in comparison to the untreated check 1 and 2 months after treatment (MAT). High levels of yellow starthistle control (>90%) were observed across all treatments at both evaluation dates (Table 2). Aminocyclopyrachlor/chlorsulfuron at 0.83 oz ai/ac resulted in less control (93%) than other treatments at 1 MAT, but no treatment differences were detected 2 MAT. Low levels of PSESP injury were observed at both evaluation dates, ranging from 0 to 15%.

Table 2. Yellow starthistle control following treatments timed to the spring rosette stage.

		CENSO control		PSESP injury	
Treatment [1]	Rate	1 MAT[2]	2 MAT	1 MAT	2 MAT
	oz ai /ac	-------- % --------		---------- % ----------	
Aminocyclopyrachlor /chlorsulfuron	0.83	93	99	0	3
Aminocyclopyrachlor /chlorsulfuron	1.38	100	100	8	0
Aminocyclopyrachlor + 2,4-D DMA	0.625 + 4.75	100	100	8	7
Aminocyclopyrachlor + 2,4-D DMA	1.00 + 7.60	100	100	15	7
Aminopyralid	2.00	100	100	12	3
Untreated check	--	0	0	0	0
Tukey's HSD		6	1	11	13

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

African rue control in Colorado from spot- or broadcast-applied herbicides. James R. Sebastian, K.G. Beck, and Scott Nissen. (Department of Bioagricultural Sciences and Pest Management, Colorado State University, Fort Collins, CO 80523) African rue (*Peganum harmala*, PEGHA) is an invasive forb species with an aggressive, woody root system. PEGHA is known to contain four poisonous alkaloids that are toxic to most livestock. PEGHA is drought tolerant and favors disturbed areas such as roadsides, over grazed pastures, and abandoned crop fields. African rue is a bushy, green, succulent, perennial herb with a bushy growth habit that reaches about 1 ft in height at maturity in Colorado. PEGHA dies back to its roots in winter and initiates new growth in early April in Colorado. After spring growth the plant typically becomes senescent in early summer then re-grows in the early fall as precipitation occurs.

PEGHA has a deep and robust perennial root system that is a major obstacle for optimum control. Imazapyr or imazapyr tank-mixes have consistently provided the best PEGHA control. Imazapyr is very active on the root system and is the most common product used for commercial PEGHA control. Imazapyr often injures non-target plants including perennial grasses. Spot spraying individual PEGHA plants, when using imazapyr for control may provide the greatest selectivity in a plant community but this approach would be limited to relatively small infestations for obvious practical reasons.

An experiment was established at a high desert rangeland site approximately 20 miles east of Trinidad, Colorado. Excellent spring moisture occurred in 2010; however, extreme drought conditions persisted from July 2010 through the 2011 growing season. The experiment was designed as a randomized complete block and treatments were replicated four times. Herbicides were applied at three timings; when PEGHA was in the bud growth stage, flowering, or in fall (Table 1). The objective of this study was to determine PEGHA control and injury to desirable plant species with low rates of imazapyr at three application timings. Tebuthiuron (Spike 80W at 3% w/v), imazapyr (3% v/v), or hexazinone (Velpar L at 50% v/v) spot treatments were compared to broadcast applications of each herbicide at the flower and fall timings. All broadcast treatments were applied with a CO_2-pressurized backpack sprayer using 11002LP flat fan nozzles at 20 gal/A and 30 psi. Spot treatment applications were sprayed at 30 psi with a Spray Systems spray handgun with 4003E tips. Plot size was 10 by 30 feet. Visual evaluations for control compared to non-treated plots were conducted in August of each year (Table2).

PEGHA reacted slowly (44 to 64% control) to herbicides the year of application. All imazapyr treatments that were sprayed on May 26, 2010 when PEGHA was at bud growth stage controlled 100% of PEGHA approximately 15 months after treatment (MAT; Table 2). Similar imazapyr rates sprayed on June 8, 2010 at the flower growth stage controlled 94 to 100% PEGHA 15 MAT. Spot spraying imazapyr at flowering controlled 93% of PEGHA 15 MAT. All fall-applied treatments in this experiment failed to control PEGHA. Poor PEGHA control with the fall timing may have resulted from the extreme drought conditions that existed at this site in 2010 and 2011. It is best to avoid spraying PEGHA when soil moisture is low because the plant will be drought stressed. All tebuthiuron and hexazinone treatments failed to control PEGHA in this experiment, regardless of application timing. Tebuthiuron turned PEGHA plants yellow in 2010 and 2011 and control from tebuthiuron slightly increased in 2012 but ranged only from 15 to 53%.

Drought conditions made it impossible to evaluate native species injury in 2010 and 2011. There were very few native species that emerged and survived the drought growing conditions although, they were present at this study site before the initial applications. The dominate perennial grass species were western wheatgrass (*Pascopyrum smithii*) and blue grama (*Bouteloua gracilis*). Collective grass species stand counts were conducted in 2012 in each 10' x 30' plot (Table 3). Grass stand densities were converted to % of check. Grass density tended to decrease with increasing rates of imazapyr but were not totally eliminated. Grass density from 8 oz ai/A of imazapyr was -80, -42, or -73 (% of check) when sprayed on May 26, June 8, or November 9, 2010, respectively. There was 92% PEGHA control from spot-sprayed imazapyr 28 MAT. Spot-spraying imazapyr would be a viable option in small infestations however, there was -61 to -79% grass density loss even from imazapyr spot treatments, owing to its high level of soil activity. PEGHA was very dense at this site so a large portion of each plot was spot sprayed. This study demonstrates that it is possible to achieve excellent long-term PEGHA control with decreased rates of broadcast-applied imazapyr without eliminating perennial grass. Additional research is currently being conducted by CSU where we are evaluating sequentially applied reduced treatment rates to control PEGHA.

Table 1. Application data for African rue control in Colorado from spot- and broadcast-applied herbicides.

Environmental data			
Application date	May 26, 2010	June 8, 2010	November 9, 2010
Air temperature, F	76	85	63
Relative humidity, %	29	32	34
Wind speed, mph	8 to 12	1 to 4	6 to 9

Application date	Species	Common Name	Growth stage	Height
				--(in.)--
May 26, 2010	PEGHA	African rue	Bud	10 to 12
June 8, 2010	PEGHA	African rue	Flower	10 to 16
November 9, 2010	PEGHA	African rue	Fall regrowth	10 to 16

Table 2. African rue control in Colorado from spot- and broadcast-applied herbicides.

			African rue control		
Herbicide[1,2,3,4,5]	Rate	Timing	August 2010	August 2011	October 2012
	oz ai/A or %		%	%	%
Imazapyr	2	Bud	50	100	99
	4	Bud	53	100	97
	8	Bud	60	100	100
Imazapyr	2	Flower	64	94	91
	4	Flower	44	97	93
	8	Flower	56	100	98
	12	Flower	63	100	99
Tebuthiuron	32	Flower	26	18	36
	48	Flower	38	11	45
Imazapyr spot	3%	Flower	64	93	92
Tebuthiuron spot	3%	Flower	55	8	53
Hexazinone spot	50%	Flower	40	30	52
Imazapyr	2	Fall	.	13	0
	4	Fall	.	5	0
	8	Fall	.	9	25
	12	Fall	.	30	38
Tebuthiuron	32	Fall	.	4	15
	48	Fall	.	13	26
Imazapyr spot	3%	Fall	.	15	31
Tebuthiuron spot	3%	Fall	.	14	41
Hexazinone spot	50%	Fall	.	19	28
Untreated check			0	0	0
LSD ((0.05)			19	14	30

[1] Methylated seed oil added to all treatments at 1% v/v.
[2] 32 or 48 oz a/ATebuthiuron broadcast treatment.
[3] 3% v/v of imazapyr spot treatment.
[4] 3% w/v of tebuthiuron spot treatment.
[5] 50% v/v of hexazinone spot treatment.

Table 3. Perennial grass density as influenced by spot- or broadcast-applied herbicides used to control African rue in Colorado.

Herbicide[,1,2,3,4,5]	Rate oz ai/A	Timing	Grass shoots # shoots/plot	Grasss shoots % of Check
Imazapyr	2	Bud	112	-35
	4	Bud	106	-39
	8	Bud	35	-80
Imazapyr	2	Flower	123	-29
	4	Flower	122	-29
	8	Flower	100	-42
	12	Flower	53	-69
Tebuthiuron		Flower	45	-74
		Flower	50	-71
Imazapyr spot	3%	Flower	68	-61
Tebuthiuron spot	3%	Flower	97	-44
Hexazinone spot	50%	Flower	73	-57
Imazapyr	2	Fall	83	-52
	4	Fall	119	-31
	8	Fall	47	-73
	12	Fall	35	-79
Tebuthiuron		Fall	85	-50
		Fall	103	-40
Imazapyr spot	3%	Fall	36	-79
Tebuthiuron spot	3%	Fall	208	17
Hexazinone spot	50%	Fall	142	-17
Untreated check			166	0
LSD ((0.05)			65	30

[1] Methylated seed oil added to all treatments at 1% v/v.
[2] 3% w/v of tebuthiuron broadcast treatment.
[3] 3% v/v of imazapyr spot treatment.
[4] 3% v/v of tebuthiuron spot treatment.
[5] 50% v/v of hexazinone spot treatment.

Feral rye control in Colorado. James R. Sebastian, K.G. Beck, and Derek Sebastian (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.

Indaziflam is a relatively new Bayer compound that is currently registered for annual weed control in orchards and ornamentals. 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 1/2 ft tall canopy of feral rye dead-stand 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 feet.

Visual evaluations for SECCE control compared to non-treated plots were conducted in May or October of 2011 and 2012 (Table 2) when SECCE was in flower or seedling growth stages. 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 89 to 98% at 22 to 24 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% SECCE 12 to 19 MAT; however, SECCE control from these treatments was 37 to 50% 24 MAT. Indaziflam would be 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.

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, 2012	SECCE	Feral rye	1 to 2 leaf	1 to 2"
March 15, 2012	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
			(% Control)			
Indaziflam	0.8	PRE	80	100	94	89
Sulfometuron + chlorsulfuron	0.5 + 0.3	Fall	92	97	94	50
Rimsulfuron	0.8	Fall	93	68	72	35
Glyphosate	13.5	Fall	93	38	27	17
Indaziflam + glyphosate	0.8 + 13.5	Fall	95	100	89	90
Indaziflam + rimsulfuron	0.8 + 0.8	Fall	99	100	100	98
Sulfometuron + chlorsulfuron	0.5 + 0.3	Spring	42	82	83	37
Rimsulfuron	0.8	Spring	48	55	68	35
Glyphosate	13.5	Spring	92	52	47	28
Indaziflam + glyphosate	0.8 + 13.5	Spring	100	100	99	96
Indaziflam + rimsulfuron	0.8 + 0.8	Spring	75	100	96	95
LSD (0.05)			23	28	15	19

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

Yellow starthistle control and forage response using aminopyralid and clopyralid combinations. John Wallace and Tim Prather. (Plant Science Divison, University of Idaho, Moscow, ID 83844-2339). An experiment was established near Lewiston, Idaho in canyon grassland to evaluate yellow starthistle (CENSO) control and forage response following aminopyralid and clopyralid applications timed to the spring and late-winter rosette stage. The experiment was designed as a randomized complete block with four replications. Treatments were replicated in paired plots to compare application timings. Plot size was 10 by 50 feet. All treatments were applied with a CO_2-pressurized backpack sprayer (Table 1).

Table 1. Application data.

Weed growth stage	spring rosette	winter rosette
Application date	May 4, 2011	February 28, 2012
Air Temp (F)	77	39
Relative humidity (%)	38	65
Wind (mph, direction)	1 to 4, W	3 to 7, W
Cloud cover (%)	10	75
Soil temp at 2 inches (F)	58	40
Gallons per Acre (gpa)	16	16

Evaluations were conducted on 17 July 2012. Yellow starthistle control (%) was evaluated in comparison to the untreated check at the whole plot level. Plant community response was evaluated by estimating cover (%) of plant species in three permanently marked 1 m^2 quadrats along transects at the center of each plot.

High levels of yellow starthistle control (>95%) were observed across treatments at both application timings (Table 2). Observations do suggest that higher rates of aminopyralid + clopyralid provide greater yellow starthistle control. Herbicide treatments resulted in increased annual grass and annual forb cover across treatments and timings. Annual grasses that increased within plots included downy brome (*Bromus tectorum* L.), field brome (*Bromus arvensis* L.) and ventenata (*Ventenata dubia* (Leers) Coss.). Annual forbs that increased within plots included wild mustard (*Sinapis arvensis* L.), prickly lettuce (*Lactuca serriola* L.) and bur chervil (*Anthriscus caucalis* M. Bieb). No differences were detected in Idaho fescue (*Festuca idahoensis* Elmer) and native forb cover across treatments (Table 3).

Table 2. Yellow starthistle control and plant community composition on 17 July 2012, approximately 5 months after treatment (MAT) for applications timed to winter rosettes and 14 MAT for applications timed to spring rosette stage.

Treatment[1]	Rate	Timing	CENSO[2]	CENSO	Annual grass[3]	Annual forb[4]
			% control	------------------	% cover	-----------------
Aminopyralid + clopyralid	0.50 + 2.30	winter	95	20	32	19
Aminopyralid + clopyralid	0.75 + 3.45	winter	99	1	42	38
Aminopyralid	1.00	winter	100	0	37	40
Picloram	4.00	winter	100	0	39	14
Untreated check	--	winter	0	64	6	4
Tukey's Studentized Range (.05)			7	24	27	32
Aminopyralid + clopyralid	0.50 + 2.30	spring	96	4	45	18
Aminopyralid + clopyralid	0.75 + 3.45	spring	99	1	53	34
Aminopyralid	1.00	spring	99	1	45	24
Picloram	4.00	spring	100	6	62	10
Untreated check	--	spring	0	65	12	8
Tukey's Studentized Range (.05)			5	19	34	22

[1] 90% non-ionic surfactant (R-11) at 0.25% v/v was applied with all treatments
[2] CENSO = yellow starthistle (*Centauea solstitialis*)
[3]Annual grass includes: downy brome (*Bromus tectorum* L.), field brome (*Bromus arvensis* L.) and ventenata (*Ventenata dubia* (Leers) Coss.).
[4]Annual forbs include wild mustard (*Sinapis arvensis* L.), prickly lettuce (*Lactuca serriola* L.) and bur chervil (*Anthriscus caucalis* M. Bieb).

Table 3. Plant community composition on 17 July 2012, approximately 5 months after treatment (MAT) for applications timed to winter rosettes and 14 MAT for applications timed to spring rosette stage.

Treatment[1]	Rate	Timing	FESID[2]	BALSA[3]	LUPSE[4]
	oz ae/ac		--------------------	% cover	---------------------
Aminopyralid + clopyralid	0.50 + 2.30	winter	20	5	2
Aminopyralid + clopyralid	0.75 + 3.45	winter	15	6	0
Aminopyralid	1.00	winter	15	7	1
Picloram	4.00	winter	24	15	1
Untreated check	--	winter	10	8	2
Tukey's Studentized Range (.05)			25	13	4
Aminopyralid + clopyralid	0.50 + 2.30	spring	25	3	1
Aminopyralid + clopyralid	0.75 + 3.45	spring	17	2	2
Aminopyralid	1.00	spring	29	6	1
Picloram	4.00	spring	22	4	3
Untreated check	--	spring	8	8	1
Tukey's Studentized Range (.05)			28	10	4

[1] 90% non-ionic surfactant (R-11) at 0.25% v/v was applied with all treatments
[2]FESID = Idaho fescue (*Festuca idahoensis*)
[3]BALSA = arrowleaf balsamroot (*Balsamorhiza sagittata*)
[4]LUPSE = silky lupine (*Lupinus sericeus*)

Canada thistle 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 Deary, ID in Conservation Reserve Program (CRP) land to evaluate Canada thistle (*Cirsium arvense* L.; CIRAR) 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	May 23, 2011
Weed growth stage	spring rosette
Air temp (F)	77
Relative humidity (%)	26
Wind (mph, direction)	2 to 4, SW
Cloud cover (%)	60
Soil temp at 2 inches (F)	60
Soil type	loam
Delivery rate (gpa)	15.7

Canada thistle control was visually evaluated in comparison to the untreated check in July of 2012, approximately 13 months after treatment (MAT). All herbicide treatments resulted in greater than 95% Canada thistle control. No perennial grass injury was observed across treatments, which was visually evaluated as a reduction in stand yields in comparison to the untreated check. Perennial grasses included timothy (*Phleum pretense* L.), smooth brome (*Bromus inermis* Leyss.) and quackgrass (*Elymus repens* L.)

Table 2. Canada thistle control 13 months after treatment (MAT).

		Canada thistle	
Treatment [1]	Rate	Density	Control
	oz ai /A	--- plt/m^2 ---	--- % ---
Aminocyclopyrachlor + chlorsulfuron	1.00 + 0.40	0	100
Aminocyclopyrachlor + chlorsulfuron	1.78 + 0.70	1	97
Aminocyclopyrachlor + 2,4-D DMA	1.00 + 7.60	1	97
Aminocyclopyrachlor + 2,4-D DMA	2.00 + 15.2	0	100
Aminopyralid	2.00	0	100
Untreated check	--	8	0
Tukey's HSD		7	9

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

Aminopyralid applied alone or in combination with clopyralid for Canada thistle 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 ai/A for Canada thistle control in North Dakota. Prior to the release of aminopyralid, clopyralid was commonly used to control Canada thistle, especially in cropland. The purpose of this research was to evaluate aminopyralid applied alone or at reduced rates with clopyralid for long-term Canada thistle control.

The study was established along a drainage ditch that had become heavily infested with Canada thistle on the North Dakota State University Agricultural Experiment Station in Fargo. The treatments were applied June 30 or September 24, 2009. 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.

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 with replications established length wise along the ditch. Canada thistle control was evaluated visually using percent stand reduction compared to the untreated control.

Canada thistle control was similar with all treatments except clopyralid alone when applied in June or September of the previous year (Table). For instance, aminopyralid at 1.25 to 1.75 oz/A alone provided an average of 97% Canada thistle control when applied in June or September, 12 to 15 MAT (months after treatment) (August 2010). In general, aminopyralid applied at 0.5 to 1 oz/A with clopyralid provided similar Canada thistle control to aminopyralid applied alone at higher rates regardless of application timing. Clopyralid alone did not provide satisfactory Canada thistle control.

All treatments that contained 1 oz/A or more of aminopyralid applied alone or with clopyralid provided approximately 90% Canada thistle control the second season after application except aminopyralid at 1.25 oz /A applied in June, which declined to 43% (Table). Canada thistle control improved to 91% when aminopyralid at 1.25 oz/A was applied with clopyralid at 5.7 oz/A in June 2009. However, this treatment would be priced at $56/A and would not be cost-effective compared to aminopyralid alone at 1.75 oz/A at $19/A.

In summary, the combination of aminopyralid plus clopyralid at reduced rates generally provided similar Canada thistle control to aminopyralid alone at 1.75 oz/A the maximum labeled use rate. Aminopyralid at 1.25 oz/A applied in the fall provided the most cost-effective long-term Canada thistle control (89%) for $14/A.

Table. Aminopyralid plus clopyralid for Canada thistle control applied on June 30 or September 24, 2009 at Fargo, ND.

		Evaluation date				
		2009	2010		2011	
Treatment[a]	Rate	28 Aug	14 June[b]	20 Aug	29 June	Cost[c]
	— oz/A —		% control			$/A
June application						
Aminopyralid[d]	1.25	99	99	92	43	14
Aminopyralid	1.75	99	100	99	92	19
Clopyralid[e]	6	88	96	92	75	44
Aminopyralid + clopyralid	0.5 + 2.3	92	93	86	62	17
Aminopyralid + clopyralid	0.75 + 3.45	99	99	98	76	25
Aminopyralid + clopyralid	1 + 4.6	98	100	99	93	44
Aminopyralid + clopyralid	1.25 + 5.7	98	100	99	91	56
September application						
Aminopyralid	1.25		98	98	89	14
Aminopyralid	1.75		100	98	99	19
Clopyralid	6		64	47	40	44
Aminopyralid + clopyralid	0.5 + 2.3		88	71	61	17
Aminopyralid + clopyralid	0.75 + 3.45		98	91	77	25
Aminopyralid + clopyralid	1 + 4.6		100	94	91	44
Aminopyralid + clopyralid	1.25 + 5.7		98	98	86	56
Untreated		0	0	0	0	
LSD (0.05)		4	9	17	29	

[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]Only two replications could be evaluated in June 2010 because the other two had been mowed.
[c]Based on Milestone and Transline at $350/gal each and does not include surfactant or application costs.
[d]Commercial formulation - Milestone and [e]Transline, from Dow AgroSciences LLC, 9330 Zionsville Road, Indianapolis, IN 46268-1189.

Yellow toadflax control with combinations of aminocyclopyrachlor and sulfonylureas at two application timings. John Wallace and Tim Prather. (Crop & Weed Science Division, University of Idaho, Moscow, ID 83844-2339). An experiment was established at Farragut State Park in northern Idaho to evaluate yellow toadflax (*Linaria vulgaris* Mill.; LINVU) control using aminocyclopyrachlor in combination with chlorsulfuron or metsulfuron. Treatments were applied as a spring or fall application, and were randomly assigned and replicated four times. Plot size was 10 by 30 feet. All treatments were applied with a CO_2-pressurized (38 psi) backpack sprayer (Table 1). Toadflax plants were approximately 1 to 2 inches tall at the spring application timing. Fall applications were timed to fall precipitation and frosts.

Table 1. Application data.

Application date	June 15, 2010	November 3, 2010
Weed growth stage	1 to 2 inches	dormant
Air temp (F)	68	55
Relative humidity (%)	36	48
Wind (mph, direction)	3 to 9, W	1 to 3, SW
Cloud cover (%)	15	0
Soil temp at 2 inches (F)	69	46
Soil type	sandy loam	sandy loam
Delivery rate (gpa)	16.1	16.9

Yellow toadflax density was measured in two 1-m quadrats per plot prior to applications. Toadflax density was variable within the study plots. Plots with low density toadflax were identified as control treatments and toadflax patches outside the study plots were visually inspected for treatment comparisons. Yellow toadflax foliar cover (%) and density (plts/m^2) were quantified on August 16, 2012, two growing seasons after treatment. Application timing had a significant effect on yellow toadflax cover and density. Fall treatments resulted in greater cover (14%) and density (33 plts/m^2) in comparison to spring treatments (1%, 1 plt/m^2). Within application timing, no differences between herbicide treatments were detected in analysis of yellow toadflax cover and density.

Table 2. Yellow toadflax (LINVU) cover and density two growing seasons after treatment.

			Yellow toadflax		
			Pre-treatment	August 6, 2012	
Treatment [1]	Rate	Application timing	cover	Cover	Density
	oz ai /A		-- % --	-- % --	-- plt/m^2--
Aminocyclopyrachlor + chlorsulfuron	0.94 + 0.38	spring	30	1	1
Aminocyclopyrachlor + chlorsulfuron	2.5 + 1.0	spring	4	0	0
Aminocyclopyrachlor + metsulfuron	2.5 + 0.8	spring	18	0	0
Chlorsulfuron	1.0	spring	14	1	1
Aminocyclopyrachlor + chlorsulfuron	0.94 + 0.38	fall	22	18	38
Aminocyclopyrachlor + chlorsulfuron	2.5 + 1.0	fall	23	5	13
Aminocyclopyrachlor + metsulfuron	2.5 + 0.8	fall	30	27	59
Chlorsulfuron	1.0	fall	20	8	21
Tukey's HSD			40	22	47

[1] 90% non-ionic surfactant (R-11) at 0.50% v/v was applied with all treatments

Seed predation and caching behavior by ground beetles; consequences for wild-proso millet (*Panicum miliaceum* L).
Jessica M. Green, R. Edward Peachey, and Alysia C. Greco (Dept. of Horticulture, Oregon State University, Corvallis, OR 97331).

Post-dispersal weed seed predation by ground beetles (Coleoptera: Carabidae) and other invertebrates may reduce seed banks and possibly weed recruitment in annual cropping systems. However, studies that evaluate removal of weed seeds from experimental feeding platters rarely correlate seedloss to weed recruitment. *Pterostichus melanarius* is a common carabid beetle in the PNW. It is a generalist feeder that scavenges for weed seeds on the soil surface and also preys on agricultural pests such as slugs. This study examined seed removal and subsequent emergence of wild-proso millet when exposed to *P.melanarius* in a confined environment.

Metal bins ($1m^2$) were planted to snap beans (year one) or spinach (year two) and randomly assigned a level of 0, 10, or 20 *P.melanarius* beetles. Wire mesh screening (1mm opening) was installed under each bin and netting was placed over the bins to minimize interference by earthworms and birds. Seed platters containing 50 wild proso millet seeds were placed at the center of each bin. Removal from seed platters was assessed from late August through September each year and platters were reset to 50 seeds at each sampling period. Bins were left undisturbed throughout the winter and recruitment of wild-proso millet was evaluated the following spring. The experiment was conducted over two years within the same metal bins.

Seed removal over two years averaged 3, 28, and 41% in bins with 0, 10, and 20 beetles, respectively. When corrected for density, "per beetle seedloss" was greatest in bins with 10 beetles (Fig.1). The greater average loss from bins with 10 beetles may suggest that *P. melanarius* has a finite density, and it has been noted that these beetles become cannibalistic under crowded conditions. In both years, recruitment of wild-proso millet was greatest in bins that had 20 *P. melanarius* beetles. This suggests that while removal increases with increased beetle density, so does recruitment the following year. Most seedlings emerged from a visible clump of seeds, indicating intentional seed caching. It is unknown why *P. melanarius* would exhibit seed caching behavior, but one hypothesis is that the beetles are caching seeds to provide an overwintering food source for developing larvae.

Table. Removal and subsequent emergence of wild-proso millet seeds when exposed to varying densities of *Pterostichus melanarius* carabid beetles. Seedloss and recruitment were evaluated within the same confined area over two years (2010 to 2011 and 2011 to 2012). Per year, mean values within a column followed by the same letter do not differ (α=0.1).

Year	Treatment	n	Seedloss[1]	Recruitment[2]
			%	*no. seeds/m²*
Year one	0 beetles	6	4 b	0.5 b
	10 beetles	6	22 a	2.3 ab
	20 beetles	6	35 a	5.5 a
Year two	0 beetles	6	3 b	1.3 b
	10 beetles	6	34 a	22 a
	20 beetles	6	47 a	23 a

[1] Percent removal of wild-proso millet, averaged across the season (Aug to Sept 2011 and Sept to Oct 2012).
[2] Values listed for recruitment of year 2 is an interim measurement, final values TBD in June 2013.

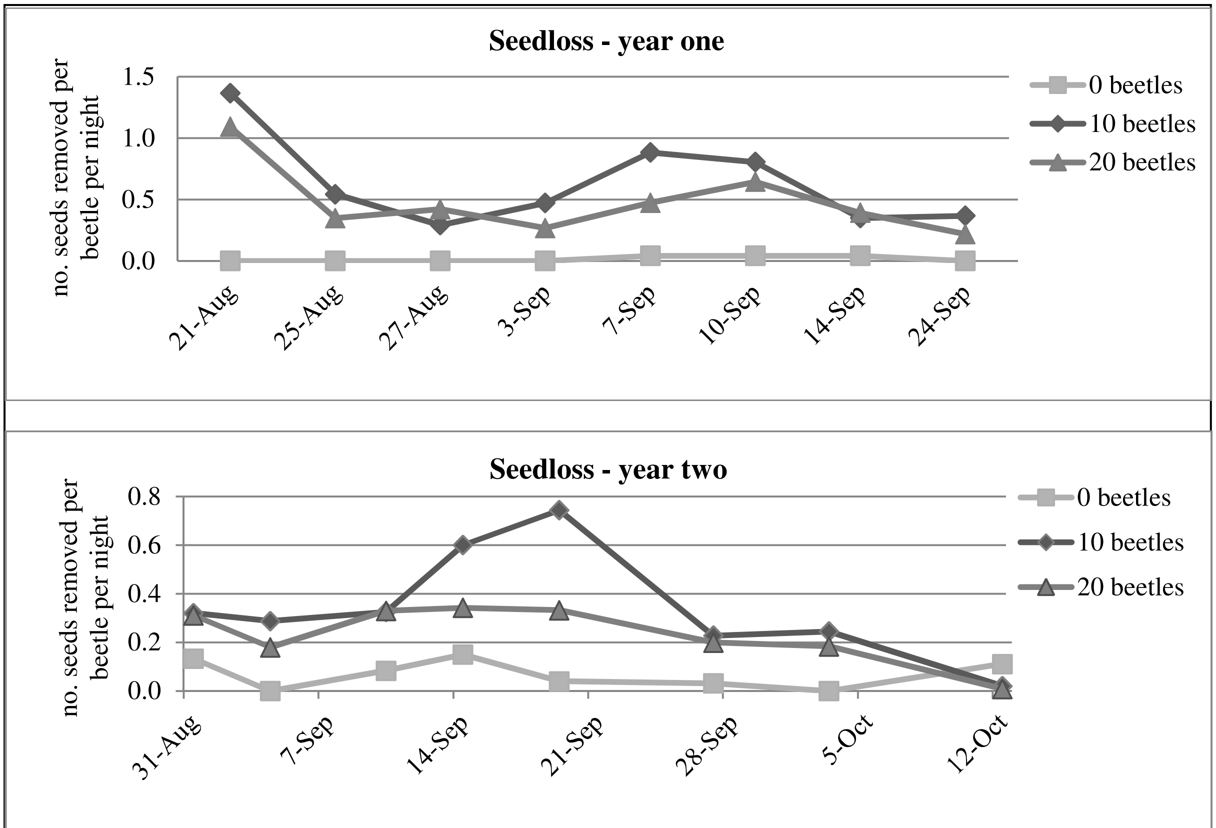

Figure. Removal of wild-proso millet over time in each treatment. *P. melanarius* can be cannibalistic under high densities, which may account for greater seed removal rates in bins with 10 beetles/m^2 versus bins with 20 beetles/m^2.

Efficacy and crop safety of herbicides on garden beet, spinach and chard. Ed Peachey (Dept. of Horticulture, Oregon State University, Corvallis, OR 97331).

The deregulation of glyphosate-resistant sugar beets is threatening to undo weed control programs in table beets. Because growers will be able to apply glyphosate selectively in sugar beets, the need for herbicides other than glyphosate will likely diminish. The objective of this study was to evaluate alternatives to currently herbicides labeled in garden beet, spinach, and chard for the control of weeds.

The experiment was located on an experimental farm near Corvallis, OR on a silt loam soil (pH 6.0, OM 4.77%, CEC 29.7 meq/100g soil). Table beets, Swiss chard, and spinach (a female line) were planted three rows per plot with 26 inches between rows and in plots 25 ft long. There were four replications of each herbicide treatment in each crop, and crops were planted in a strip-plot arrangement with herbicide treatment subplots randomized within large crop plots. Herbicides were applied with a CO_2 powered back-pack sprayer with four nozzles on an 18 inch spacing. One of the untreated check plots was hand hoed. Spinach and chard were harvested from 10 ft of row and biomass weighed on June 27. Table beets were pulled from 10 ft of the middle row in each plot and weighed and graded on August 8.

S-metolachlor caused the least injury to the beets with reasonable but insufficient weed control by seasons end, even though the plots were cultivated (Table 1). Amicarbazone at the low rate improved hairy nightshade control slightly but also injured beets more than *s*-metolachlor. Yield was not improved by the combination of amicarbazone plus *s*-metolachlor. Clomazone caused severe whitening early in the season but also provided weed control that brought yields up to the level of the weeded check plots. Pendimethalin caused excessive injury even when applied at the 2-leaf stage. Pyroxasulfone (1x) improved weed control compared to *s*-metolachlor (1x) but caused more injury to beets than *s*-metolachlor. The combination of *s*-metolachlor (0.48 lb ai/A) plus ethofumesate (0.5 lb ai/A) gave the best yield, even though weed control was poor. Increasing the rate of *s*-metolachlor to (0.63 lb ai/A) in combination with ethofumesate improved weed control but not yield. Triflusulfuron (Upbeet) EPOST following *s*-metolachlor had the greatest beet yield, and weed control averaged 90% at harvest. Swiss chard also was tolerant of triflusulfuron (Table 2).

Table 1. Table beet response to herbicides.

	Herbicide	Timing	Date	Rate	Crop stand Jun 4	Crop injury Jun 4	Jun 11	Jun 26	Ju13	Beet harvest Roots/ plot	Yield	Grade	Avg. beet wt
						Phyto		*Stunting*					
				lbs ai/A	*no/3 ft*	*0-10*		------ %------			*t/A*	*%1-2*	*g*
1	**Unweeded**	-	-	-	10	0	15	0	11	18	4.8	35	199
2	S-metolachlor	PPS	19-May	0.63	21	0	0	0	4	55	15.2	15	412
3	S-metolachlor	PPS	19-May	1.26	25	0	10	10	14	53	16.8	12	360
4	Amicarbazone	PPS	19-May	0.056	16	0	18	23	19	28	5.8	34	195
5	Amicarbazone	PPS	19-May	0.111	9	0	43	45	49	20	8.9	5	541
6	Amicarbazone	PPS	19-May	0.223	5	0	75	73	84	7	5.0	4	666
7	Clomazone	PPS	19-May	0.5	16	2	53	18	40	25	16.1	4	978
8	Clomazone	PPS	19-May	1.0	17	2	63	53	41	29	14.3	6	505
9	Pendimethalin	PPS	19-May	1.0	13	0	63	99	99	0	0.4	0	378
10	Pendimethalin	PPS	19-May	2.0	11	0	80	100	100	0	0.0	0	0
11	Pyroxasulfone	PPS	19-May	0.015	18	0	23	18	24	33	10.9	7	551
12	Pyroxasulfone	PPS	19-May	0.031	19	0	20	15	8	35	15.7	6	582
13	S-metolachlor +	PPS	19-May	0.63	15	0	8	15	9	48	16.1	10	403
	S-metolachlor	EPOST	8-Jun	0.63									
14	Amicarbazone +	PPS	19-May	0.056	13	0	18	23	23	31	14.5	5	484
	S-metolachlor	PPS	19-May	0.63									
15	Clomazone +	PPS	19-May	0.25	19	1	55	35	34	31	12.6	8	516
	S-metolachlor	PPS	19-May	0.63									
16	Pendimethalin	Delayed PRE	25-May	1.0	13	0	70	100	100	0	0.0	0	0
17	Pendimethalin +	PPS	19-May	0.5	17	0	65	100	100	0	0.0	0	0
	Pendimethalin	Delayed PRE	25-May	0.5									
18	Triflusulfuron	EPOST	9-Jun	0.031	20	0	10	10	8	35	9.1	11	260
19	S-metolachlor	PPS	19-May	0.63	17	0	20	23	21	33	16.7	5	824
	Triflusulfuron	EPOST	9-Jun	0.031									
20	Pyroxasulfone+	PPS	19-May	0.015	18	0	18	33	25	30	10.2	8	734
	Triflusulfuron	EPOST	9-Jun	0.031									
21	Pyroxasulfone +	PPS	19-May	0.015	16	0	25	15	35	29	14.9	4	905
	Ethofumesate	PPS	19-May	0.5									
22	S-metolachlor +	PPS	19-May	0.48	12	0	23	23	25	25	16.8	3	1053
	Ethofumesate	PPS	19-May	0.5									
23	S-metolachlor +	PPS	19-May	0.64	12	0	30	5	38	35	14.8	7	965
	Ethofumesate	PPS	19-May	0.5									
24	S-metolachlor +	PPS	19-May	0.64	10	0	50	50	50	19	14.0	4	809
	Ethofumesate	PPS	19-May	1									
25	S-metolachlor +	PPS	19-May	0.4775	12	0	55	90	95	2	0.7	13	115
	Pendimethalin	Delay-PRE	25-May	0.5									
26	Weeded				19	0	18	13	28	34	12.9	6	520
	FPLSD (0.05)				*12*	*0.7*	*25*	*21*	*24*	*21*	*4.9*	*17*	*589*

Table 2. Swiss chard and spinach tolerance to select herbicide treatments. See Table 1 for treatment key.

	Swiss chard						Spinach					
Treatment	Emergence (June 4)	Phytotoxicity (June 4)	Stunting (June 11)	Plants harvested	Biomass	Weed control at harvest	Emergence (June 4)	Phytotoxicity (June 4)	Stunting (June 11)	Plants harvested	Biomass	Weed control at harvest
	no/3 ft	*0-10*	*%*	*no/10 ft*	*t/A*	*%*	*no/3 ft*	*0-10*	*%*	*no/10 ft*	*t/A*	*%*
1	37	0	0	74	11.8	0	16	0	0	38	5.3	0
2	33	0	13	74	20.6	83	17	0	8	35	11.7	73
4	38	0	18	70	15.1	40	17	0	5	32	10.2	18
7	32	2.8	80	31	14.6	90	16	3.0	15	31	11.5	96
9	31	0	48	0	0.0	86	18	0	63	0	0.0	81
11	39	0	8	85	17.0	83	19	0	10	33	9.0	60
14	35	0	18	61	21.2	92	16	0	13	33	10.7	90
15	28	1.3	78	44	17.4	95	18	1.0	23	35	9.8	97
16	41	0	55	0	0.0	89	18	0.3	65	0	0.0	79
18	40	0	5	70	16.0	60	18	0	20	5	0.7	23
19	31	0	23	70	20.0	93	19	0	30	14	9.6	81
20	30	0	20	48	17.0	91	20	0	18	11	4.6	63
22	37	0	13	74	18.7	91	18	0	15	37	9.9	85
FPLSD (0.05)	*ns*	*0.3*	*13*	*25*	*5.7*	*14*	*ns*	*0.4*	*11*	*11*	*6.7*	*13*

Developing new techniques to improve efficacy and detection of *Tyta luctuosa*, a biological control agent for field bindweed (*Convolvulus arvensis* L.). Jessica M. Green and R. Edward Peachey (Dept. of Horticulture, Oregon State University, Corvallis, OR 97331).

This project focused on the introduction and recovery of a biological control agent (BCA) throughout the Willamette Valley, OR. *Tyta luctuosa*, a host-specific noctuid moth, defoliates field bindweed and larvae have been released as a BCA in Western states for many years. However, inability to recover adult moths following release has limited widespread adoption of this integrated weed management tactic. Field releases of *T. luctuosa* (approx. 200 larvae per site) were made onto growing field bindweed from June through August, 2011. Signs of herbivory were evident at each release site for up to six weeks.

Sweep net sampling and light trapping for adult moths in 2011 were largely unsuccessful; mid-season light traps averaged less than 0.1% recapture. However, moths overwinter in the soil as pupae and emerge the following summer. Therefore, the majority of our sampling efforts were performed from June through September, 2012. Pheromone traps were baited with blends of a previously identified sex-attractant used alone or in combination with other semiochemicals. Lures were placed in paperboard wing traps and hung 1.5m above the soil surface. There were four traps at each site and location was randomized within sites each time traps were checked. Additionally, traps were placed in three locations (north, middle, south Willamette Valley) that did not have larvae released the year prior and were intended to serve as a baseline control.

Adult moths were detected at each of four locations where larvae had been released the year prior (see table). Although total trap catch numbers were low in proportion to the number of larvae released, these preliminary data suggest that *T. luctuosa* can be sampled using pheromone traps and that releases made by our research team were successful. Detection of moths at control sites may indicate that the moth is established in the Willamette Valley, or that adults are able to disperse more than five miles from release sites. We are currently evaluating dispersal capacity of *T. luctuosa* and how semiochemicals can be utilized to better predict and enhance the success of biological weed control efforts.

Table. Number of recovered moths from pheromone traps (Jun to Sept 2012) at release sites of larval *Tyta luctuosa* (2011). Traps either contained a known ratio of semiochemicals (baited) or a blank rubber septa (unbaited). For each location, mean values within a row followed by the same letter do not differ (α=0.1).

Trap location	Site	Trap type		Crop[1]
		Baited	Unbaited	
		----------- *no. adult moths* -------------		
Prior release site	Dayton	5 a	0 b	Blackberries
	Jefferson	12 a	0 b	Blueberries
	Junction City	7 a	0 b	Organic vegetables
	Philomath	15 a	0 b	Home landscape
Control	North	8 a	0 b	Raspberries
	Middle	6 a	0 b	Wildlife refuge
	South	1 a	0 a	Hazelnuts
Total		54	0	

[1] Cropping system or land use when larvae were released (prior release sites) or when traps were placed (controls).

Timing of application of amicarbazone for *Poa annua* control in overseeded turf. Kai Umeda. (University of Arizona Cooperative Extension, Maricopa County, Phoenix, AZ 85040) A small plot experiment was conducted at the Whirlwind Golf Club in Chandler, AZ on a fairway with bermudagrass cv. Tifway 419 that was overseeded with perennial ryegrass on 19 – 23 September 2011. Amicarbazone at 0.13 or 0.18 lb a.i./A was applied at 4 different timings after overseeding and then followed with a sequential application at 2 weeks after the initial application. All treatments were applied with a backpack CO_2 sprayer equipped with a hand-held boom with three 8003LP flat fan nozzles spaced 20 inches apart. Sprays were applied in 46 gpa water pressurized to 30 psi. A non-ionic surfactant (NIS) Latron CS-7 at 0.25% v/v was added to treatments only on the first date of application on 18 November 2011. Amicarbazone application dates and conditions were: 18 November 2011 had 58°F, clear, no wind, 55°F @ 4", dew, just mowed; 02 December had 43°F, high fog - clearing, no wind, 48°F @ 4", dew; 16 December had 56°F, clear, calm, 48°F @ 4", dew, just mowed; 29 December had 43°F, clear, no wind, 42°F @ 4", dew, frost; 14 January 2012 had 46°F, clear, no wind, 42°F @ 4"; and 28 January had 50°F, clear, 1.5 mph wind SW, 44°F @ 4". On 12 April, none of the amicarbazone treatments adequately controlled *P. annua*.

Table. Amicarbazone for *Poa annua* control in overseeded turf, Whirlwind GC, Chandler, AZ, 2011-12

Amicarbazone Treatment Rate	Timing	POANN control 08 March	POANN control 12 April
		---------------- %	-----------------------
Untreated check		0	0
0.13 lb a.i./A	18 Nov + 02 Dec	77	60
0.18 lb a.i./A	18 Nov + 02 Dec	80	60
0.13 lb a.i./A	02 Dec + 16 Dec	23	43
0.18 lb a.i./A	02 Dec + 16 Dec	33	47
0.13 lb a.i./A	16 Dec + 29 Dec	33	40
0.18 lb a.i./A	16 Dec + 29 Dec	70	58
0.13 lb a.i./A	14 Jan + 28 Jan	63	43
0.18 lb a.i./A	14 Jan + 28 Jan	77	62
LSD (p=0.05)		32.8	23.3

Flumioxazin timing of application and combination treatment comparison study. Kai Umeda. (University of Arizona Cooperative Extension, Maricopa County, Phoenix, AZ 85040.) A small plot field experiment was conducted at the Karsten Golf Course in Tempe, AZ in a rough area with dormant common bermudagrass infested with annual bluegrass (*Poa annua*). Treatment plots measured 5 ft by 14 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 8002LP flat fan nozzles spaced 20 inches apart. The sprays were applied in 55 gpa water delivered under 30 psi pressure. Environmental conditions at applications were: 11 October 2011 had 86°F, clear, wind at 3 mph NW, soil 70°F at 4 inch depth; 08 November 2 had 54°F, clear, wind at 5 mph NE, soil 54°F at 4 inch depth; 06 December had 43°F, clear, wind at 3 mph NE, soil 46°F at 4 inch depth; and 03 January 2012 had 60°F, clear, wind at 5 mph E, soil 46°F at 4 inch depth.

Flumioxazin alone at 0.32 lb a.i./A applied in October and November gave 77 and 80% control of *P. annua*, respectively, at the end of the winter season in April. The addition of metsulfuron-methyl at 0.011 lb a.i./A to flumioxazin improved *P. annua* control compared to flumioxazin applied alone. The combination treatment also controlled *P. annua* with the December application where flumioxazin alone was not effective. Flumioxazin treatments in January were not effective against *P. annua*. Simazine controlled *P. annua* at all timings of application. Barricade applied only in October was comparable to flumioxazin treatments. No turf injury was observed when treatments were applied prior to bermudagrass dormancy in late November and in the spring during transition.

Table. Flumioxazin combinations and timing for *P. annua* control, Tempe, AZ

Treatment	Rate (lb a.i./A)	Timing of application	POANN Control 13 Feb	14 Apr
			------- % --------	
Untreated check			0	0
Flumioxazin	0.32	October	80	77
Flumioxazin + Metsulfuron-methyl	0.32 + 0.011	October	86	88
Simazine	1.0	October	91	93
Prodiamine	1.0	October	86	83
Flumioxazin	0.32	November	88	80
Flumioxazin + Metsulfuron-methyl	0.32 + 0.011	November	90	82
Simazine	1.0	November	99	86
Flumioxazin	0.32	December	73	53
Flumioxazin + Metsulfuron-methyl	0.32 + 0.011	December	85	82
Simazine	1.0	December	99	98
Flumioxazin	0.32	January	43	33
Flumioxazin + Metsulfuron-methyl	0.32 + 0.011	January	33	33
Simazine	1.0	January	17	99
LSD (p=0.05)			29.7	32.5

Applications on 11 October 2011, 08 November, 06 December, and 03 January 2012. Ratings collected in 2012.

Indaziflam timing of application comparison study. Kai Umeda. (University of Arizona Cooperative Extension, Maricopa County, Phoenix, AZ 85040.) A small plot field experiment was conducted at the Karsten Golf Course in Tempe, AZ in a rough area with dormant common bermudagrass infested with annual bluegrass (*Poa annua*). 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 8002LP flat fan nozzles spaced 20 inches apart. The sprays were applied in 55 gpa water delivered under 30 psi pressure. At the time of applications, the environmental conditions were: 11 October 2011 - 86°F, clear, wind at 3 mph NW, soil 70°F at 4 inch depth; 08 November 2011 - 54°F, clear, wind at 5 mph NE, soil 54°F at 4 inch depth.

Indaziflam treatments at all rates were all effective for controlling *P. annua*. The October timing of application showed indaziflam at 0.014 lb a.i./A to be as effective as 0.028 or 0.042 lb a.i./A. For all indaziflam treatments in comparison to the untreated check, there was no observable difference in overall quality of common bermudagrass as it started to green up.

Table. Timing of indaziflam application for *P. annua* control in dormant bermudagrass turf, Karsten GC, AZ, 2011-12

Treatment	Rate (lb a.i./A)	Application Timing	POANN Control					Turf Quality
			11 Nov	03 Jan	13 Feb	09 Mar	17 Apr	17 Apr
			------------------------ % ----------------------------					
Untreated check			0	0	0	0	0	5
Indaziflam	0.014	October	92	94	90	90	91	5
Indaziflam	0.028	October	93	94	94	92	93	5
Indaziflam	0.042	October	95	93	96	96	93	5
Prodiamine	1.5	October	92	87	90	90	92	5
Indaziflam	0.014	November	90	80	75	78	82	5
Indaziflam	0.028	November	93	88	86	85	90	5
Indaziflam	0.042	November	95	92	92	88	95	5
Prodiamine	1.5	November	30	0	0	0	0	5
LSD (p=0.05			31	7.2	10.7	12	4.8	0.03

Applications made on 11 October and 08 November 2011
POANN = *P. annua* ratings conducted during 2011-12
Turf quality rating on a 1-9 scale where 1 = poor, 9 = best

Evaluation and comparison of postemergence herbicide applications for goosegrass control in rough turf. Kai Umeda, Joe DeFrank, and Orville Baldos. (University of Arizona Cooperative Extension, Phoenix, AZ and University of Hawaii, Tropical Plant and Soil Sciences, Honolulu, HI). A small plot field experiment was conducted at the City of Honolulu Waipio Soccer Complex. Common bermudagrass turfgrass infested with goosegrass (*Eleusine indica*) and lovegrass (*Eragrostis pectinacea*) was mowed twice weekly at a height of 1.5 inches and sprinkler irrigated daily. Experimental plots measured 6 ft by 10 ft and replicated 4 times in a randomized complete block design. The treated area was 5 ft wide with a 1 ft buffer between adjacent plots. A CO_2 backpack sprayer was equipped with a hand-held boom with 3 flat fan 8004 nozzles spaced 20 inches apart. The sprays were applied in 46 gpa water delivered at 20 psi. The initial sprays were applied on 13 August 2012. A sequential application scheduled for 2 weeks after the first application for one treatment was actually made on 06 September at 23 days after the first application. The sequential application of sprays made when adequate regrowth occurred was sprayed on 13 September at 31 days after the first application. Goosegrass control was effective for 2 to 3 weeks following applications of thiencarbazone plus foramsulfuron plus halosulfuron. The addition of MSO or sulfentrazone improved efficacy of the pre-mix product compared to the addition of NIS.

Table. Evaluation and comparison of postemergence herbicides for grass weed control in turf, Waipio, HI, 2012

Treatment	Rate (lb a.i/A) & Application Timing	Weed Control								Turf Injury		
		ELEIN				ERAPE				CYNDA		
		28-Aug	6-Sep	05-Oct	18-Oct	28-Aug	6-Sep	05-Oct	18-Oct	28-Aug	6-Sep	05-Oct
		---------------- % ------------------				----------------- % ------------------				----------- % -----------		
Untreated check		0b	0b	0e	0c	0b	0	0c	0d	0b	0c	0c
Thiencarbazone + Foramsulfuron + Halosulfuron + NIS	0.121 1st	81a	53a	50d	0c	35a	0	0c	0d	0b	8ab	8ab
Thiencarbazone + Foramsulfuron + Halosulfuron + NIS	0.121 + 0.121 1st+2wks	81a	53a	80c	41b	10b	0	5c	11c	5a	9a	10ab
Thiencarbazone + Foramsulfuron + Halosulfuron + NIS	0.121 + 0.121 1st+regrow	80a	54a	83bc	68a	13b	0	19bc	30b	8a	8ab	10ab
Thiencarbazone + Foramsulfuron + Halosulfuron + MSO	0.121 + 0.121 1st+regrow	81a	61a	93a	75a	5b	0	48a	50a	6a	3c	6ab
Thiencarbazone + Foramsulfuron + Halosulfuron + Metribuzin	0.121 + .13 + 0.121 +.13 1st+regrow	76a	58a	79c	69a	3b	0	43a	55a	6a	2c	9ab
AMS	1st+regrow	0b	0b	0e	0c	0b	0	0c	0d	0b	0c	0c
Thiencarbazone + Foramsulfuron + Halosulfuron + Sulfentrazone	0.121 +.25 + 0.121 +.25 1st+regrow	78a	53a	85b	66a	5b	0	38ab	50a	5a	4bc	12a
Foramsulfuron + Metribuzin	0.027 +.13 1st+regrow	78a	61a	78c	49b	7b	13	0c	0b	50a	2c	
				**			-	**				**

**** data subjected to arcsine transformation. Means followed by the same letters are not significantly different.
All treatments applied initially on 13 August 2012 followed by 2 weeks later on 06 September and regrowth applications on 13 September.
All treatments included ammonium sulfate (21-0-0 AMS) at 3 lb/A of N. Induce added at 0.25% v/v and MSO Concentrate added at 0.5% v/v.

Postemergence herbicides for sedge control in turf. K. Umeda and J. DeFrank. (University of Arizona Cooperative Extension, Phoenix, AZ and University of Hawaii, Tropical Plant and Soil Sciences, Honolulu, HI) A small plot field experiment was conducted at the City of Honolulu Waipio Soccer Complex. Common bermudagrass turfgrass infested with green kyllinga (*Kyllinga brevifolia*), with occasional purple nutsedge (*Cyperus rotundus*), goosegrass (*Eleusine indica*) and lovegrass (*Eragrostis pectinacea*) was mowed twice weekly at a height of 1.5 inches and sprinkler irrigated daily. Experimental plots measured 6 ft by 10 ft and replicated 4 times in a randomized complete block design. The treated area was 5 ft wide with a 1 ft buffer between adjacent plots. A CO_2 backpack sprayer was equipped with a hand-held boom with 3 flat fan 8004 nozzles spaced 20 inches apart. The sprays were applied in 46 gpa water delivered at 20 psi. The initial sprays were applied on 14 September 2012 then followed again on 08 November. At 6 weeks after a sequential application of herbicides, the pre-mix products, sulfentrazone plus metsulfuron-methyl and thiencarbazone plus halosulfuron plus foramsulfuron gave better than 91% control of sedges in turf.

Table. Sedge control in sports turf study, Waipahu, HI.

Treatment	Rate	Sedge Color	Sedge Control					Turf Injury
	lb a.i./A	20-Sep	5-Oct	18-Oct	26-Oct	19-Nov	21-Dec	5-Oct
		%	------------------------ % ---------------------------					%
untreated check		98	0	0	0	0	0	0
sulfentrazone + metsulfuron-methyl	0.269	73	43	33	20	78	25	0
sulfentrazone + metsulfuron-methyl	0.33	75	60	15	18	83	39	0
sulfentrazone + metsulfuron-methyl	0.413	68	83	73	71	88	98	0
thiencarbazone + iodosulfuron + dicamba	0.208	70	95	36	43	86	63	5
thiencarbazone + halosulfuron + foramsulfuron	0.121	70	96	68	58	86	91	9
sulfentrazone	0.25	65	56	46	40	79	43	0
LSD (P=0.05)		ns	ns	38.2	37.8	9.5	35	ns

Treatments applied 14 September and 08 November 2012.
Sedge predominately *Kyllinga brevifolia* (green kyllinga) with some *Cyperus rotundus* (purple nutsedge) interspersed.
Chlorosis on 20 September rated as % of maximum green color of untreated sedge.

<u>Broadleaf weed control in chickpea with linuron combinations</u>. Joan M. Campbell, Traci A. Rauch and Donald C. Thill. (Crop and Weed Science Division, University of Idaho, Moscow, ID 83844-2339) An experiment was established in chickpea to evaluate broadleaf weed control with linuron combinations near Genesee, ID. The plots were arranged in a randomized complete block design with four replications and included an untreated check. 'Sierra' chickpea was planted May 11, 2012. Herbicide treatments were applied pre-emergence using a CO_2 pressurized backpack sprayer calibrated to deliver 10 gpa at 32 psi and 3 mph on May 18. Air temperature, relative humidity, soil temperature, pH, CEC, organic matter, texture, and moisture were 48 F, 38%, 59 F, 5.5, 24.8 meq/100 g, 4.4%, silt loam, and high, respectively. Crop injury and weed control were evaluated throughout the season.

Chickpea was injured 0 to 5% and injury did not differ statistically among treatments on June 29 (Table). Injury was no longer visible from July 11 through the remainder of the growing season. Volunteer rape (BRSNN) control ranged from 77 to 97% and was not different statistically among treatments. On June 29, field pennycress (THLAR) control was lowest at 57% with linuron+metribuzin compared to all other treatments. On July 11, field pennycress control with that treatment had increased to 88%, but control was still lower than all other treatments except linuron+saflufenacil at 0.357+0.0445 lb ai/A at 80%. Common lambsquarters (CHEAL) control was also lowest with linuron+metribuzin at 48% on June 29. Common lambsquarters control was still low with that treatment on July 11 and July 29 (79 and 53%), but means were not statistically different among any treatments.

Table. Broadleaf weed control in chickpea near Genesee, Idaho.

				Weed control[1]						
		Chickpea injury		June 29			July 11			July 26
Treatment	Rate	June 29	July 11	BRSNN	CHEAL	THLAR	BRSNN	CHEAL	THLAR	CHEAL
	lb ai/A	% of untreated								
Linuron + saflufenacil	0.375 0.0445	3 a[2]	0 a	85 a	70 a	82 a	77 a	79 a	80 c	62 a
Linuron + saflufenacil	0.5 0.0445	0 a	0 a	95 a	91 a	93 a	96 a	94 a	97 a	86 a
Linuron + saflufenacil	0.375 0.0557	4 a	0 a	95 a	87 a	90 a	92 a	86 a	97 a	76 a
Linuron + saflufenacil	0.5 0.0557	5 a	0 a	95 a	85 a	96 a	95 a	89 a	97 a	80 a
Linuron + flumioxazin	0.375 0.048	1 a	0 a	97 a	92 a	95 a	95 a	91 a	99 a	86 a
Linuron + flumioxazin	0.375 0.064	4 a	0 a	93 a	85 a	94 a	95 a	88 a	99 a	74 a
Linuron + flumioxazin	0.5 0.048	4 a	0 a	88 a	82 a	87 a	86 a	91 a	99 a	75 a
Linuron + flumioxazin	0.5 0.064	4 a	0 a	90 a	90 a	93 a	93 a	94 a	99 a	87 a
Linuron + metribuzin	0.625 0.14	0 a	0 a	80 a	48 b	57 b	86 a	79 a	88 b	53 a

[1] BRSNN (volunteer rape), CHEAL (common lambsquarters), THLAR (field pennycress)

[2] Means followed by the same letter within a column are not statistically different from one another LSD (0.05).

Weed control with tank mixes of saflufenacil, dimethenamid-p, atrazine, and pyroxasulfone herbicide in irrigated glyhposate-resistant corn. Randall S. Currie and Jennifer Jester. (K-State Southwest Research-Extension Center, 4500 E Mary Street, Garden City, KS 67846) Pyroxasulfone (experimental number KIH 485) is projected to be labeled for 2012. Although its strengths are grassy weed control, pyroxasulfone tank mixes seem to provide Palmer amaranth control as well. The degree and duration of control appears to be contingent on the application rate.

As many weed species develop resistance to common herbicide modes of action, labeling new compound novel modes of action becomes even more important. Pyroxasulfone has been exhaustively researched at the Southwest Research-Extension Center in Garden City, KS, for over a decade with the experimental code name KIH 485. Pyroxasulfone is finally expected to be labeled in 2012. Saflufenacil was labeled at the beginning of the 2011 growing season. The objective of this study was to measure the effects of various tank mixes of saflufenacil and pyroxasulfone with other known herbicide standards for Palmer amaranth control.

Palmer amaranth control was evaluated in the glyphosate-resistant corn variety DKC 64-83 at the Kansas State Research Center located near Garden City, KS. Corn was planted on May 5, 2011, with pre-emergence herbicides applied within 24 hours of planting. Pre-emergent application conditions of air temperature, soil temperature, wind speed, relative humidity, and soil moisture were 62ºF, 55ºF, 5 mph, 83%, and adequate, respectively. Soil was Ulysses silt loam, and organic matter, soil pH, and cation exchange capacity (CEC) were 1.4%, 8, and 18.4. All herbicide treatments were applied with a tractor-mounted CO_2 pressurized windshield sprayer calibrated to deliver 20 gpa at 30 psi at 4.1 mph. All plots were treated with 32 ounces/a of glyphosate to remove any emerged plants from the plots. Adjuvant and ammonium sulfate (AMS) were added per manufacturer recommendations. The first post-herbicide application was made on June 13, 2011, when corn was 14 inches tall. Air temperature, soil temperature, wind speed, relative humidity, and soil moisture were 78ºF, 68ºF, 7 mph, 58%, and adequate. The second post-application herbicide application was made on June 15, 2011, with air temperature, soil temperature, wind speed, relative humidity, and soil moisture at 72ºF, 70ºF, 5 mph, 26%, and adequate. Trial was established as a randomized complete block design with four replications, and plots were 10 by 30 foot. Crop injury and percentage weed control were visually rated.

No crop injury was observed. Palmer amaranth was controlled 95% or better with 3 treatments 49 days after planting (DAP) compared with 0 to 13% in untreated checks. By 113 DAP, only 2 treatments had greater than 97% control compared with 0% control in the untreated check. Due to extraordinary drought conditions, corn yield varied widely based on when maximal drought stress occurred. Although the planting date of this trial produced the highest yields of any near this test site, the highest yields still ranged from 40 to 50 bu/a. The primary value of pyroxasulfone is as a control agent for grassy weeds; it also appears to have activity on Palmer amaranth, a small-seed broadleaf weed. Previous work has shown that this result occurs two out of three years and is dependent on herbicide rate and rainfall. This pattern of control is consistent with other grass herbicides. In this study, saflufenacil and pyroxasulfone tank mixes appear to provide Palmer amaranth control. The degree and duration of control appears to be contingent on the rate used. The price of pyroxasulfone has yet to be determined and will not be static over the next several years, but after a few years, market forces will establish its value. When the price is known, the economical rate to use the compound will be more easily determined.

Table. AMAPA control 49 and 113 days after planting (DAP).

Active ingredient	Rate	Timing	AMAPA % control 49 DAP	113 DAP
	lb ai/A			
Untreated check	0	Pre	0	0
Dimethenamid-p + saflufenacil+ atrazine	0.59+0.07+1	Pre	81.3	80
Dimethenamid-p + saflufenacil fb glyphosate + dicamba	0.59+0.07 fb 0.7+ 0.125	Pre fb Post	95	90
Dimethenamid-p + saflufenacil +pyroxasulfone	0.5+0.06+0.1	Pre	75	45
Saflufenacil + pyroxasulfone	0.06+0.1	Pre	8	88
Dimethenamid-p + saflufenacil + proxasulfone fb dicamba + glyphosate	0.5+0.06+0.1 fb 0.1+0.7	Pre fb Post	99	99
Pyroxasulfone + salflufenacil fb pyroxasulfone + dicamba + glyphosate	0.1+0.02 fb 0.05+0.1+0.7	Pre fb Post	100	97
Acetochlor + flumetsulam + clopyralid fb glyphosate	0.82+0.3+0.08 fb 0.75	Pre fb EPost	85	88
Acetochlor + flumetsulam + clopyralid + dichlormid + glyphosate	0.82+0.3+0.08+0.75	Post	88	86
LSD (0.10)			23	26

Abbreviations: AMAPA, Palmer amaranth; DAP, days after planting; fb, followed by; Pre, pre-emergence; Epost, early post-emergence 2 DAP; Post, post-emergence 39 DAP

Weed control with tank mixes of isoxaflutole, tembotrione thiencarbazone-methyl, atrazine, s-metolachlor, and mesotrione herbicide in irrigated glyhposate-resistant corn. Randall S. Currie and Jennifer Jester. (K-State Research-Extension Center, 4500 East Mary Street, Garden City, KS 67846) No pre-emergence treatment alone produced sufficient control 49 days after planting (DAP). With only one exception, all pre-emergence treatments followed by a post-emergence application provided greater than 95% control 106 DAP. All of these treatments contained more than one herbicide mode of action.

With the advent of weeds with herbicide resistance to multiple modes of herbicide activity, tank mixes have become increasingly complex. Furthermore, a single pre-emergence application of even a complex mix of modes of herbicide action is seldom sufficient for commercial levels of control. The objective of this study was to test several pre-emergence and post-emergence tank-mix combinations.

Palmer amaranth control was evaluated in the glyphosate-resistant corn variety DKC 64-83 at the Kansas State Research Center located near Garden City, KS. Corn was planted on May 15, 2011, with pre-emergence herbicides applied within 24 hours of planting. Pre-emergent application conditions of air temperature, soil temperature, wind speed, relative humidity, and soil moisture were 47ºF, 65ºF, 10 mph, 74%, and adequate, respectively. Soil was Ulysses silt loam, organic matter, soil pH, and cation exchange capacity (CEC) were 1.4%, 8, and 18.4. All herbicide treatments were applied with a tractor-mounted CO_2 pressurized windshield sprayer calibrated to deliver 20 gpa at 30 psi and 4.1 mph. All treatments included 32 ounces/a of glyphosate to remove any emerged plants from the plots. Adjuvant and ammonium sulfate (AMS) were added per manufacturer recommendations. Post-herbicide application was made on June 15, 2011, when corn was 14 inches tall. Post-application conditions of air temperature, soil temperature, wind speed, relative humidity, and soil moisture were 83ºF, 76ºF, 4 mph, 26%, and adequate, respectively. The trial was established as a randomized complete block design with four replications. Plots were 10 by 30 foot. Crop injury and percentage weed control were visually rated.

No crop injury was observed. Palmer amaranth control 49 DAPS was greater than 95% in all but 3 treatments compared with 0% in untreated checks. With the exception of 3 treatments all treatments provided greater than 93% control by 106 DAP. Although yield data was collected due to drought, yield was too poor for the data to be useful. No pre-emergence treatment alone produced sufficient control 49 DAP. With only one exception, all pre-emergence treatments followed by a post-emergence application provided greater than 95% control 106 DAP. All of these treatments contained more than one herbicide mode of action.

Table. AMAPA control 49 and 106 days after planting (DAP).

Active ingredient	Rate	Timing[1]	AMAPA % control	
			49 DAP	106 DAP
	lb ai/A			
Untreated check	0		0	0
Isoxaflutole + thiencarbazone-methyl + atrizine fb tembotrine + atrazine	0.04+0.017+1 fb 0.08+0.5	Pre fb Post	95	95
Isoxaflutole + thiencarbazone-methyl + atrizine fb glyphosate	0.04+0.017+1 fb 0.7	Pre fb Post	98	98
Isoxaflutole + atrazine fb tembotrine + atrazine	0.05+1 fb 0.08+0.5	Pre fb Post	95	99
Isoxaflutole +atrazine fb trileton/isoxazoline + glyphosate	0.05+1 fb 0.08+0.7	Pre fb Post	99	99
Isoxaflutole + atrazine fb tembotrine + thiencarbazone-methyl + glyphosate	0.05+1 fb 0.07+0.01+0.7	Pre fb Post	98	99
S-metolachlor + atrazine + metolachlor fb mesotrione + metolachor + glyphosate	0.75+0.75+0.1 fb 0.09+0.9+0.9	Pre fb Post	98	98
Dimethenamid-p + saflufenacil + atrazine fb dicamba + glyphosate	0.5+0.06+1 fb 0.08+0.7	Pre fb Post	95	88
Isoxaflutole + thiencarbazone-methly + atrazine	0.07+0.03+1.3	Pre	88	89
Isoxaflutole + atrazine	0.08+1.3	Pre	85	91
Tembotrine + thiencarbazone-mehtyl + atrazine	0.07+0.01+1	Post	96	98
Tembotrine + thiencarbazone-mehtyl + glyphosate	0.07+0.01+0.7	Post	95	93
Tembotrine +thiencarbazone-mehtyl + atrazine + glyphosate	0.07+0.01+1+0.7	Post	99	98
S-metolachlor + atrazine + mesotrione	1.3+1.3+0.17	Pre	70	95
Mesotrione + metolachlor + glyphosate	0.094+0.94+0.94	Post	96	96
LSD (0.10)=			20	9

Abbreviations: AMAPA, Palmer amaranth; DAP, days after planting; fb, followed by; Pre, pre-emergence; Post, post-emergence 39 DAP

Weed control with tank mixes of rimsulfuron, mesotrione, atrazine and isoxaflutole herbicide in irrigated glyhposate-resistant corn. Randall S. Currie and Jennifer Jester (K-State Research-Extension Center, 4500 East Mary Street, Garden City, KS 67846) Although corn yields were very low due to severe drought, treatments that produced greater than 95% control 98 days after planting (DAP) had the highest yields. These treatments all contained some level of atrazine.

As their patents expire or approach expiration, products are often augmented with newer compounds to extend their useful life in the marketplace. The objective of this study was to determine how rimsulfuron and atrazine effectiveness could be enhanced with various tank mixes of other products.

Palmer amaranth control was evaluated in the glyphosate-resistant corn variety DKC 64-83 at the Southwest Research-Extension Center near Garden City, KS. Corn was planted on May 20, 2011, with pre-emergent herbicides applied within 24 hours of planting under air temperature, soil temperature, wind speed, relative humidity, and soil moisture of 52ºF, 63ºF, 6 mph, 75%, and adequate, respectively. Soil was Ulysses silt loam, and organic matter, soil pH, and cation exchange capacity (CEC) were 1.4%, 8, and 18.4. All herbicide treatments were applied with a tractor-mounted CO_2 pressurized windshield sprayer calibrated to deliver 20 gpa at 30 psi at 4.1 mph. All plots were treated with 32 ounces/a of glyphosate to remove any emerged plants from the plots. Adjuvant and ammonium sulfate (AMS) were added per manufacturer recommendations. The first post-herbicide application was made on June 15, 2011, when corn was 14 inches tall and air temperature, soil temperature, wind speed, relative humidity, and soil moisture were 85ºF, 76ºF, 4 mph, 26%, and adequate, respectively. The second post-herbicide application was made on June 29, 2011, with air temperature, soil temperature, wind speed, relative humidity, and soil moisture of 70ºF, 77ºF, 15 mph, 55%, and adequate. Trial was established as a randomized complete block design with four replications and plots were 10 by 30 foot. Crop injury and percentage weed control were visually rated.

No crop injury was observed. Palmer amaranth control was 93% or greater with 7 herbicide treatments 41 DAP compared with 0% in untreated checks. Only 5 treatments had greater than 95% control 69 DAP, compared with 0% control in the untreated check. All of these treatments contained atrazine. Although yield data were gathered, they were not included because the highest-yielding treatment produced only from 28 to 50 bushels/acre due to historic drought conditions. These highest-yielding treatments also had the best weed control 98 DAP (data not shown).

Table. AMAPA control 41 and 69 days after planting (DAP)

Active ingredient	Rate	Timing	AMAPA % control 41 DAP	AMAPA % control 69 DAP
	oz/ai/A			
Untreated check			0	0
Rimsulfuron + mesotrione + glyphosate + atrazine	0.075+0.63+16+16	Post	88	93
Rimsulfuron + mesotrione + atrazine fb	0.075+0.63+16 fb	Post	98	71
glyphosate	16	Lpost		
Atrazine + s-metolachlor fb	12.3+9.6 fb	Pre	85	96
rimsulfuron + mesotrione	0.075+0.63	Post		
Atrazine + S-metolachlor fb	12.3+9.6 fb	Pre	88	88
rimsulfuron + Mesotrione + glyphosate	0.075+0.63+16	Post		
Rimsulfuron + Isoxaflutole + atrazine fb	0.075+0.125+16 fb	Pre	90	93
rimsulfuron + mesotrione	0.075+0.63	Post		
Rimsulfuron + isoxaflutole fb	0.075+0.125 fb	Pre	99	100
rimsulfuron + mesotrione + atrazine	0.075+0.63+16	Post		
Rimsulfuron + isoxaflutole + atrazine fb	0.075+0.125+16 fb	Pre	81	84
rimsulfuron + mesotrione + glyphosate	0.075+0.63+16	Post		
Rimsulfuron + isoxaflutole + atrazine fb	0.075+0.125+16 fb	Pre	95	90
glyphosate	16	Post		
Atrazine + s-metolachlor + rimsulfuron + mesotrione fb	12.3+9.6+0.075+0.63 fb	Post	94	93
glyphosate	16	Lpost		
Mesotrione + metolachlor + glyphosate	1.5+15+15	Lpost	0	23
Rimsulfuron + mesotrione	0.063+0.7	Pre	83	90
Rimsulfuron + mesotrione	0.09+0.7	Pre	90	93
Rimsulfuron + thifensulfuron + mesotrione	0.063+0.12+0.7	Pre	84	80
Rimsulfuron + mesotrione + atrazine	0.063+0.7+16	Pre	93	96
Rimsulfuron + mesotrione + atrazine	0.09+0.7+16	Pre	88	90
Rimsulfuron + thifensulfuron + mesotrione + atrazine	0.067+0.12+0.7+16	Pre	93	93
Rimsulfuron + mesotrione + atrazine fb	0.067+0.7+16 fb	Pre	96	99
glyphosate	16	Epost		
Rimsulfuron + mesotrione + atrazine fb	0.067+0.7+16 fb	Pre	89	91
glyphosate	16	Lpost		
Rimsulfuron + thifensulfuron + mesotrione + atrazine	0.067+0.12+0.7+16 fb	Pre	93	98
Glyphosate	16	Epost		
S-Metolachlor + Atrazine + Mesotrione	32+0.75+0.2	Pre	96	96
S-Metolachlor + Atrazine + Mesotrione	32+0.75+0.2 fb	Pre	99	100
glyphosate	16	Epost		
LSD (0.10)			17	15

Abbreviations: AMAPA, Palmer amaranth; DAP, days after planting; fb, followed by; Pre, pre-emergence; Epost, early post-emergence 28 DAP; Post, post-emergence; Lpost, late post-emergence 40 DAP

Broadleaf weed control in field corn with preemergence followed by sequential postemergence treatments. Richard N. Arnold, Kevin A. Lombard and Samuel C. Allen. (New Mexico State University Agricultural Science Center, Farmington, NM 87499) Research plots were established on May 8, 2012 at the Agricultural Science Center, Farmington, New Mexico, to evaluate the response of field corn (var. Pioneer PO636HR) and annual broadleaf weeds to preemergence followed by sequential postemergence herbicides. Soil type was a Wall sandy loam with a pH of 7.8 and an organic matter content of less than 0.3%. The experimental design was a randomized complete block with four replications. Individual plots were 4, 30 in rows 30 ft long. Field corn was planted with flexi-planters equipped with disk openers on May 8. Preemergence treatments were applied on May 9 and immediately incorporated with 0.75 in of sprinkler applied water. Sequential postemergence treatments were applied on June 12 when field corn was in the 3rd to 5th leaf stage and weeds were small. Russian thistle, prostrate and redroot pigweed infestations were heavy and common lambsquarters and black nightshade infestations were moderate throughout the experimental area. Preemergence followed by sequential postemergence treatments and crop injury were evaluated on July 12. No crop injury was noted from any of the treatments.

All treatments except the weedy check gave excellent control of common lambsquarters, black nightshade, redroot and prostrate pigweed and Russian thistle.

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

Treatments[1,2]	Rate	Crop Injury[3]	Weed control[3,4] CHEAL	SOLNI	AMARE	AMABL	SASKR
	lb ai/A	%	%				
Isoxaflutole/thiencarbazone + atrazine + glyphosate + AMS	0.06+0.5 0.95 2.5	0	100	100	100	100	100
Isoxaflutole/thiencarbazone + atrazine+ thiencarbazone/tembotrione + COC + AMS	0.06+0.5 0.08 1 + 2.5	0	100	100	100	100	100
S-metolachlor/atrazine/mesotrione + glyphosate + AMS	1.5 0.95 2.5	0	100	100	100	100	100
Dimethenamid-p/saflufenacil + dicamba/diflufenzopyr + AMS	0.52 0.19 2.5	0	100	100	97	99	96
Dimethenamid-p/atrazine + dicamba/diflufenzopyr + AMS	1.9 0.19 2.5	0	100	100	100	99	98
Saflufenacil + dicamba/diflufenzopyr + AMS	0.06+0.19 2.5	0	100	100	99	100	97
Weedy check			0	0	0	0	0
LSD 0.05			1	1	1	1	1

[1]pm indicates packaged mix.
[2]COC =crop oil concentrate (Rigo oil concentrate) at 1.0% v/v and AMS (ammonium sulfate) at 2.5 lb/A applied with post emergence treatments.
[3]Rated on a scale from 0 to 100 with 0 being no control or crop injury and 100 being dead plants.
[4]CHEAL (common lambsquarters), SOLNI (black nightshade), AMARE (redroot pigweed), AMABL (prostrate pigweed), and SASKR (Russian thistle).

Preemergence weed control in fallow. Patrick W. Geier and Phillip W. Stahlman. (Kansas State University Agricultural Research Center, Hays, KS 67601-9228) A study was conducted near Hays, KS in 2012 to examine the efficacy of isoxaflutole-based preemergence herbicides for weed control in fallow. Treatments of dicamba+atrazine and dicamba+metribuzin were included as comparative checks. Plots were 10 by 32 ft arranged in a randomized complete block with four replications. All herbicide treatments were applied on March 5 using a CO_2 pressurized backpack sprayer calibrated to deliver 15 gpa at 30 psi and 3 mph. Kochia (a glyphosate-susceptible population), slimleaf lambsquarters, and Palmer amaranth control was estimated visually on June 7, which was 94 days after herbicide treatment (DAT).

All herbicides controlled kochia 98% or more except dicamba+2,4-D (70%) at 94 DAT. Similarly, slimleaf lambsquarters control was 93% or more with all herbicides except dicamba+2,4-D (53%). Palmer amaranth was controlled best (84 to 93%) when the premix of isoxaflutole/thiencarbazone was applied with atrazine, atrazine+dicamba, or diuron, and when isoxaflutole was applied with atrazine+acetochlor. Dicamba+2,4-D provided only 50% Palmer amaranth control at 94 DAT.

Table. Weed control with preemergence herbicides at 94 days after treatment, Hays, KS, 2012.

Treatment[1]	Rate	KCHSC[2]	CHELE[2]	AMAPA[2]
	lb ai/A	%	%	%
Isoxaflutole/thiencarbazone + atrazine	0.082 + 1.0	99	100	84
Isoxaflutole/thiencarbazone + atrazine + dicamba	0.082 + 1.0 + 0.5	100	100	88
Isoxaflutole/thiencarbazone + metribuzin	0.082 + 0.375	100	98	73
Isoxaflutole/thiencarbazone + metribuzin + dicamba	0.082 + 0.375 + 0.5	100	99	79
Isoxaflutole/thiencarbazone + diuron	0.082 + 1.0	100	95	93
Isoxaflutole + atrazine	0.06 + 1.0	100	100	65
Isoxaflutole + atrazine + dicamba	0.06 + 1.0 + 0.5	100	100	68
Isoxaflutole + atrazine + acetochlor	0.06 + 1.0 + 1.125	100	100	87
Dicamba + 2,4-D ester	0.5 + 0.5	70	53	50
Dicamba + metribuzin	0.5 + 0.375	98	93	75
LSD (0.05)		6	11	11

[1]Dicamba was the diglycolamine salt, and rate is expressed as lb ae/A.
[2]KCHSC = kochia, CHELE = slimleaf lambsquarters, AMAPA = Palmer amaranth.

Broadleaf weed control with glyphosate and saflufenacil plus adjuvants in fallow. Traci A. Rauch, Joan M. Campbell and Donald C. Thill. (Crop and Weed Science Division, University of Idaho, Moscow, ID 83844-2339) Glyphosate is often combined with a broadleaf herbicide to improve broadleaf weed control. Saflufenacil, a PPO inhibitor broadleaf herbicide, may be used to control ALS and 2,4-D resistant broadleaf weeds in fallow. A study was established near Genesee, ID to evaluate broadleaf weed control with glyphosate and saflufenacil combined with various adjuvants in fallow. All plots were 8 by 25 feet 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). Broadleaf weed control was evaluated visually.

Table 1. Application and soil data.

Application date	May 31, 2012
Growth stage	
Prickly lettuce(LACSE)	bolting
Common lambsquarters (CHEAL)	4 inches
Shepherd’s purse (CAPBP)	flowering
Field pennycress (THLAR)	flowering
Air temperature (F)	63
Relative humidity (%)	69
Wind (mph, direction)	0
Cloud cover (%)	100
Soil moisture	dry
Soil temperature at 2 inch (F)	58
pH	5.8
OM (%)	3.6
CEC (meq/100g)	20
Texture	silt loam

At 3 days after treatment (DAT), prickly lettuce (LACSE) control ranged from 94 to 98% (Table 2). By 42 DAT, all treatments continued to control prickly lettuce 91% or greater. Common lambsquarters (CHEAL) control ranged from 84 to 94% at 3 DAT and 81 to 92% at 42 DAT. All treatments controlled shepherd’s purse (CAPBP) and field pennycress (THLAR) 79 to 85 and 78 to 88%, respectively. By 42 DAT, all treatments controlled shepherd’s purse and field pennycress 99% (data not shown).

Table 2. Broadleaf weed control with glyphosate and saflufenacil combined with adjuvants in fallow near Genesee, ID in 2012.

		Weed control[2]					
Treatment[1]	Rate	LACSE - 3 DAT	LACSE – 42 DAT	CHEAL – 3 DAT	CHEAL – 42 DAT	CAPBP – 3 DAT	THLAR – 3 DAT
		%	%	%	%	%	%
Glyphosate +	0.84 lb ae/A						
saflufenacil +	0.0223 lb ai/A						
Super Spread MSO +	16 fl oz/A						
AMS dry	8.5 lb ai/100 gal	96	95	87	90	79	86
Glyphosate +	0.84 lb ae/A						
saflufenacil +	0.0223 lb ai/A						
Super Spread MSO +	16 fl oz/A						
Bronc	2.5 gal/ 100 gal	94	93	89	90	82	80
Glyphosate +	0.84 lb ae/A						
saflufenacil +	0.0223 lb ai/A						
Super Spread MSO +	16 fl oz/A						
Bronc	5 gal/ 100 gal	95	92	94	87	80	81
Glyphosate +	0.84 lb ae/A						
saflufenacil +	0.0223 lb ai/A						
Super Kix	30 fl oz/A	98	92	84	88	82	84
Glyphosate +	0.84 lb ae/A						
saflufenacil +	0.0223 lb ai/A						
Super Kix +	30 fl oz/A						
Bronc	2.5 gal/ 100 gal	98	91	89	81	85	86
Glyphosate +	0.84 lb ae/A						
saflufenacil +	0.0223 lb ai/A						
Super Kix +	30 fl oz/A						
Bronc	5 gal/ 100 gal	96	96	90	81	85	78
Glyphosate +	0.84 lb ae/A						
saflufenacil +	0.0223 lb ai/A						
Super Kix	40 fl oz/A	94	97	93	92	83	88
Glyphosate +	0.84 lb ae/A						
saflufenacil +	0.0223 lb ai/A						
Super Kix +	40 fl oz/A						
Bronc	2.5 gal/ 100 gal	98	93	88	84	84	86
Glyphosate +	0.84 lb ae/A						
saflufenacil +	0.0223 lb ai/A						
Super Kix +	40 fl oz/A						
Bronc	5 gal/ 100 gal	96	92	87	82	84	82
LSD (0.05)		NS	NS	NS	NS	NS	NS
Density (plants/ft^2)		5		5		10	5

[1]AMS dry = ammonium sulfate. Bronc = liquid ammonium sulfate. Super Kix = methylated seed oil/nitrogen/nonionic surfactant. Super Spreader MSO = methylated seed oil/nonionic surfactant.

[2]LACSE = prickly lettuce, CHEAL = common lambsquarters, CAPBP = shepherd's purse, THLAR = field pennycress.

Glyphosate-resistant kochia control with postemergence herbicides in fallow. Patrick W. Geier, Phillip W. Stahlman, and Seshadri S. Reddy. (Kansas State University Agricultural Research Center, Hays, KS 67601-9228) An experiment conducted near Hays, KS in 2012 evaluated the efficacy of tembotrione- and pyrasulfotole-based herbicide mixtures for control of glyphosate-resistant (GR) kochia in fallow. Plots were 10 by 32 ft arranged in a randomized complete block with four replications. All herbicides were applied postemergence to kochia on May 21 using a compressed-CO_2 backpack sprayer delivering 15 gpa at 30 psi and 3 mph. Kochia was 2 to 12 inches tall with 100 to 200 leaves at application time, and averaged 35 plants per meter^2. No other weed species were present in the trial. Kochia control was visually estimated on May 29, June 11, and July 16, which was 8, 21, and 56 days after treatment (DAT).

The premixture of pyrasulfotole/thiencarbazone + fluroxypyr and the tank mixture of paraquat + metribuzin provided the best kochia control at 8 DAT (78 and 81%). No tembotrione-based herbicide treatment provided as much as 70% kochia control at 8 DAT. Kochia control increased 16 to 32% with most herbicide by 21 DAT, such that tembotrione or pyrasulfotole, each with fluroxypyr and bromoxynil, provided greater than 90% control. These treatments also provided the greatest control at 56 DAT, as little or no increase in kochia control occurred between 21 and 56 DAT.

Table. Glyphosate-resistant kochia control with postemergence herbicides at Hays, KS, 2012

		Days after treatment		
Treatment[1]	Rate[2]	8	21	56
	lb ai/A		%	
Tembotrione + atrazine+ MSO	0.08 + 0.5 + 1%	20	20	20
Tembotrione + atrazine + dicamba + MSO	0.08 + 0.5 + 0.25 + 1%	53	76	83
Tembotrione + bromoxynil + COC	0.08 + 0.125 + 1%	40	43	40
Tembotrione + fluroxypyr / bromoxynil + MSO	0.08 + 0.32 + 1%	68	91	91
Pyrasulfotole / bromoxynil + NIS	0.26 + 0.25%	55	71	71
Pyrasulfotole / bromoxynil + atrazine + NIS	0.26 + 0.5 + 0.25%	65	81	80
Pyrasulfotole / bromoxynil + fluroxypyr + NIS	0.26 + 0.094 + 0.25%	78	97	97
Tembotrione / thiencarbazone + atrazine + glyphosate	0.08 + 0.5 + 0.77	23	53	55
Tembotrione / thiencarbazone + atrazine + glufosinate	0.08 + 0.5 + 0.53	38	70	70
Fluroxypyr / bromoxynil + NIS	0.32 + 0.5%	70	79	83
Paraquat + metribuzin + NIS	0.625 + 0.375 + 0.5%	81	83	83
LSD (0.05)		9	11	12

[1]All treatments contained ammonium sulfate at 2% v/w, MSO = methylated seed oil, COC = crop oil concentrate, NIS = nonionic surfactant.
[2]Glyphosate is the potassium salt formulation and rate is expressed as lb ae/A. Rates for MSO, COC, and NIS are percent v/v.

Tembotrione and pyrasulfotole/bromoxynil postemergence for kochia control in fallow. Patrick W. Geier and Phillip W. Stahlman. (Kansas State University Agricultural Research Center, Hays, KS 67601-9228) An experiment conducted near Quinter, KS in 2012 evaluated the efficacy of tembotrione- and pyrasulfotole-based herbicide mixtures for control of glyphosate-resistant (GR) kochia in fallow. Plots were 10 by 32 ft arranged in a randomized complete block with four replications. All herbicides were applied postemergence to kochia on May 11 using a tractor-mounted, compressed air sprayer delivering 12.8 gpa at 30 psi and 3 mph. Kochia was 8 to 18 inches tall and averaged 50 plants per meter^2 at application timing. No other weed species were present in the trial. Kochia control was visually estimated on May 18, May 25, and June 1, which was 7, 14, and 21 days after treatment (DAT).

The premix of fluroxypyr/bromoxynil, with either tembotrione or pyrasulfotole, controlled GR kochia 72% at 7 DAT, compared to 43 to 63% for all other treatments. Kochia control increased with all treatments by 14 DAT, such that all treatments containing bromoxynil provided 85 to 88% control. Kochia control with tembotrione + atrazine was 60% at 14 DAT. By 21 DAT, only tembotrione or pyrasulfotole, each with fluroxypyr/bromoxynil, controlled kochia as much as 90%.

Table. Glyphosate-resistant kochia control with tembotrione and pyrasulfotole at Quinter, KS, 2012

		Days after treatment		
Treatment[1]	Rate[2]	7	14	21
	lb ai/A		%	
Tembotrione + atrazine + MSO	0.08 + 0.5 + 1%	43	60	70
Tembotrione + fluroxypyr / bromoxynil + MSO	0.08 + 0.32 + 1%	72	88	90
Tembotrione + bromoxynil + MSO	0.08 + 0.25 + 1%	57	85	80
Pyrasulfotole/bromoxynil + fluroxypyr/bromoxynil + NIS	0.26 + 0.32 + 0.25%	72	88	90
Pyrasulfotole/bromoxynil + atrazine + NIS	0.26 + 0.5 + 0.25%	63	85	82
LSD (0.05)		11	5	7

[1]All treatments contained ammonium sulfate at 2% v/w, MSO = methylated seed oil and NIS = nonionic surfactant.
[2]Rates for MSO and NIS are percent v/v.

Herbicide and spray volume effects on glyphosate-resistant kochia control in fallow. Patrick W. Geier, Phillip W. Stahlman, and David A. Brachtenbach. (Kansas State University Agricultural Research Center, Hays, KS 67601-9228) An experiment was conducted near Grainfield, KS in 2012 to determine the effect of herbicide treatment and spray volume on glyphosate-resistant (GR) kochia control in fallow. Plots were 15 by 20 feet and arranged in a randomized factorial design with three replications. Herbicides were applied July 18, 2012 to kochia that was 6 to 12 inches tall and averaged 6 plants per meter^2. Herbicides were applied with a tractor-mounted, compressed air sprayer calibrated to deliver 9.6, 14.3, or 19.5 gpa at 50 psi. Kochia control was visually estimated on July 25, July 30, and August 15, 2012, which was 7, 12, and 28 days after treatment (DAT).

No interaction of herbicide treatment by application volume occurred at any rating date, so the main effects of herbicide and application volume are discussed separately. Averaged over application volume, paraquat + linuron controlled GR kochia 87% at 7 DAT, and was 9 to 56% better than any other treatment (Table 1). By 12 DAT, both treatments containing paraquat controlled kochia 82 to 85%, compared to 70% or less for glyphosate or tembotrione treatments. Paraquat treatments were 13 to 29% more effective on kochia than other treatments at 28 DAT. Averaged over herbicide treatments, kochia control was slightly better with the 14.3 and 19.5 gpa spray volumes than the 9.6 gpa volume at 7 and 12 DAT (Table 2). However, no difference occurred between spray volumes at 28 DAT.

Table 1. Kochia control with various herbicides, averaged over application volume, Grainfield, KS, 2012.

Treatment[1]	Rate[2]	7 DAT[3]	12 DAT	28 DAT
	lb ai/A		% visual	
Glyphosate+dicamba+2,4-D ester+AMS	1.13+0.5+0.47+2.5%	31	46	67
Glyphosate+f luroxypyr/bromoxynil+AMS	1.13+0.32+2.5%	51	66	72
Tembotrione+fluroxypyr/bromoxynil+MSO+AMS	0.08+0.32+1%+2.5%	66	70	82
Paraquat+metribuzin+NIS+AMS	0.75+0.38+0.5%+2.5%	78	82	96
Paraquat+linuron+NIS+AMS	0.75+0.75+0.5%+2.5%	87	85	95
LSD (0.05)		8	4	7

[1]Glyphosate was the potassium salt and dicamba was the diglycolamine salt. NIS = Activator 90 nonionic surfactant. AMS = Class Act NG ammonium sulfate.

[2]Rates for glyphosate, dicamba, 2,4-D, fluroxypyr, and bromoxynil are lb ae/A, and NIS and AMS rates are percent v/v.

[3]DAT = days after herbicide treatment.

Table 2. Spray volume effects on kochia control, averaged over herbicide treatments, Grainfield, KS 2012.

Spray volume	7 DAT[1]	12 DAT	28 DAT
gpa		% visual	
9.6	58	64	80
14.3	64	72	84
19.5	65	73	83
LSD (0.05)	4	2	NS

[1]DAT = days after herbicide treatment.

Broadleaf weed control in grain sorghum with postemergence herbicides. Richard N. Arnold, and Kevin A. Lombard and Samuel C. Allen. (New Mexico State University Agricultural Science Center, Farmington, NM 87499) Research plots were established on May 29, 2012 at the Agricultural Science Center, Farmington, New Mexico, to evaluate the response of grain sorghum (var. DKS 44-20) and annual broadleaf weeds to postemergence herbicides. Soil type was a Wall sandy loam with a pH of 7.8 and an organic matter content of less than 0.3%. The experimental design was a randomized complete block with four replications. Individual plots were 4, 30 in rows 30 ft long. Grain sorghum was planted with flexi-planters equipped with disk openers on May 29. Postemergence treatments were applied on June 26 when grain sorghum was in the V5 leaf stage and weeds were <6 inch in height. Russian thistle, prostrate and redroot pigweed infestations were heavy and common lambsquarters and black nightshade infestations were moderate throughout the experimental area. Postemergence treatments were evaluated on July 26. None of the treatments resulted in crop injury.

All treatments except the weedy check gave excellent control of common lambsquarters, black nightshade, redroot and prostrate pigweed and Russian thistle.

Table. Broadleaf weed control in grain sorghum with postemergence herbicides.

Treatments[1,2]	Rate	Crop Injury[2]	Weed control[2,3] CHEAL	SOLNI	AMARE	AMABL	SASKR
	lb ai/A	%	%				
Pyrasulfotole/bromoxynil + atrazine + AMS[1]	0.17 0.5	0	100	100	100	100	100
Pyrasulfotole/bromoxynil + atrazine + AMS[1]	0.21 0.5	0	100	100	100	100	100
Pyrasulfotole/bromoxynil + atrazine + AMS[1]	0.26 0.5	0	100	100	100	100	100
Pyrasulfotole/bromoxynil + atrazine + AMS[1]	0.42 0.5	0	100	100	100	100	100
Pyrasulfotole/bromoxynil + AMS[1]	0.21	0	100	100	97	97	95
Atrazine + bromoxynil + AMS[1]	0.5+0.5	0	100	100	100	100	100
Weedy check		0	0	0	0	0	0

[1]Treatments applied with ammonium sulfate (AMS) at either 1 or 2 lb/A.
[2]Rated on a scale from 0 to 100 with 0 being no control or crop injury and 100 being dead plants.
[3]CHEAL (common lambsquarters), SOLNI (black nightshade), AMARE (redroot pigweed), AMABL (prostrate pigweed), and SASKR (Russian thistle).

Weed control with flumioxazin and pyroxasulfone in spring wheat. Joan M. Campbell, Traci A. Rauch, and Donn C. Thill. (Crop and Weed Science Division, University of Idaho, Moscow, ID 83844-2339) A study was established in 'Waikea' spring wheat to evaluate broadleaf weed and Italian ryegrass control with flumioxazin alone or combined with pyroxasulfone at three application times 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). Wheat injury and weed control were evaluated visually.

Table 1. Environmental and edaphic data.

Application date	November 1, 2011	May 9, 2012	June 13, 2012
Wheat growth stage	Pre-plant fall	Pre-plant spring	Joint, 14 inch tall
Italian ryegrass growth stage	Pre-emerge	Pre-emerge	1 to 4 tiller
Air temperature (F)	38	59	68
Relative humidity (%)	68	48	52
Wind (mph, direction)	0	3, S	2, NW
Cloud cover (%)	0	10	5
Soil moisture	fair	excellent	good
Soil temperature at 2 inch (F)	40	63	70

Spiny sowthistle and redroot pigweed control was better with flumioxazin/pyroxasulfone applied fall or spring pre-plant and flumioxazin alone applied spring pre-plant compared to flumioxazin applied alone in the fall (Table 2). Mayweed chamomile control was higher with pre-plant spring flumioxazin/pyroxasulfone (97%) than flumioxazin in the fall (55%). Italian ryegrass control was higher with flumioxazin/pyroxasulfone applied pre-plant fall (82%) compared to flumioxazin alone applied in the fall (22%) or post-emergence (32%). Italian ryegrass control did not differ among other treatments. Wheat was injured with pre-plant spring flumioxazin/pyrosasulfone (12%) compared to the untreated check. Overall, the best treatment with low injury was flumioxazin/pyroxasulfone applied in the fall.

Table 2. Broadleaf and Italian ryegrass control in spring wheat with flumioxazin and flumioxazin/pyroxasulfone at three application times near Genesee, ID in 2012.

			Weed control[1]				
Treatment	Rate	Application timing	SONAS	ANTCO	AMARE	LOLMU	Wheat injury
	lb ai/A		---------------- % of untreated check ----------------				
Flumioxazin	0.096	Pre-plant fall	62 b	55 b	51 b	22 bc	0 b
Flumioxazin/pyroxasulfone	0.214	Pre-plant fall	81 a	86 ab	90 a	82 a	1 b
Flumioxazin	0.064	Pre-plant spring	92 a	73 ab	96 a	49 ab	8 ab
Flumioxazin/pyroxasulfone	0.214	Pre-plant spring	93 a	97 a	98 a	59 ab	12 a
Flumioxazin	0.096	1 to 4 tiller LOLMU	-	-	-	32 bc	0 b
Flumioxazin/pyroxasulfone	0.214	1 to 4 tiller LOLMU	-	-	-	40 abc	0 b

[1] Wheat injury, spiny sowthistle (SONAS), mayweed chamomile (ANTCO), and redroot pigweed (AMARE) were evaluated on June 10 before post treatment was applied. Broadleaf weeds were not controlled with postemergence applications and the entire study was over sprayed with pyrasulfotole/bromoxynil + thifensulfuron/tribenuron + fluroxypyr to control broadleaf weeds July 8. Italian ryegrass (LOLMU) was rated on July 17.

Weed control with pyroxasulfone combinations in spring wheat. Joan M. Campbell, Traci A. Rauch and Donald C. Thill. (Crop and Weed Science Division, University of Idaho, Moscow, ID 83844-2339) Two experiments were established in spring wheat to evaluate Italian ryegrass (LOLMU) control with 1) pyroxasulfone combined with fluthiacet or carfentrazone plus florasulam/fluroxypyr/pyroxsulam and 2) pyroxasulfone/fluthiacet with flucarbazone near Potlatch, ID. The plots were arranged in a randomized complete block design with four replications and included an untreated check. 'Jefferson' wheat was planted May 26, 2012. Herbicide treatments were applied using a CO_2 pressurized backpack sprayer calibrated to deliver 10 gpa at 32 psi and 3 mph (Table 1). Mayweed chamomile was evaluated June 23 and then both studies were oversprayed with thifensulfuron/tribenuron at 0.0313 lb ai/A, pyrasulfotole/bromoxynil at 0.177 lb ai/A, and fluroxypyr at 0.124 lb ae/A for broadleaf weed control on June 25. Wheat injury and Italian ryegrass control were evaluated visually during the growing season.

Table 1. Environmental and edaphic data.

Application date	May 30, 2012	June 27, 2012
Wheat growth stage	pre-emerge, 0.5 inch coleoptile	4 to 5 leaf, 8 to 10 inch tall
Italian ryegrass growth stage	pre-emerge, germinated	2 to 4 leaf, 1 to 4 inch tall
Air temperature (F)	67	70
Relative humidity (%)	55	54
Wind (mph)	0	0
Cloud cover (%)	50	0
Soil moisture	excessive	excellent
Soil temperature at 2 inch (F)	56	70
pH	4.2	
Organic matter (%)	4.0	
CEC (meq/100 g)	17.8	
Texture	silt loam	

Wheat was not injured with any treatments in either experiment (data not shown). In the first experiment, mayweed chamomile control was 80% or better with all treatments except carfentrazone/pyroxasulfone applied at 0.1145 lb ai/A, pyroxasulfone/fluthiacet applied alone post emergence, and pinoxaden (Table 2). Italian ryegrass control was higher with carfentrazone/pyroxasulfone treatments compared to pyroxasulfone/fluthiacet treatments. In the second experiment, mayweed chamomile was controlled 81% with pyroxasulfone/fluthiacet applied at 0.084 lb ai/A alone or with flucarbazone (Table 3). Italian ryegrass control was highest with pyroxasulfone/fluthiacet treatments except when it was applied alone at the 0.042 lb ai/A rate. Flucarbazone alone did not control Italian ryegrass.

Table 2. Weed control in spring wheat with pyroxasulfone combinations near Potlatch, Idaho in 2012.

Treatment[1]	Rate	Application timing	June 23 Mayweed chamomile		July 27 Italian ryegrass	
	lb ai/A		---------------- % ----------------			
Carfentrazone/pyroxasulfone	0.0859	Pre-emergence	81	ab[2]	89	a
Carfentrazone/pyroxasulfone	0.1145	Pre-emergence	62	bc	84	ab
Carfentrazone/pyroxasulfone	0.229	Pre-emergence	92	a	91	a
Pyroxasulfone/fluthiacet	0.0825	Pre-emergence	88	a	55	bc
Pyroxasulfone	0.084	Pre-emergence	80	ab	66	abc
Carfentrazone/pyroxasulfone +	0.057	Pre-emergence	90	a	72	abc
florasulam/fluroxypyr/pyroxsulam	0.173	Postemergence				
Carfentrazone/pyroxasulfone +	0.0875	Pre-emergence	92	a	92	a
florasulam/fluroxypyr/pyroxsulam	0.173	Postemergence				
Carfentrazone/pyroxasulfone +	0.114	Pre-emergence	95	a	91	a
florasulam/fluroxypyr/pyroxsulam	0.173	Postemergence				
Carfentrazone/pyroxasulfone +	0.057	Pre-emergence	93	a	88	a
florasulam/fluroxypyr/pyroxsulam	0.087	Postemergence				
Carfentrazone/pyroxasulfone +	0.086	Pre-emergence	95	a	92	a
florasulam/fluroxypyr/pyroxsulam	0.087	Postemergence				
Carfentrazone/pyroxasulfone +	0.114	Pre-emergence	96	a	88	a
florasulam/fluroxypyr/pyroxsulam	0.087	Postemergence				
Pyroxasulfone/fluthiacet	0.109	Postemergence	41	cd	44	c
Pyroxasulfone/fluthiacet +	0.0825	Postemergence	88	a	55	bc
florasulam/fluroxypyr/pyroxsulam	0.173	Postemergence				
Florasulam/fluroxypyr/pyroxsulam	0.173	Postemergence	92	a	68	abc
Pinoxaden	0.054	Postemergence	21	d	75	ab

[1] Ammonium sulfate (Bronc) at 1.5 lb ai/A and nonionic surfactant (R11) at 0.25 %v/v were added to all postemergence treatments except pinoxaden which only had ammonium sulfate added.
[2] Means followed by the same letter within a column are not significantly different from on another (LSD 0.05)

Table 3. Weed control in spring wheat with pyroxasulfone/fluthiacet and flucarbazone combinations near Potlatch, Idaho in 2012.

Treatment[1]	Rate	Application timing	June 23 Mayweed chamomile		July 27 Italian ryegrass	
	lb ai/A					
Pyroxasulfone/fluthiacet	0.042	Pre-emergence	35	bc[2]	53	bcd
Pyroxasulfone/fluthiacet	0.084	Pre-emergence	81	a	83	ab
Pyroxasulfone/fluthiacet +	0.042	Pre-emergence	30	cd	84	ab
flucarbazone	0.0205	Postemergence				
Pyroxasulfone/fluthiacet +	0.063	Pre-emergence	61	ab	68	abc
flucarbazone	0.0205	Postemergence				
Pyroxasulfone/fluthiacet +	0.084	Pre-emergence	81	a	84	a
flucarbazone	0.0205	Postemergence				
Pyroxasulfone/fluthiacet +	0.042	Pre-emergence	20	cd	76	ab
flucarbazone	0.0273	Postemergence				
Flucarbazone	0.0273	Postemergence	18	cd	43	cd
Flucarbazone +	0.0273	Postemergence	5	d	23	d
thifensulfuron +	0.0141	Postemergence				
tribenuron	0.0047	Postemergence				

[1] Basic blend (Quad 7) at 1% v/v was added to all postemergence applications.
[2] Means followed by the same letter within a column are not significantly different from one another (LSD 0.05).

Catchweed bedstraw 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 'OR CF 102' winter wheat near Lapwai, ID to evaluate winter wheat response and catchweed bedstraw control with pyrasulfotole/bromoxynil and florasulam/MCPA. The studies were arranged in a randomized complete block design with four replications and included an untreated check. All herbicide treatments were applied at the same application time using a CO_2 pressurized backpack sprayer calibrated to deliver 10 gpa at 32 psi and 3 mph (Table 1). Wheat response and weed control were evaluated visually.

Table 1. Application and soil data.

Application date	4/29/2012
Growth stage	
Winter wheat	3 tiller
Catchweed bedstraw	3 inch tall
Air temperature (F)	65
Relative humidity (%)	62
Wind (mph)	0
Cloud cover (%)	40
Soil moisture	adequate
Soil temperature at 2 inch (F)	63
pH	5.2
OM (%)	3.8
CEC (meq/100g)	24.6
Texture	silty clay loam

In the pyrasulfotole/bromoxynil study, no winter wheat injury was visible (data not shown). At 18 and 45 DAT, all treatments containing fluroxypyr controlled catchweed bedstraw 92 to 99% (Table 2).

In the florasulam/MCPA study, no winter wheat injury was visible (data not shown). Catchweed bedstraw control was best with florasulam/MCPA plus clopyralid/fluroxypyr (91%) but did not differ from clopyralid/fluroxypyr or bromoxynil/MCPA alone, and pyrasulfotole/bromoxynil combined with florasulam/MCPA or fluroxypyr (82 to 89%) (Table 3). At 45 DAT, all treatments containing fluroxypyr controlled catchweed bedstraw 98 to 99% but did not differ from pyrasulfotole/bromoxynil plus florasulam/MCPA (89%).

Table 2. Catchweed bedstraw control with pyrasulfotole/bromoxynil combinations near Lapwai, ID in 2012.

Treatment	Rate[1]	Catchweed bedstraw control 18 DAT	Catchweed bedstraw control 45 DAT
	lb ai/A	%	%
Pyrasulfotole/bromoxynil	0.217	84	84
Florasulam/fluroxypyr	0.092	92	99
Pyrasulfotole/bromoxynil +	0.217		
florasulam/fluroxypyr	0.0615	97	99
Pyrasulfotole/bromoxynil +	0.217		
florasulam/fluroxypyr	0.092	98	99
Clopyralid/fluroxypyr	0.188	95	99
LSD (0.05)		6	3
Density (plants/ft^2)		20	

[1]Rate is in lb ae/A for all treatments containing fluroxypyr.

Table 3. Catchweed bedstraw control with florasulam/MCPA combinations near Lapwai, ID in 2012.

Treatment	Rate[1]	Catchweed bedstraw control	
		18 DAT	45 DAT
	lb ai/A	%	%
Florasulam/MCPA	0.315	65	35
Pyrasulfotole/bromoxynil	0.21	79	71
Clopyralid/fluroxypyr	0.188	88	99
Bromoxynil/MCPA	0.64	82	74
Florasulam/MCPA +	0.315		
pyrasulfotole/bromoxynil	0.177	84	89
Florasulam/MCPA +	0.315		
clopyralid/fluroxypyr	0.14	91	99
Florasulam/MCPA +	0.315		
bromoxynil/MCPA	0.5	80	72
Pyrasulfotole/bromoxynil +	0.177		
fluroxypyr	0.105	89	98
LSD (0.05)		10	16
Density (plants/ft^2)		20	

[1]Rate is in lb ae/A for all treatments containing MCPA and fluroxypyr.

Downy brome 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 to evaluate winter wheat response and downy brome control with preemergence and postemergence herbicides near Lenore, ID; a liquid formulation of pyroxsulam applied at two application times near Moscow, ID; and sulfosulfuron or propoxycarbazone combined with buffering agents near Uniontown, WA. Plots were 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). At Moscow, the study was oversprayed with thifensulfuron/tribenuron at 0.025 lb ai/A and pyrasulfotole/bromoxynil at 0.19 lb ai/A on May 7, 2012 for broadleaf weed control. The Uniontown and Lenore sites were oversprayed on May 15 and 19, 2012, respectively, with thifensulfuron/tribenuron at 0.0313 lb ai/A, pyrasulfotole/bromoxynil at 0.177 lb ai/A, and fluroxypyr at 0.124 lb ae/A for broadleaf weed control; and with azoxystrobin/propiconazole at 0.09 lb ai/A for stripe rust control. In all experiments, wheat injury and downy brome control were evaluated visually.

Table 1. Application and soil data.

Location	Lenore, ID		Moscow, ID		Uniontown, WA
Application date	10/13/11	4/23/12	4/21/12	5/1/12	5/7/12
Growth stage					
Winter wheat	preemergence	2 tiller	1 tiller	3 tiller	3 tiller
Downy brome (BROTE)	preemergence	1 tiller	1 tiller	2 tiller	2 tiller
Air temperature (F)	56	78	60	47	67
Relative humidity (%)	84	56	76	78	47
Wind (mph, direction)	0	2, N	0	1, W	0
Cloud cover (%)	100	0	10	100	10
Soil moisture	adequate	adequate	excessive	excessive	adequate
Soil temperature at 2 in (F)	50	70	60	52	63
pH	5.1		5.0		5.7
OM (%)	5.2		2.8		3.4
CEC (meq/100g)	22.2		12.7		18.2
Texture	Silty clay loam		Silt loam		Silt loam

At Lenore, no treatment injured winter wheat (data not shown). Pyroxsulam and propoxycarbazone applied postemergence controlled downy brome 84 and 94% (Table 2). No other treatment, applied pre or postemergence, controlled downy brome (0 to 52%).

At Moscow, pyroxsulam and propoxycarbazone/mesosulfuron at the early application time (1 tiller downy brome) and propoxycarbazone at the late application time (2 tiller downy brome) injured wheat 8 to 12% (Table 3). Downy brome control was best with pyroxsulam applied at the early timing (88%) but did not differ from propoxycarbazone and propoxycarbazone/mesosulfuron (74 and 76%). Pyroxsulam and propoxycarbazone/mesosulfuron controlled downy brome better when applied at the 1 tiller (88 and 76%) versus the 2 tiller application time (42 and 38%).

At Uniontown, all propoxycarbazone treatments combined with an adjuvant injured wheat 4 to 14% (Table 4). All propoxycarbazone and sulfosulfuron treatments combined with adjuvant containing a surfactant (Sure Up, Transactive, R-11 or Super Kix) controlled downy brome 92 to 99%.

Table 2. Downy brome control and with preemergence and postemergence herbicides in winter wheat near Lenore, ID in 2012.

Treatment[1]	Rate	Application timing[2]	Downy brome control[3]
	lb ai/A		%
Flufenacet/metribuzin	0.425	preemergence	25
Pyroxasulfone	0.08	preemergence	20
Propoxycarbazone	0.026	preemergence	29
Flucarbazone	0.013	preemergence	10
Flufenacet/metribuzin +	0.34		
propoxycarbazone	0.026	preemergence	52
Flucarbazone +	0.013		
triasulfuron	0.026	preemergence	0
Flucarbazone +	0.013	preemergence	
flucarbazone	0.013	1 tiller	42
Flucarbazone +	0.027		
triasulfuron	0.026	1 tiller	32
Flucarbazone	0.027	1 tiller	12
Pyroxsulam	0.016	1 tiller	94
Propoxycarbazone	0.039	1 tiller	84
LSD (0.05)			33
Density (plants/ft^2)			10

[1]All propoxycarbazone treatments were applied with 90% nonionic surfactant (R-11) at 0.5% v/v. Ammonium sulfate (Bronc) at 1.5 lb ai/A and a nonionic surfactant (R-11) at 0.25% v/v was applied with flucarbazone preemergence and pyroxsulam. Basic blend (Newtone) at 1% v/v was applied with flucarbazone postemergence.
[2]Application timing based on downy brome growth stage.
[3]July 19, 2012 evaluation.

Table 3. Winter wheat injury and downy brome control with grass herbicide standards and a liquid formulation of pyroxsulam applied at two application times near Moscow, Idaho in 2012.

Treatment[1]	Rate	Application timing[2]	Winter wheat injury[3]	Downy brome control[4]
	lb ai/A		%	%
Pyroxsulam	0.016	1 tiller	8	88
Propoxycarbazone/mesosulfuron	0.025	1 tiller	12	76
Propoxycarbazone	0.039	1 tiller	1	74
Sulfosulfuron	0.031	1 tiller	1	44
Pyroxsulam	0.016	2 tiller	0	42
Propoxycarbazone/mesosulfuron	0.025	2 tiller	0	38
Propoxycarbazone	0.039	2 tiller	10	65
Sulfosulfuron	0.031	2 tiller	0	37
LSD (0.05)			7	17
Density (plants/ft^2)				15

[1]Ammoium sulfate (dry sprayable) was applied at 1.5 lb ai/A with pyroxsulam and propoxycarbazone/mesosulfuron. A 90% nonionic surfactant (Activator 90) was applied at 0.5% v/v with all treatments.
[2]Application timing based on downy brome growth stage.
[3]June 7, 2012 evaluation date.
[4]June 14, 2012 evaluation date.

Table 4. Winter wheat injury and downy brome control with propoxycarbazone and sulfosulfuron combined with buffering agents near Uniontown, WA in 2012.

Treatment[1]	Rate	Winter wheat injury (72 DAT)	Downy brome control (28 DAT)
	lb ai/A	%	%
Propoxycarbazone	0.039	0	62
Sulfosulfuron	0.031	0	50
Propoxycarbazone +	0.039		
Climb	1.6% v/v	4	87
Sulfosulfuron +	0.031		
Climb	1.6% v/v	0	88
Climb +	1.6% v/v		
sulfosulfuron	0.031	1	74
Sure Up +	0.5% v/v		
propoxycarbazone	0.039	14	94
Sure Up +	0.5% v/v		
sulfosulfuron	0.031	0	99
Transactive +	0.4% v/v		
propoxycarbazone	0.039	11	99
Transactive +	0.4% v/v		
sulfosulfuron	0.031	0	92
Propoxycarbazone +	0.039		
Climb +	1.6% v/v		
R-11	0.5% v/v	12	99
Sulfosulfuron +	0.031		
Climb +	1.6% v/v		
R-11	0.5% v/v	0	94
Propoxycarbazone +	0.039		
Climb +	1.6% v/v		
In-Place +	1 fl oz/A		
R-11	0.5% v/v	9	99
Sulfosulfuron +	0.031		
Climb +	1.6% v/v		
In-Place +	1 fl oz/A		
R-11	0.5% v/v	0	99
Propoxycarbazone +	0.039		
Climb +	1.6% v/v		
Super Kix	28 fl oz/A	12	97
Sulfosulfuron +	0.031		
Climb +	1.6% v/v		
Super Kix	28 fl oz/A	0	96
LSD (0.05)		3	8
Density (plants/ft^2)			5

[1]Treatments were mixed with distilled water in the order listed. Climb = pH buffer. Sure Up = pH buffer/surfactant. R-11 = nonionic surfactant (NIS). Transactive = pH buffer/nitrogen/NIS. In- Place = deposition/retention aid. Super Kix = Methylated seed oil/nitrogen/NIS.

<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 'Eddy' winter wheat near Kendrick, ID to evaluate winter wheat response and mayweed chamomile control with pyrasulfotole/bromoxynil and pyraflufen/2,4-D. The studies were arranged in a randomized complete block design with four replications and included an untreated check. All herbicide treatments were applied at the same application time 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 19, 2012 with pinoxaden at 0.054 lb ai/A to control wild oat 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.

Application date	4/24/2012
Growth stage	
Winter wheat	2 tiller
Mayweed chamomile	3 inch tall
Air temperature (F)	73
Relative humidity (%)	68
Wind (mph), direction	3, N
Cloud cover (%)	100
Soil moisture	excessive
Soil temperature at 2 inch (F)	68
pH	5.4
OM (%)	3.8
CEC (meq/100g)	22.5
Texture	silty clay loam

In the pyrasulfotole/bromoxynil study, no winter wheat injury was visible (data not shown). All treatments controlled mayweed chamomile 90% or better except pyrasulfotole/bromoxynil at 0.177 lb ai/A combined with florasulam/fluroxypyr (88%) (Table 2).

In the pyraflufen/2,4-D study at 9 DAT, pyraflufen/2,4-D injured winter wheat 11% (leaf tip chlorosis) (Table 3). By 25 DAT, no visible winter wheat injury was present (data not shown). All treatments controlled mayweed chamomile 88% or greater.

Table 2. Mayweed chamomile control with pyrasulfotole/bromoxynil combinations near Kendrick, ID in 2012.

Treatment[1]	Rate[2]	Mayweed chamomile control 25 DAT
	lb ai/A	%
Pyrasulfotole/bromoxynil	0.217	95
Florasulam/fluroxypyr	0.092	90
Pyrasulfotole/bromoxynil +	0.177	
florasulam/fluroxypyr	0.092	88
Pyrasulfotole/bromoxynil +	0.217	
florasulam/fluroxypyr	0.092	95
Bromoxynil/MCPA +	0.5	
thifensulfuron/tribenuron	0.0313	94
LSD (0.05)		5
Density (plants/ft^2)		5

[1]A nonionic surfactant (R-11) was applied with thifensulfuron/tribenuron treatment at 0.25% v/v.
[2]Rate is in lb ae/A for all treatments containing fluroxypyr or MCPA.

Table 3. Winter wheat injury and mayweed chamomile control with pyraflufen/2,4-D near Kendrick, ID in 2012.

Treatment	Rate[1]	Winter wheat injury 9 DAT	Mayweed chamomile control 25 DAT
	lb ai/A	%	%
Pyraflufen/2,4-D ester	0.33	11	92
2,4-D ester	0.356	0	88
Clopyralid/fluroxypyr	0.188	0	89
Pyrasulfotole/bromoxynil	0.21	0	89
LSD (0.05)		2	NS
Density (plants/ft^2)			5

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

Wild oat 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 crop response and 1) wild oat (AVEFA) control with flucarbazone applied pre and postemergence near Cottonwood, ID and 2) wild oat and mayweed chamomile (ANTCO) control with flucarbazone/fluroxypyr alone or in combinations with broadleaf herbicides near Kendrick, ID. 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). At the Cottonwood site, the study was oversprayed with thifensulfuron/tribenuron at 0.0313 lb ai/A, pyrasulfotole/bromoxynil at 0.177 lb ai/A, and fluroxypyr at 0.124 lb ae/A for broadleaf weed control on May 14. At Kendrick, the study was oversprayed with azoxystrobin/propiconazole at 0.09 lb ai/A for stripe rust control on May 19. Wheat response and weed control were evaluated visually.

Table 1. Application and soil data.

Location	Cottonwood, ID		Kendrick, ID
Winter wheat variety/planting date	Westbred 528 -10/12/2011		ORCF 102- 9/22/2011
Application date	10/13/2011	5/8/ 2012	5/6/2012
Growth stage			
Winter wheat	preemergence	3 tiller	3 tiller
Wild oat (AVEFA)	preemergence	2 leaf	1 tiller
Mayweed chamomile (ANTCO)	--	--	5 inch
Air temperature (F)	51	74	63
Relative humidity (%)	77	50	49
Wind (mph), direction	0	3, W	0
Cloud cover (%)	100	10	40
Soil moisture	adequate	adequate	excessive
Soil temperature at 2 inch (F)	46	60	62
pH	5.3		6.4
OM (%)	4.6		5.0
CEC (meq/100g)	32		21
Texture	silty clay loam		silt loam

At the Cottonwood site, no treatment injured winter wheat (data not shown). On July 11, wild oat control was 97 to 99% with all postemergence treatments (Table 2). Preemergence treatments alone controlled wild oat (72 to 86%).

At the Kendrick site, no treatment injured winter wheat (data not shown). At 32 DAT, treatments containing pyrasulfotole/bromoxynil plus MCPA ester or thifensulfuron plus tribenuron controlled mayweed chamomile 90% or greater but did not differ from all the other treatments, except flucarbazone/fluroxypyr alone (Table 3). At 74 DAT, mayweed chamomile control was 80% or greater with pyroxsulam/florasulam/fluroxypyr, pyrasulfotole/bromoxynil/thiencarbazone, and treatments containing pyrasulfotole/bromoxynil plus MCPA ester or thifensulfuron plus tribenuron. At 50 DAT, wild oat control was 90% or greater with pinoxaden/fluroxypyr, pyroxsulam/florasulam/fluroxypyr, pyrasulfotole/bromoxynil/thiencarbazone and flucarbazone/fluroxypyr plus thifensulfuron and tribenuron. By 74 DAT, pyroxsulam/florasulam/fluroxypyr and pinoxaden/fluroxypyr controlled wild oat 98 and 99%, respectively.

Table 2. Wild oat control with flucarbazone pre and postemergence in winter wheat near Cottonwood, ID in 2012.

Treatment[1]	Rate	Application timing[2]	Wild oat control[3]
	lb ai/A		%
Flucarbazone	0.013	preemergence	72
Flucarbazone +	0.013		
triasulfuron	0.021	preemergence	86
Flucarbazone +	0.013	preemergence	
flucarbazone	0.013	2 leaf	99
Flucarbazone +	0.013	preemergence	
pinoxaden	0.054	2 leaf	99
Pinoxaden	0.054	2 leaf	98
Pyroxsulam	0.016	2 leaf	97
LSD (0.05)			12
Density (plants/ft^2)			3

[1]All preemergence treatments were applied with glyphosate (Touchdown Total) at 0.78 lb ae/A and ammonium sulfate (Bronc) at 1.5 lb ai/A. Basic blend (Newtone) at 1% v/v was applied with flucarbazone postemergence. Ammonium sulfate (Bronc) at 1.5 lb ai/A and a nonionic surfactant (R-11) at 0.25% v/v was applied with pyroxsulam.
[2]Application timing based on wild oat growth stage.
[3]July 11, 2012 evaluation.

Table 3. Wild oat and mayweed chamomile control in winter wheat with flucarbazone/fluroxypyr near Kendrick, ID in 2012.

		ANTCO control[3]		AVEFA control[3]	
Treatment[1]	Rate[2]	32 DAT	74 DAT	50 DAT	74 DAT
	lb ai/A	%	%	%	%
Flucarbazone/fluroxypyr	0.125	22	36	78	82
Flucarbazone/fluroxypyr	0.141	46	35	82	82
Flucarbazone/fluroxypyr	0.166	66	49	86	85
Flucarbazone/fluroxypyr +	0.141				
thifensulfuron+	0.0141				
tribenuron +	0.0047	91	81	91	94
Flucarbazone/fluroxypyr +	0.141				
MCPA ester	0.39	88	56	82	79
Flucarbazone/fluroxypyr +	0.141				
thifensulfuron +	0.0141				
tribenuron +	0.0047				
MCPA ester	0.39	94	81	90	72
Flucarbazone/fluroxypyr +	0.141				
pyrasulfotole/bromoxynil	0.21	82	59	69	64
Flucarbazone/fluroxypyr +	0.141				
bromoxynil/MCPA	0.5	71	51	75	68
Flucarbazone +	0.0273				
pyrasulfotole/bromoxynil +	0.21				
MCPA ester	0.39	94	86	83	90
Pinoxaden/fluroxypyr +	0.147				
MCPA ester	0.39	84	72	97	99
Pyroxsulam/florasulam/fluroxypyr	0.104	88	86	97	98
Pyrasulfotole/bromoxynil/thiencarbazone	0.256	87	82	90	80
Untreated check	--	--	--	--	26
LSD (0.05)		24	27	13	14
Density (plants/ft^2)		10		15	

[1]A basic blend (Quad 7) was applied at 1% v/v with all treatments, except pinoxaden/fluroxypyr plus MCPA ester and pyrasulfotole/bromoxynil/thiencarbazone.
[2]Rate for bromoxynil/MCPA and MCPA ester based on lb ae/A.
[3]ANTCO = mayweed chamomile and AVEFA = wild oat.

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) A study was established at Genesee, ID in 'Westbred 523/Westbred 528' winter wheat blend to evaluate rattail fescue control with flucarbazone, flufenacet/metribuzin and pyroxasulfone combinations. 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.

Application date	October 19, 2011	April 28, 2012	May 8, 2012
Growth stage			
Winter wheat	pre	3 tiller	3 tiller
Rattail fescue (VLPMY)	pre	2 tiller	3 tiller
Air temperature (F)	55	58	79
Relative humidity (%)	67	59	54
Wind (mph, direction)	4, E	1, W	0
Cloud cover (%)	50	80	30
Soil moisture	adequate	adequate	adequate
Soil temperature at 2 inch (F)	53	58	67
pH		5.2	
OM (%)		3.6	
CEC (meq/100g)		19	
Texture		silty clay loam	

No treatment visually injured winter wheat (data not shown). On June 14, pyroxasulfone and flufenacet/metribuzin preemergence combined with flucarbazone postemergence controlled rattail fescue 92 to 98% (Table 2). By July 19, all treatments containing pyroxasulfone and flufenacet/metribuzin controlled rattail fescue 85 to 98%. At both evaluation times, rattail fescue control with postemergence flucarbazone alone or with tribenuron applied at the rattail fescue 3 tiller growth stage was better than the same treatment applied at the 2 tiller timing.

Table 2. Rattail fescue control in winter wheat with flucarbazone, flufenacet/metribuzin, and pyroxasulfone combinations near Genesee, ID in 2012.

Treatment[1]	Rate	Application timing[2]	Rattail fescue control June 14	Rattail fescue control July 19
	lb ai/A		%	%
Pyroxasulfone	0.053	pre	86	86
Flufenacet/metribuzin	0.34	pre	81	88
Pyroxasulfone +	0.053	pre		
flucarbazone	0.027	2 tiller	92	85
Flufenacet/metribuzin +	0.34	pre		
flucarbazone	0.027	2 tiller	95	96
Flucarbazone +	0.0131	pre		
flucarbazone	0.0137	2 tiller	52	30
Flucarbazone	0.027	2 tiller	48	22
Flucarbazone	0.041	2 tiller	55	38
Flucarbazone +	0.027	2 tiller		
thifensulfuron	0.00078	2 tiller	62	38
Pyroxsulam	0.0164	2 tiller	50	35
Pyroxasulfone +	0.053	pre		
flucarbazone	0.027	3 tiller	98	98
Flufenacet/metribuzin +	0.34	pre		
flucarbazone	0.027	3 tiller	97	95
Flucarbazone	0.027	3 tiller	82	61
Flucarbazone	0.041	3 tiller	81	64
Flucarbazone +	0.027	3 tiller		
thifensulfuron	0.00078	3 tiller	84	61
Pyroxsulam	0.0164	3 tiller	74	40
LSD (0.05)			11	15
Density (plants/ft^2)			20	

[1]A non-ionic surfactant (R-11) at 0.25% v/v and Bronc, ammonium sulfate (AMS), at 1 lb ai/A were applied with pyroxsulam and flucarbazone postemergence treatments.

[2]Application timing based on rattail fescue growth stage.

Prickly lettuce control with pyroxasulfone in winter wheat. Joan M. Campbell, Traci A. Rauch, and Donn C. Thill. (Crop and Weed Science Division, University of Idaho, Moscow, ID 83844-2339) A study was established in winter wheat to evaluate broadleaf weed control and crop tolerance with flumioxazin alone or combined with pyroxasulfone at four application times 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). WestBred 523/528 blend winter wheat was seeded on October 12, 2011. Azoxystrobin/ propiconazole was applied at 0.09 lb ai/A for stripe rust control on May 17. Winter wheat injury and prickly lettuce control were evaluated visually during the growing season. Grain was harvested with a small plot combine on August 14, 2012.

Table 1. Environmental and edaphic data.

Application date	10/2/11	10/13/11	10/19/11	4/22/12
Wheat growth stage	Pre-plant	Postplant- not germinated	0.5 inch root	4 leaf
Air temperature (F)	68	57	51	76
Relative humidity (%)	51	60	70	55
Wind (mph, direction)	4.5, SE	0	3, SSE	0
Cloud cover (%)	0	95	70	10
Soil moisture	dry	moist	moist	moist
Soil temperature at 2 inch (F)	60	50	42	61
pH	5.3			
OM (%)	4.4			
CEC (meq/100g)	22.7			
Texture	silt loam (63% silt, 26% clay, 11% sand)			

Injury to wheat did not appear until mid-June at which time some stunting was evident. Stunting was highest (6%) with flumioxazin/pyroxasulfone applied at the time of germinated wheat, but there were no differences among treatments (Table 2).

Prickly lettuce control ranged from 84 to 99% on June 4 and 90 to 99% on August 1 with all flumioxazin or flumioxazin/pyroxasulfone treatments. Prickly lettuce control on June 4 was inadequate with flucarbazone treatments which ranged from 31 to 71%. On August 1, prickly lettuce control was still poor with most flucarbazone treatments except when applied at the 3 leaf wheat stage. Prickly lettuce stand was variable and only three replications were evaluated due to low plant density in the first replicate. The competitive wheat stand likely contributed to prickly lettuce control.

Winter wheat yield and test weight were not statistically different among treatments.

Table 2. Wheat response and Italian ryegrass control in winter wheat with flumioxazin, flumioxazin/pyroxasulfone and flucarbazone at 4 application times near Genesee, ID in 2012.

Treatment[1]	Rate	Application timing[2]	Wheat injury June 29	Wheat injury July 11	Prickly lettuce control June 4	Prickly lettuce control August 1	Wheat Yield	Wheat Test weight
	lb ai/A		------------ %	of check	------------		bu/A	lb/bu
Glyphosate +	0.77	preplant						
flumioxazin	0.064	preplant	4	4	98	91	6369	63.6
Glyphosate +	0.77	preplant						
flumioxazin/pyroxasulfone	0.143	preplant	5	3	96	94	6669	62.9
Glyphosate +	0.77	preplant						
flucarbazone	0.013	preplant	3	1	38	30	5550	63.9
Glyphosate +	0.77	postplt - no germ						
flumioxazin	0.064	postplt - no germ	5	2	84	99	6503	63.4
Glyphosate +	0.77	postplt - no germ						
flumioxazin/pyroxasulfone	0.143	postplt - no germ	4	2	96	96	6121	63.5
Glyphosate +	0.77	postplt - no germ						
flucarbazone	0.013	postplt - no germ	2	1	71	50	6457	63.8
Glyphosate +	0.77	germinated						
flumioxazin	0.064	germinated	4	1	99	98	5974	63.7
Glyphosate +	0.77	germinated						
flumioxazin/pyroxasulfone	0.143	germinated	6	6	94	90	6192	63.5
Glyphosate +	0.77	germinated						
flucarbazone	0.013	germinated	0	0	31	25	6227	63.3
Glyphosate +	0.77	preplant						
flumioxazin	0.064	3 leaf	4	2	98	96	6058	63.7
Glyphosate +	0.77	preplant						
flumioxazin/pyroxasulfone	0.143	3 leaf	3	1	99	99	6166	63.4
Glyphosate +	0.77	preplant						
flucarbazone	0.027	3 leaf	2	2	35	82	6208	63.7
Glyphosate check	0.77	preplant	-	-	-	-	6517	63.0
LSD (0.05)			NS	NS	32	39	NS	NS
Density (plants/ft^2)					1/yd^2	1/yd^2		

[1]Ammonium sulfate (Bronc) was applied with glyphosate at 2.5 lb ai/A. A 90% nonionic surfactant (R-11) was applied at 0.25% v/v with flucarbazone at the 3 leaf timing. Glyphosate rate is expressed as lb ae/A.

[2]Application timing based on winter wheat growth stage. Preplant = 10 days before planting. Postplt – no germ = post-plant wheat seed not germinated. Germinated = 0.5 inch radicle extruded, wheat plant not emerged.

Italian ryegrass control with pyroxasulfone 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 Italian ryegrass (LOLMU) control with 1) pyroxasulfone combined with pyroxsulam and 2) pyroxasulfone combined with carfentrazone or fluthiacet near Lapwai, ID; and 3) flumioxazin alone or combined with pyroxasulfone at four application times 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). At Genesee, all plots were oversprayed preemergence with glyphosate at 0.77 lb ae/A. All studies were oversprayed with thifensulfuron/tribenuron at 0.0313 lb ai/A, pyrasulfotole/bromoxynil at 0.177 lb ai/A, and fluroxypyr at 0.124 lb ae/A for broadleaf weed control; and with azoxystrobin/propiconazole at 0.09 lb ai/A for stripe rust control on May 17 at Genesee and May 20, 2012 at Lapwai, ID. Winter wheat injury and Italian ryegrass control were evaluated visually during the growing season. At Genesee, grain was harvested with a small plot combine on August 15, 2012.

Table 1. Application and soil data.

Experiment	Pyroxasulfone and pyroxsulam				Pyroxasulfone plus carfentrazone or fluthiacet		
Location - variety – planting date	Lapwai, Idaho - ORCF 102 – 10/23/11						
Application date	10/2/11	10/25/11	4/23/12	5/6/12	10/25/11	4/23/12	5/6/12
Growth stage							
Winter wheat	preplant	postplt pre	2 tiller	4 tiller	postplt pre	2 tiller	4 tiller
Italian ryegrass (LOLMU)	pre	pre	1 tiller	1 tiller	pre	1 tiller	3 tiller
Air temperature (F)	67	53	71	60	53	71	60
Relative humidity (%)	57	61	69	43	61	69	43
Wind (mph, direction)	1, NW	1, W	0	0	1, W	0	0
Cloud cover (%)	10	0	60	40	0	60	40
Soil moisture	very dry	adequate	adequate	adequate	adequate	adequate	adequate
Soil temperature at 2 inch (F)	50	50	58	55	50	58	55
pH	5.2						
OM (%)	3.8						
CEC (meq/100g)	23						
Texture	silty clay loam						

Experiment -Location	Flumioxazin and flumioxazin/pyroxasulfone – Genesee, Idaho			
Variety – planting date	Legion – 10/24/11			
Application date	9/29/11	10/26/11	11/1/11	4/21/12
Growth stage				
Winter wheat	preplant	postplt- no germ	postplt -germ	3 leaf
Italian ryegrass (LOLMU)	pre	pre	pre	2 leaf
Air temperature (F)	78	50	45	66
Relative humidity (%)	39	65	63	68
Wind (mph, direction)	0	3, SE	4, W	0
Cloud cover (%)	0	90	10	10
Soil moisture	very dry	dry	adequate	excessive
Soil temperature at 2 inch (F)	65	45	44	60
pH	5.1			
OM (%)	4.2			
CEC (meq/100g)	22			
Texture	silt loam			

In the pyroxasulfone combined with pyroxsulam study, both rates of pyroxasulfone applied post-plant preemergence followed by pyroxsulam injured wheat 12 to13 and 25 to 27% on May 17 and June 13, 2012, respectively (Table 2). At both evaluation times, winter wheat was injured 7 and 10% by flufenacet/metribuzin plus pyroxsulam and 7 and 15% by the low rate of pyroxasulfone at the 2 tiller stage plus pyroxsulam. At both evaluation times, pyroxasulfone applied preplant or post-plant preemergence followed by pyroxsulam controlled Italian ryegrass 86 to 96% and did not differ from flufenacet/metribuzin plus pyroxsulam (70 and 90%).

In the pyroxasulfone plus carfentrazone or fluthiacet study, the high rate of carfentrazone/pyroxasulfone (0.23 lb ia/A) injured wheat 10 and 14% on May 17 and June 13, 2012, respectively (Table 3). On May 17, fluthiacet/pyroxasulfone plus pyroxsulam applied at the 4 tiller application time injured wheat 12%. On June 13, carfentrazone/pyroxasulfone at 0.144 lb ai/A injured wheat 10%. All treatments containing pyroxasulfone applied preemergence controlled Italian ryegrass 80 to 92%.

In the flumioxazin alone or combined with pyroxasulfone study, treatments containing flumioxazin applied post-plant preemergence with or without germinated seed injured wheat 52 to 65% on May 4, 2012 (Table 4). By July 17, the post-plant preemergence timings of flumioxazin and flumioxazin plus pyroxasulfone injured wheat 42 to 48 and 51 to 65%, respectively. Treatments containing flumioxazin caused extreme stand thinning and stunting due to a shallow seeded winter wheat crop. Seed was planted less than 0.5 inch deep with some seed on the surface. All flumioxazin plus pyroxasulfone treatments suppressed Italian ryegrass 66 to 82% but no treatment adequately controlled Italian ryegrass due to poor competition from severely injured winter wheat. Winter wheat yield and test weight ranged from 65 to 90 bu/A and 57.5 to 59.4 lb/bu, respectively, and did not differ among treatments including the check. Differences in yield and test weight among treatments were confounded by winter wheat injury and a heavy Italian ryegrass infestation.

Table 2. Winter wheat injury and Italian control with pyroxasulfone combined with pyroxsulam near Lapwai, ID in 2012.

Treatment[1]	Rate	Application timing[2]	Wheat injury[3]		Italian ryegrass control[3]	
			May 17	June 13	May 17	June 13
	lb ai/A		%	%	%	%
Pyroxasulfone +	0.08	preplant				
pyroxsulam	0.0164	4 tiller	5	10	86	89
Pyroxasulfone +	0.093	preplant				
pyroxsulam	0.0164	4 tiller	2	7	90	90
Pyroxasulfone +	0.08	postplant pre				
pyroxsulam	0.0164	4 tiller	13	27	93	96
Pyroxasulfone +	0.093	postplant pre				
pyroxsulam	0.0164	4 tiller	12	25	89	96
Flufenacet/metribuzin +	0.425	postplant pre				
pyroxsulam	0.0164	4 tiller	7	10	70	90
Pyroxasulfone +	0.08					
pyroxsulam	0.0164	2 tiller	7	15	58	55
Pyroxasulfone +	0.093					
pyroxsulam	0.0164	2 tiller	2	7	53	60
Pyroxsulam	0.0164	2 tiller	0	0	43	45
LSD (0.05)			6	14	26	20
Density (plants/ft^2)					20	

[1]Ammonium sulfate (dry sprayable) at 3 lb ai/A and a 90% nonionic surfactant (R-11) at 0.5% v/v was applied with pyroxsulam.

[2]Application timing based on winter wheat growth stage. Preplant = 21 days before planting. Postplant pre = post-plant preemergence to wheat (no germination).

[3]Only 3 replications were included in the analysis due to non-uniform stand.

Table 3. Winter wheat injury and Italian control with pyroxasulfone combined with carfentrazone and fluthiacet near Lapwai, ID in 2012.

Treatment[1]	Rate	Application timing[2]	Wheat injury May 17	Wheat injury June 13	LOLMU control[3]
	lb ai/A		%	%	%
Carfentrazone/pyroxasulfone	0.057	postplant pre	4	5	84
Carfentrazone/pyroxasulfone	0.086	postplant pre	4	6	87
Carfentrazone/pyroxasulfone	0.114	postplant pre	5	10	92
Carfentrazone/pyroxasulfone	0.23	postplant pre	10	14	92
Fluthiacet/pyroxasulfone	0.082	postplant pre	0	1	86
Triasulfuron	0.0164	postplant pre	1	0	2
Pyroxasulfone	0.08	postplant pre	4	2	80
Flufenacet/metribuzin	0.425	postplant pre	1	0	54
Flufenacet/metribuzin + triasulfuron	0.425 0.0164	postplant pre	1	1	62
Carfentrazone/pyroxasulfone + pyroxsulam	0.086 0.0164	postplant pre 2 tiller	5	9	89
Fluthiacet/pyroxasulfone	0.082	2 tiller	0	1	64
Fluthiacet/pyroxasulfone + pyroxsulam	0.082 0.0164	2 tiller	2	2	49
Pyroxsulam	0.0164	2 tiller	0	0	30
Fluthiacet/pyroxasulfone + pyroxsulam	0.082 0.0164	4 tiller	12	5	32
LSD (0.05)			6	8	16
Density (plants/ft^2)					20

[1]Ammonium sulfate (Bronc) at 1.5 lb ai/A and a 90% nonionic surfactant (R-11) at 0.5% v/v was applied with pyroxsulam treatments and fluthiacet/pyroxasulfone alone at the 2 tiller application timing.
[2]Application timing based on winter wheat growth stage. Postplant pre = post-plant preemergence to wheat (no germination).
[3]LOLMU = Italian ryegrass. Evaluation date June 13, 2012.

Table 4. Wheat response and Italian ryegrass control in winter wheat with flumioxazin, flumioxazin/pyroxasulfone and flucarbazone at four application times near Genesee, ID in 2012.

Treatment[1]	Rate	Application timing[2]	Wheat injury May 4	Wheat injury July 17	LOLMU control[3]	Wheat Yield	Wheat Test weight
	lb ai/A		%	%	%	bu/A	lb/bu
Flumioxazin	0.064	preplant	39	35	64	80	58.7
Flumioxazin/pyroxasulfone	0.143	preplant	19	34	82	90	58.8
Flucarbazone	0.013	preplant	0	0	5	72	59.2
Flumioxazin	0.064	postplt - no germ	64	42	38	65	58.3
Flumioxazin/pyroxasulfone	0.143	postplt - no germ	65	65	77	70	58.1
Flucarbazone	0.013	postplt - no germ	0	0	8	73	59.0
Flumioxazin	0.064	postplt - germ	52	48	38	65	57.9
Flumioxazin/pyroxasulfone	0.143	postplt - germ	55	51	78	71	57.5
Flucarbazone	0.013	postplt - germ	0	0	0	78	59.0
Flumioxazin	0.064	3 leaf	12	26	30	65	58.1
Flumioxazin/pyroxasulfone	0.143	3 leaf	20	34	66	82	58.0
Flucarbazone	0.013	3 leaf	5	0	20	76	58.5
Check	--	--	--	--	--	71	59.4
LSD (0.05)			15	19	19	NS	NS
Density (plants/ft^2)					30		

[1]All treatments, including the check, were oversprayed with glyphosate at 0.77 lb ae/A plus ammonium sulfate (Bronc) at 2.5 lb ai/A. A 90% nonionic surfactant (R-11) was applied at 0.25% v/v with flucarbazone at the 3 leaf timing.

[2]Application timing based on winter wheat growth stage. Preplant = 25 days before planting. Postplt – no germ = post-plant wheat not germinated. Postplt – germ = post-plant wheat germinated but no emergence.

[3]LOLMU = Italian ryegrass. Evaluation date July 17, 2012.

Winter barley tolerance to flufenacet and flufenacet/metribuzin herbicides. Joan M. Campbell, Traci A. Rauch, Don Morishita and Donn C. Thill. (Crop and Weed Science Division, University of Idaho, Moscow, ID 83844-2339) Three varieties of winter barley were planted in Moscow (dryland) and Kimberly (irrigated) fall 2011. Flufenacet/metribuzin and flufenacet were applied to the soil before barley emergence. Rates used were 0.5, 1, and 1.5 times the use rate of flufenacet/metribuzin. Flufenacet was applied at equivalent rates compared to the flufenacet portion of flufenacet/metribuzin. Pinoxaden was applied in the spring at the four leaf barley stage. Soil type at Moscow was silt loam with 4% organic matter, 4.6 pH, and 17.5 meq/100 g CEC. Soil type at Kimberly was silt with 1.4% organic matter, 8.3 pH, and 25.5 meq/100 g CEC. Plots were harvested at maturity. Injury, height, yield, test weight, and plumps/thins (Moscow only) were measured. This was a repeat of the experiment initiated in 2010.

At Moscow, a few areas of the field showed injury, but it appeared to be related to shallow seeds rather than specific treatments. The small amount of stunting was evident for about 2 weeks. No injury was evident at Moscow throughout the rest of the growing season. Charles treated with some flufenacet/metribuzin and flufenacet treatments were shorter than the check, but Endeavor treated with the highest rate of flufenacet/metribuzin and flufenacet were taller than the check (Table 1). Yield was not different from the untreated check for any treatments on Eight-Twelve and Charles, but Endeavor treated with the highest rate of flufenacet/metribuzin and flufenacet yielded greater than the untreated check (Table 2). Weeds were not a factor as the area was kept weed-free. Averaged over varieties, test weight was higher with the two highest rates of flufenacet and lower with the lowest rate of flufenacet/metribuzin compared to the untreated check (Table 3). Plump kernel percentage did not vary among any treatments, but thin kernel percentage was lower than the untreated check with the highest rate of flufenacet.

At Kimberly, no damage was evident from the herbicide treatments fall 2011. The primary reason for the difference between fall 2010 and 2011 may be the 0.97 inches of precipitation 3 days after planting in 2010. In 2011, there was no precipitation for some time after seeding. However, 0.25 inch of water was applied three times over a period of 6 days. All varieties were injured at Kimberly 25 to 30% with the 1.5 use rates of both flufenacet/metribuzin and flufenacet (data not shown). Injury from all other treatments ranged from 8 to 12%. Plants were shorter with the highest rates of flufenacet/metribuzin and flufenacet compared to the untreated check (Table 3). Yield was not different among treatments for Eight-Twelve, but Charles yield was higher with the use rate of flufenacet/metribuzin and Endeavor yield was lower with all rates of flufenacet compared to the untreated check (Table 2). Test weight did not vary among treatments (Table 3).

Averaged over treatments at Moscow, yield was highest for Eight-Twelve and lowest for Endeavor, and yield was negatively proportional with plant height (Table 4). This was likely due to a high degree of lodging with Endeavor and Charles. Charles had the highest percentage plump kernels and test weight did not vary among treatments.

Averaged over treatments at Kimberly, visual injury was highest for Endeavor and lowest for Charles, but there was no difference in yield among varieties (Table 5). Test weight was higher with Endeavor compared to Eight twelve and Charles.

Table 1. Barley height affected by treatment within varieties at Moscow in 2012.

Herbicide	Rate	Plant height Eight-12	Charles	Endeavor
	lb ai/a	---------------------- lb/a ----------------------		
Untreated	0	34.5 ab[2]	37.0 d	37.6 abc
Flu/met[1]	0.231	34.1 a	37.2 de	38.4 cde
Flu/met	0.425	34.7 b	35.9 a	37.2 ab
Flu/met	0.64	34.5 ab	36.0 a	38.9 e
Flufenacet	0.17	34.6 b	36.1 ab	38.0 bcd
Flufenacet	0.34	34.5 ab	36.9 bcd	37.5 abc
Flufenacet	0.51	34.6 b	36.3 abc	38.6 e
Pinoxaden	0.054	34.5 ab	37.6 def	37.4 ab

[1] Flu/met is flufenacet/metribuzin.
[2] Means followed by the same letter within a column are not statistically different at P>0.05.

Table 2. Barley yield affected by treatment within varieties at Moscow and Kimberly in 2012.

Herbicide	Rate	Moscow Eight-12	Moscow Charles	Moscow Endeavor	Kimberly Eight-12	Kimberly Charles	Kimberly Endeavor
	lb ai/a	---------------- lb/a ----------------			------------------ lb/a ------------------		
Untreated	0	7763 ab	7527 ab[2]	6387 ab	4843 a-e	5738 c-f	5955 d-h
Flu/met[1]	0.231	7866 ab	7217 a	6604 abc	5582 b-e	5912 d-f	5761 c-g
Flu/met	0.425	7871 ab	7305 a	6930 bcd	6105 e-h	6938 h	6673 gh
Flu/met	0.64	7501 a	7571 ab	7400 d	4488 a	6503 f-h	5487 b-e
Flufenacet	0.17	8059 ab	7989 b	6475 ab	6167 e-h	5816 c-g	5308 a
Flufenacet	0.34	8229 b	7912 b	6553 abc	6023 d-g	5799 c-g	4764 a
Flufenacet	0.51	7949 ab	7625 ab	7115 cd	5446 b-e	4917 a-c	4744 a
Pinoxaden	0.054	8195 b	7537 ab	6285 a	5716 c-f	6082 d-h	6047 d-g

[1] Flu/met is flufenacet/metribuzin.
[2] Means followed by the same letter within a column are not statistically different at P>0.05.

Table 3. Barley, test weight, plant height, plump and thin kernels averaged over variety in 2012.

		Test weight		Plant height		Plump	Thin
Herbicide	Rate	Moscow	Kimberly	Moscow	Kimberly	Moscow	
	lb ai/a	----- lb/bu -----		----- inch -----		----- % -----	
Untreated	0	52.8 c[2]	49.8 a	36.0 a	38.0 c	89 a	3.6 a
Flu/met[1]	0.231	52.1 d	49.5 a	36.5 a	38.0 c	90 a	4.0 a
Flu/met	0.425	52.8 c	50.1 a	36.0 a	38.9 c	89 a	3.8 a
Flu/met	0.64	53.1 bc	49.6 a	36.5 a	35.3 ab	91 a	2.9 ab
Flufenacet	0.17	53.3 abc	49.7 a	36.2 a	38.0 c	90 a	3.9 a
Flufenacet	0.34	53.6 ab	49.3 a	36.3 a	37.0 bc	92 a	3.0 ab
Flufenacet	0.51	53.8 a	49.4 a	36.5 a	34.9 a	94 a	2.4 b
Pinoxaden	0.054	53.1 bc	49.9 a	36.5 a	38.0 c	89 a	4.0 a

[1] Flu/met is flufenacet/metribuzin.

[2] Means followed by the same letter within a column are not statistically different at P>0.05.

Table 4. Barley yield, test weight, plumps and thins averaged over herbicide at Moscow.

Variety	Yield	Test weight	Plumps	Height
	lb/a	lb/bu	%	%
Endeavor	6719 a[1]	53.2 a	89 b	38 a
Eight-Twelve	7929 c	53.2 a	88 b	34 c
Charles	7585 b	52.8 a	95 a	37 b

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

Table 5. Barley yield, test weight, plumps and thins averaged over herbicide at Kimberly.

Variety	Yield	Test weight	Visual injury	Plant height
	lb/a	lb/bu	%	%
Endeavor	5604 a[1]	51.4 a	19 a	41 a
Eight-Twelve	5609 a	48.6 b	13 b	34 c
Charles	5963 a	48.9 b	7 c	37 b

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

Spring lentil, chickpea and pea response to pyroxsulam, fluroxypyr/florasulam, and other herbicides. 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 and Moscow, ID to evaluate 'Brundage 96'winter wheat and 'Alturas' spring wheat injury, respectively, in 2011 and spring lentil, chickpea and pea soil carryover response in 2012 to pyroxsulam, fluroxypyr/florasulam, and other grass herbicides. In 2011, the experimental design was a randomized complete block with four replications and plots were 16 by 30 ft. All herbicides were applied at 1X (labeled rate), 2X and 4X rate. All herbicide treatments were applied using a CO_2 pressurized backpack sprayer calibrated to deliver 10 gpa at 32 psi and 3 mph (Table 1). The winter wheat study was oversprayed with pyrasulfotole/bromoxynil at 0.193 lb ai/A and thifensulfuron/tribenuron at 0.025 lb ai/A to control broadleaf weeds on May 20 and azoxystrobin/propiconazole at 0.09 lb ai/A on May 28, 2011 to control stripe rust. Wheat injury was evaluated visually. Winter and spring wheat seed was harvested with a small plot combine on August 23 and September 8, 2011, respectively. In 2012, the experimental design was a randomized split-block with four replications. Main plots were three rotational crops (10 by 160 ft) and subplots were the nine herbicide treatments applied in 2011 and an untreated check (16 by 30 ft). 'Pardina' lentil at 45 lb/A, 'Billy Beans' chickpea at 120 lb/A and 'Aragorn' pea at 120 lb/A were direct-seeded into each plot on May 15 at Moscow and May 16, 2012 at Genesee, ID. Both studies were oversprayed preemergence with linuron at 0.62 lb ai/A on May 19 at Genesee and May 21, 2012 at Moscow, ID. Both studies were also hand weeded to maintain weed free plots. Rotational crop injury was evaluated visually and lentil, chickpea and pea seed were harvested with a small plot combine at maturity.

Winter and spring wheat visual injury, yield and test weight data can be found in the WSWS Research Progress Report 2012 (http://www.wsweedscience.org/Research%20Report%20Archive/2012%20WSWS%20RPR.pdf) on page 87-88.

Table 1. Soil and application data in 2011.

Location	Genesee, ID	Moscow, ID
Application date	May 28, 2011	June 8, 2011
Winter wheat growth stage	early joint	--
Spring wheat growth stage	--	1 tiller
Air temperature (F)	57	60
Relative humidity (%)	61	60
Wind (mph, direction)	2, W	2, W
Cloud cover (%)	90	100
Soil moisture	adequate	adequate
Soil temperature at 2 in (F)	51	53
pH	5.6	4.5
OM (%)	3.7	3.9
CEC (meq/100g)	23	28
Texture	silt loam	clay loam

At Genesee, sulfosulfuron at the 2X and 4X rates injured lentil and chickpea 10 to 49% at both evaluation times (Table 2). At 35 DAP, sulfosulfuron at the 2X and 4X rate injured pea 10 and 12%, respectively, while at 60 DAP, pea was injured 14% by the sulfosulfuron 4X rate. Lentil and chickpea seed yield was reduced 58 and 16%, respectively, by the 4X rate of sulfosulfuron. Pea seed yield did not differ among treatments including the untreated check.

At Moscow, all pyroxsulam/florasulam/fluroxypyr (pyro/flora/fluro) rates injured lentil 12 to 62% at both evaluation times (Table 3). At 45 and 60 DAP, pyro/flora/fluro at the 2X and 4X rate injured chickpea 15 to 45%. At all rating dates, lentil and chickpea injury increased with increasing pyro/fluro/flora rate. Pea injury was only significant at the 4X rate of pyr/flora/fluro (15 and 19% at 45 and 60 DAT, respectively). Lentil seed yield was reduced 74 and 94% by the 2X and 4X rate of pyro/flora/fluro, respectively. Pyr/flora/fluro at the 2X and 4X rate reduced chickpea seed yield 51%. Pea seed yield was reduced 55% by the 4X rate of pyro/flora/fluro and 31% unexplainably by the 1X rate of fluroxypyr/florasulam.

Table 2. Lentil, chickpea, and pea response to pyroxsulam and florasulam near Genesee, Idaho in 2012.

		Lentil			Chickpea			Pea		
		Injury			Injury			Injury		
Treatment[1]	Rate	35 DAP	60 DAP	Yield	45 DAP	60 DAP	Yield	35 DAP	60 DAP	Yield
	lb ai/A	%	%	lb/A	%	%	lb/A	%	%	lb/A
Pyroxsulam + NIS + AMS	0.0164 0.5% v/v 1.5	4	0	1284	0	0	2351	1	0	1851
Pyroxsulam + NIS + AMS	0.0328 1% v/v 3	5	2	886	4	0	2394	0	0	1841
Pyroxsulam + NIS + AMS	0.0656 2% v/v 6	2	2	1114	4	0	2374	4	0	1601
Fluroxypyr/florasulam	0.092	4	0	1219	0	0	2600	0	0	1837
Fluroxypyr/florasulam	0.185	0	0	1476	4	0	2510	0	0	1722
Fluroxypyr/florasulam	0.37	1	0	1328	2	0	2390	2	0	1687
Sulfosulfuron + NIS	0.0313 0.5% v/v	4	0	1320	1	0	2276	2	0	1798
Sulfosulfuron + NIS	0.0623 1% v/v	31	22	1172	10	11	2174	10	6	1639
Sulfosulfuron + NIS	0.125 2% v/v	29	49	455	18	28	1956	12	14	1422
Untreated check	--	--	--	1076	--	--	2317	--	--	1739
LSD (0.05)		14	7	464	7	3	284	7	7	NS

[1]NIS is a 90% nonionic surfactant (Activator 90) and AMS is ammonium sulfate.

Table 3. Lentil, chickpea, and pea response to pyroxsulam and florasulam near Moscow, Idaho in 2012.

		Lentil			Chickpea			Pea		
		Injury			Injury			Injury		
Treatment[1]	Rate	35 DAP	60 DAP	Yield	45 DAP	60 DAP	Yield	35 DAP	60 DAP	Yield
	lb ai/A	%	%	lb/A	%	%	lb/A	%	%	lb/A
Pyro/floras/fluro +	0.105									
NIS +	0.5% v/v									
AMS	1.52	12	20	302	12	5	1111	0	4	717
Pyro/floras/fluro +	0.21									
NIS +	1% v/v									
AMS	3.05	25	32	131	15	28	598	4	4	719
Pyro/floras/fluro +	0.42									
NIS +	2% v/v									
AMS	6.1	45	62	31	27	45	591	15	19	413
Fluroxypyr/florasulam	0.092	0	0	493	4	1	909	0	1	637
Fluroxypyr/florasulam	0.185	0	0	487	0	0	1250	0	1	688
Fluroxypyr/florasulam	0.37	1	0	323	0	0	1468	0	2	793
Flucarbazone +	0.0205									
2,4-D ester	0.374	8	0	428	5	0	1542	0	0	815
Flucarbazone +	0.041									
2,4-D ester	0.75	0	0	496	0	0	1215	0	0	775
Flucarbazone +	0.082									
2,4-D ester	1.5	1	0	397	0	0	1218	0	0	764
Untreated check	--	--	--	501	--	--	1212	--	--	918
LSD (0.05)		7	16	317	13	12	567	4	5	252

[1]Pyro/flora/fluro = pyroxsulam/florasulam/fluroxypyr. NIS is a 90% nonionic surfactant (Activator 90) and AMS is ammonium sulfate.

Impact of corn residue quantity on yield of following crops. Randy L. Anderson. (USDA-ARS, Brookings SD 57006). We are encouraging producers in the western Corn Belt to consider more crop diversity in their corn-soybean rotation. Producers, however, are hesitant to add alternative crops to their rotation because of a possible economic penalty. Yet, it is possible that ancillary benefits gained with alternative crops, such as lower inputs, could compensate for lower gross returns.

We have found that dry pea is synergistic to corn, improving corn growth efficiency (*Advances in Agronomy 112:205-226; 2011*). One benefit of this synergy is that the density of corn needed for optimum yield is less; corn yields similarly at 21,000 plants/acre following dry pea as at 30,000 plants/acre following soybean.

High quantities of corn residue on the soil surface can reduce stand establishment and yield of following crops. This yield suppression is partially attributed to corn residue interfering with crop seed placement in soil. Because corn density can be reduced when following dry pea, less after-harvest residue may be present on the soil surface to disrupt following crop establishment. Therefore, we examined the impact of two densities of corn (and the subsequent residue levels after harvest) on yield of three cool-season crops, red clover, spring wheat, and dry pea. We also evaluated if residue quantity altered crop tolerance to weed interference.

Methodology:

The study involved 12 treatments across a 2-year sequence. In the first year, corn was planted at 21,000 and 30,000 seeds/acre. After harvest, we established four residue treatments:

1. **High residue** (corn planted at 30,000 plants/acre)
2. **Control**: tillage buried residue of high residue treatment
3. **Low residue** (corn planted at 21,000 plants/acre)
4. **Control**: tillage buried residue of low residue treatment

In the second year, red clover (no variety name), dry pea (Admiral), and spring wheat (Briggs) were established in each of the four residue treatments, resulting in 12 treatments. Treatments were arranged in a randomized complete block design with four replications. Plot size was 20 feet by 40 feet. The study was conducted twice.

Residue levels on the soil surface after corn harvest were determined in one randomly-placed yd^2 quadrat in each plot. Tillage to bury residue in the control treatments included chisel plowing and disking in the fall following corn harvest.

Red clover, dry pea, and spring wheat were established with conventional cultural practices in this region. Stand counts in 1 yd of row were recorded at two sites in each plot, four weeks after emergence. Yield measurements included forage biomass of red clover (harvested 12 weeks after emergence), and grain yield for spring wheat and dry pea.

We also examined crop tolerance to weeds as affected by corn residue management. Oat was uses as an indicator weed in dry pea and red clover, and canola was used in spring wheat. With both indicator weeds, 100 seeds yd^2 was broadcast in an area, 3 yd by 3 yd. An adjacent weed-free subplot was also established. Weeds other than the indicator species were removed from the 3 yd by 3 yr subplots by hand. Yield (forage biomass for red clover, grain yield for spring wheat and dry pea) was compared between 1 yd^2 quadrats in both weed-infested and weed-free subplots that were harvested by hand.

Results:

After-harvest residue levels were 25% higher in the 30,000 corn density treatment (950 gm/yd^2) compared to the treatment of 21,000 corn plants (760 gm/yd^2).

Corn residue lying on the soil surface reduced yield of following crops. Compared with the tilled control, spring wheat, dry pea, and red clover yielded approximately 15% less in the low residue treatment (See Figure). Yield loss was much greater in the high residue treatment (30,000 plants/acre). Yield loss with red clover was almost 45% whereas dry pea yield loss was 30%. Spring wheat yield was similar in both residue levels. The high residue level reduced stand establishment in all crops (data not shown), but spring wheat compensated for less plants by producing more tillers.

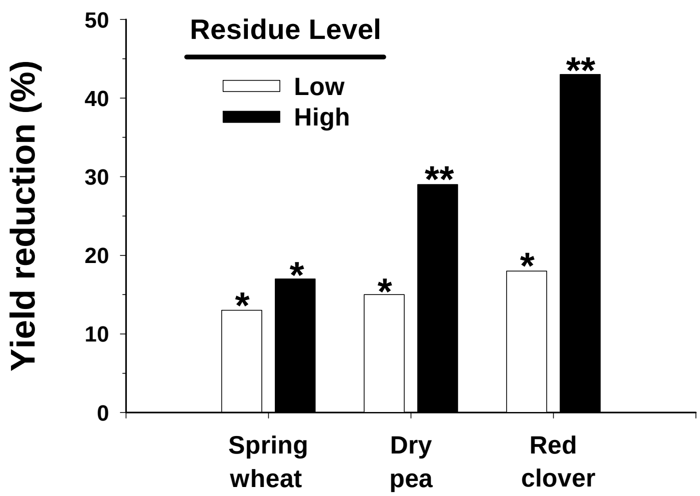

Figure. Yield loss in red clover, spring wheat, and dry pea as affected by corn residue level on the soil surface. The low residue treatment followed corn planted at 21,000 seeds/acre and the high residue treatment followed corn planted at 30,000 seeds/acre. Yield loss was determined by comparison with tilled controls. An asterisk indicates that the means differed from the tilled control; two asterisks signify that means within the crop differed from each other.

Because of reduced stand establishment in the high residue treatment, crops were less tolerant of weed interference. Red clover yield loss due to oat interference was 25% higher in the high residue treatment compared with the low-residue treatment (data not shown). Compared to the tilled controls in weed-free conditions, the combination of high residues and oat interference reduced biomass of red clover 80%. Spring wheat yield loss due to canola interference increased from 12% in tilled controls to 20% in the high residue treatment. Dry pea did not tolerate oat interference in any treatment; yield loss was > 75% with all treatments.

Management Implications:

The synergy of dry pea to corn enables producers in eastern South Dakota to reduce corn density and seed costs. Our study demonstrates an additional benefit of this synergy in no-till systems. Yield of red clover and dry pea were higher following corn planted at 21,000 seeds/acre. In high residue situations, spring wheat may be a more favorable crop choice because plant tillering compensates for reduced stands.

Timothy tolerance with pyrasulfotole/bromoxynil. Traci A. Rauch, Joan M. Campbell, and Donald C. Thill. (Crop and Weed Science Division, University of Idaho, Moscow, ID 83844-2339) Studies were conducted in seedling and established timothy stands near Princeton and Harvard, Idaho, respectively, to evaluate timothy response to pyrasulfotole/bromoxynil. 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. Timothy injury was evaluated visually.

Table 1. Application data for grass weed sites.

Location	Princeton, ID	Harvard, ID
Timothy variety and age	Titan – 6 month	Alma – 3 year
Application date	May 30, 2012	May 30, 2012
Timothy growth stage	1 tiller – 3 inch	stem elongation – 7 inch
Air temperature (F)	62	60
Relative humidity (%)	57	63
Wind (mph, direction)	3, W	1, W
Cloud cover (%)	100	100
Soil moisture	excessive	adequate
Soil temperature at 2 inch (F)	55	50

At the Princeton site, treatments containing dicamba plus 2,4-D amine stunted timothy4 and 9% at 9 DAT (Table 2). By 26 DAT, timothy injury ranged from 0 to 8% and was not different among treatments. At the Harvard site, timothy injury did not differ among treatments and ranged from 0 to 10% at 9 DAT and 0 to 9% at 26 DAT.

Table 2. Timothy tolerance with pyrasulfotole/bromoxynil near Princeton and Harvard, ID in 2012.

		Princeton, ID - seedling site		Harvard, ID - established site	
		Injury		Injury	
Treatment	Rate	9 DAT	26 DAT	9 DAT	26 DAT
	lb ai/A	%	%	%	
Pyrasulfotole/bromoxynil	0.241	0	0	0	4
Pyrasulfotole/bromoxynil	0.217	0	2	0	0
Pyrasulfotole/bromoxynil +	0.177				
dicamba	0.125	1	0	2	0
Pyrasulfotole/bromoxynil +	0.177				
2,4-D amine	0.5	0	1	6	0
Pyrasulfotole/bromoxynil +	0.177				
dicamba +	0.125				
2,4-D amine	0.5	4	6	10	9
Dicamba +	0.125				
2,4-D amine	0.5	9	8	8	4
LSD (0.05)		4	NS	NS	NS

Spring wheat response to trinexapac. 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 in spring wheat at the University of Idaho Parker Farm near Moscow, ID to evaluate spring wheat response to trinexapac combinations. Trinexapac is a plant growth regulator that can shorten internodes or cause internode thickening which decreases plant lodging. The study was arranged in a randomized complete block design with four replications and included an untreated check. All herbicide treatments were applied using a CO_2 pressurized backpack sprayer calibrated to deliver 10 gpa at 32 psi and 3 mph (Table 1). The study was oversprayed on June 27 with thifensulfuron/tribenuron at 0.0313 lb ai/A to control broadleaf weeds and propiconazole/azoxystrobin at 0.09 lb ai/A to control stripe rust. On July 10, the entire study was sprayed with cyhalothrin at 0.03 lb ai/A to control aphids. Wheat response was evaluated visually during the growing season and seed was harvested with a small plot combine at maturity on August 28.

Table 1. Application and soil data.

Spring wheat variety – seeding date and rate		Louise – May 10, 2012 at 100 lb/A
Application date		June 19, 2012
Spring wheat growth stage		3 tiller
Air temperature (F)		64
Relative humidity (%)		54
Wind, direction (mph)		3, W
Cloud cover (%)		60
Soil moisture		adequate
Soil temperature at 2 inch (F)		60
Soil data:	pH	5.1
	OM (%)	3.2
	CEC (meq/100g)	16.5
	Texture	silt loam

At 9 DAT, trinexapac combined with pinoxaden/fluroxypyr or propiconazole/azoxystrobin injured (stunted) spring wheat 10 to 14% compared to trinexapac alone (Table 2). By 27 DAT, no treatment visually injured wheat. Winter wheat yield and test weight ranged from 55 to 60 bu/A and 59.9 to 60.8 lb/bu, respectively, and did not differ among treatments including the untreated check.

Table 2. Spring wheat response to trinexapac combinations near Moscow, ID in 2012.

		Visual injury		Grain	
Treatment[1]	Rate	9 DAT	27 DAT	Yield	Test weight
	lb ai/A	%	%	bu/A	lb/A
Trinexapac	0.081	0	0	60	60.2
Trinexapac +	0.081				
Ammonium sulfate	17	4	0	57	60.1
Trinexapac +	0.081				
pinoxaden/fluroxypyr	0.147	15	0	55	60.4
Trinexapac +	0.081				
pinoxaden/fluroxypyr +	0.147				
pyrasulfotole/bromoxynil	0.177	11	0	55	60.8
Trinexapac +	0.081				
propiconazole/azoxystrobin	0.091	10	0	58	60.5
Untreated check	--	--	--	60	59.9
LSD (0.05)		8	0	NS	NS

[1]Ammonium sulfate (Bronc) rate is in lb ai/100 gal of mix.

Winter wheat 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 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. Each plot will be planted in spring 2013 to barley, lentil, soft white wheat, and hard red wheat to evaluate soil persistence of all herbicide treatments.

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	

Winter wheat injury ranged 0 to 9 and 0 to 11% on June 7 and July 16, respectively, and did not differ among treatments (Table 2). Grain yield and test weight did not differ among treatments, including the untreated check, but tended to be lowest for the flufenacet/metribuzin treatment.

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

Treatment	Rate	Application timing	Injury June 7	Injury July 16	Yield	Test weight
	lb ai/A		%	%	bu/A	lb/bu
Pyroxasulfone	0.08	preplant	2	0	110	62.3
Pyroxasulfone	0.093	preplant	6	11	99	61.9
Pyroxasulfone	0.16	preplant	2	5	106	61.9
Pyroxasulfone	0.186	preplant	4	0	108	62.3
Flufenacet/metribuzin	0.425	post plant pre	9	4	94	61.7
Pyroxasulfone	0.08	post plant pre	0	0	110	62.3
Pyroxasulfone	0.093	post plant pre	0	0	111	62.5
Pyroxasulfone	0.16	post plant pre	0	0	115	62.5
Pyroxasulfone	0.186	post plant pre	5	10	105	62.6
Untreated check	--		--	--	109	62.5
LSD (0.05)			NS	NS	NS	NS

Newly reported exotic species in Idaho for 2012. 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 199 specimens for identification in 2012 (Figure 1). One hundred and seven introduced species were identified. The lab received four weedy species not previously reported in the state and identified 33 exotic species that were new county records (see Table 1 and Figure 2). A total of 22 counties in Idaho submitted samples (Figure 3) and we had on-line photo submissions from western states and Alberta, 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	Poaceae	Ventenata	dubia	North Africa grass
Benewah	Brassicaceae	Draba	verna	spring draba
Bingham	Poaceae	Bromus	commutatus	bald brome
Boise	Apiaceae	Pastinaca	sativa	wild parsnip
Boise*	Polygonaceae	Polygonum	bohemicum	bohemian knotweed
Bonner	Campanulaceae	Campanula	rapunculoides	rampion bellflower
Bonner	Liliaceae	Ornithogalum	umbellatum	sleepydick
Bonner	Poaceae	Festuca	myuros	annual fescue
Bonner	Poaceae	Ventenata	dubia	North Africa grass
Clearwater	Asteraceae	Tragopogon	dubius	yellow salsify
Clearwater	Asteraceae	Tripleurospermum	perforatum	scentless false mayweed
Clearwater	Brassocaceae	Brassica	nigra	black mustard
Clearwater	Brassocaceae	Brassica	campestris	field mustard
Jerome	Poaceae	Agrostis	tenuis	colonial bentgrass
Kootenai*	Celastraceae	Euonymus	fortunei	winter creeper
Latah	Caryophyllaceae	Lepyrodiclis	holosteoides	false jagged-ckickweed
Latah	Polygonaceae	Rumex	crispus	curly dock
Latah	Ranunculaceae	Ranunculus	acris	tall buttercup
Latah*	Asteraceae	Madia	sativa	coast tarweed
Latah*	Asteraceae	Tussilago	farfara	coltsfoot
Lemhi	Campanulaceae	Campanula	rapunculoides	rampion bellflower
Lemhi	Cucurbitaceae	Bryonia	alba	white bryony
Lemhi	Liliaceae	Hemerocallis	fulva	orange daylily
Lemhi	Poaceae	Elymus	repens	quackgrass
Madison	Asteraceae	Centaurea	macrocephala	bighead napweed
Madison	Brassicaceae	Hesperis	matronalis	dames rocket
Madison	Lamiaceae	Lamium	amplexicaule	henbit deadnettle
NezPerce	Asteraceae	Bidens	frondosa	devil's beggartick
Oneida	Poaceae	Panicum	miliaceum	proso millet
Teton	Apiaceae	Pastinaca	sativa	wild parsnip
Teton	Asteraceae	Carduus	acanthoides	spiny plumeless thistle
Teton	Brassicaceae	Lepidium	campestre	field pepperweed
Teton	Malvaceae	Hibiscus	trionum	flower of an hour

*=New to State

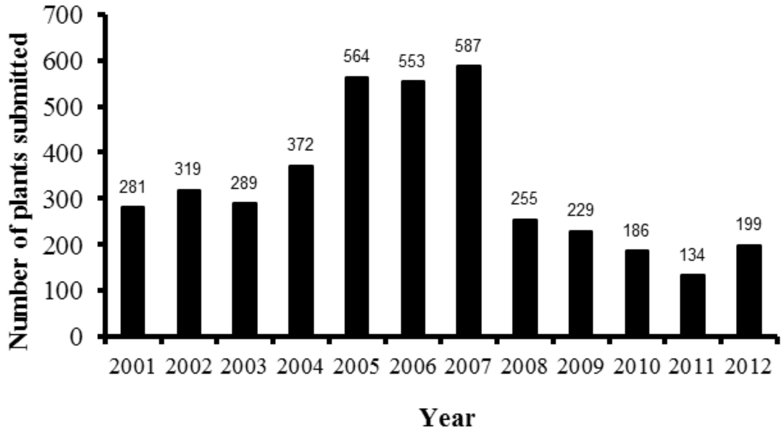

Figure 1. Erickson Weed Diagnostic Laboratory received 199 plants for identification in 2012.

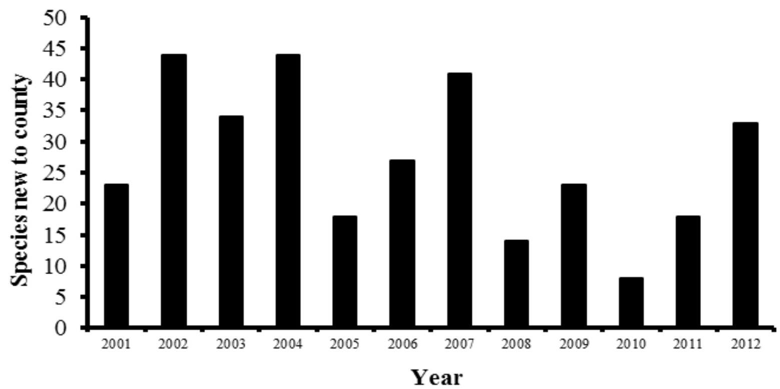

Figure 2. The lab identified 33 exotic species that were new Idaho records in 2012.

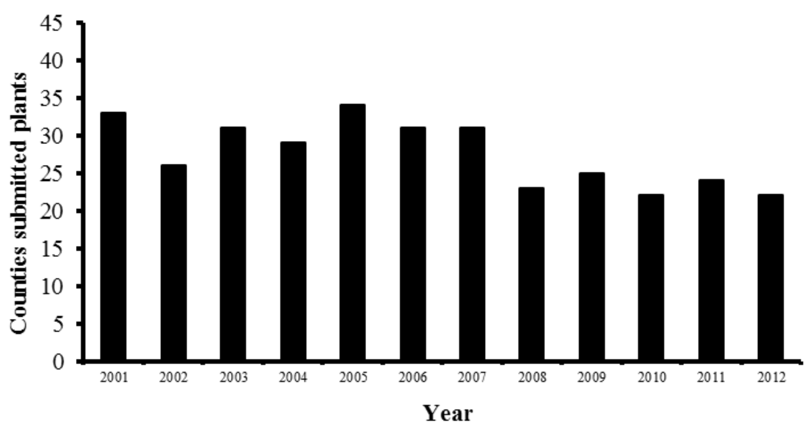

Figure 3. Twenty-two Idaho counties submitted plants in 2012.

Leafy spurge and Canada thistle control with aminocyclopyrachlor applied with various herbicides. Rodney G. Lym (Department of Plant Sciences, North Dakota State University, Fargo, ND 58108-6050). Aminocyclopyrachlor (AMCP) provides good to excellent control of many invasive weeds and is generally applied with either metsulfuron or chlorsulfuron. These herbicide combinations may also be applied with other compounds to broaden the spectrum of weed control, or with insecticides to control pests with a single application. The purpose of this research was to evaluate the effect of AMCP plus chlorsulfuron or metsulfuron applied with other herbicides, malathion, or with nitrogen as a carrier for leafy spurge or Canada thistle control.

The leafy spurge experiment was established near Walcott, ND in an ungrazed area of pasture with a dense stand of leafy spurge. Treatments were applied June 24, 2011 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 Canada thistle experiment was established on unused cropland on the campus of North Dakota State University in Fargo. Treatments were applied as previously described on June 30, 2011 when Canada thistle was in the rosette to starting to bolt growth stage and 4 to 6 inches tall. Leafy spurge and Canada thistle control was evaluated visually using percent stand reduction compared to the untreated control.

Initial leafy spurge control was excellent regardless of treatment but most treatments resulted in smooth bromegrass injury (Table 1). The highest injury occurred (> 60%) when AMCP was applied with triclopyr plus fluroxypyr or AMCP plus metsulfuron was applied in a nitrogen carrier. Leafy spurge control averaged near 100% 11 and 14 months after treatment (MAT) with all treatments except AMCP plus metsulfuron applied alone. Grass injury was not observed the year after treatment (data not shown). Canada thistle control averaged 99% 14 MAT regardless of treatment (Table 2). All treatments provided excellent control of annual foxtail species. No chemical incompatibility was observed with any treatment in either experiment.

AMCP applied with chlorsulfuron or metsulfuron has provided excellent leafy spurge and Canada thistle control in previous studies. Control was excellent in this study as well with nearly all herbicide mixtures except when AMCP was applied with metsulfuron on leafy spurge. In general, application of AMCP with other herbicides or with malathion should not affect leafy spurge or Canada thistle control.

Table 1. Aminocyclopyrachlor applied with various herbicides for leafy spurge control near Walcott, ND.

		Evaluation date			
		4 August 11		24 May 12	28 Aug 12
Treatment	Rate	Leafy spurge control	Smooth brome injury	Leafy spurge control	Leafy spurge control
	oz/A	%			
Aminocyclpyrachlor + chlorsulfuron[a] + NIS[b]	2 + 0.8 + 0.25%	100	15	99	96
Aminocyclpyrachlor + chlorsulfuron + 2,4-D + NIS	2 + 0.8 + 15.2 + 0.25%	96	20	97	92
Aminocyclpyrachlor + chlorsulfuron + picloram + NIS	2 + 0.8 + 8 + 0.25%	99	48	100	99
Aminocyclpyrachlor + chlorsulfuron + aminopyralid[c] + NIS	2 + 0.8 + 1.75 + 0.25%	100	24	99	97
Aminocyclpyrachlor + triclopyr + fluroxypyr[d] + NIS	2 + 0.8 + 12 + 4 + 0.25%	100	68	99	96
Aminocyclpyrachlor + metsulfuron + NIS	2 + 0.3 + 0.25%	99	10	88	82
Aminocyclpyrachlor + metsulfuron + 2,4-D + dicamba[e] + NIS	2 + 0.3 + 11.5 + 4.01 + 0.25%	100	20	96	90
Aminocyclpyrachlor + metsulfuron + picloram + 2,4-D[f] + NIS	2 + 0.3 + 2.1 + 8.1 + 0.25%	98	21	97	96
Aminocyclpyrachlor + metsulfuron + NIS in nitrogen carrier[g]	2 + 0.3 + 0.25%	100	63	97	96
Aminocyclpyrachlor + metsulfuron + malathion + NIS	2 + 0.3 + 16 + 0.25%	98	14	96	94
Untreated	• • •	0	0	20[h]	0
LSD (0.05)		3	19	11	9

[a]Dispersible granule formulation - Perspective by E.I. duPont de Nemours and Company, 1007 Market Street, Wilmington, DE 19898.
[b]Surfactant Induce by Helena Chemical Co., 225 Schilling Blvd, Collierville, TN 38017.
Commercial formulatons - [c]Milestone, [d]Pastureguard, [f]Grazon P+D by Dow AgroSciences LLC, 9330 Zionsville Road, Indianapolis, IN 46268-1189.
[e]Commercial formulation - Weedmaster by Nufarm Inc., 150 Harvester Drive, Burr Ridge, IL 60527.
[g]Nitrogen fertilizer 28-0-0.
[h]Biological control agents (*Aphthona* spp.) reduced leafy spurge stand.

Table 2. Aminocyclopyrachlor applied with various herbicides for Canada thistle control Fargo, ND.

		Evaluation date/species				
		16 August 11		13 Sep 11	1 June 12	16 Aug 12
Treatment[a]	Rate	Canada thistle	Foxtail spp.	Canada thistle		
	oz/A	% control				
Aminocyclpyrachlor + chlorsulfuron[a] + NIS[b]	2 + 0.8 + 0.25%	99	98	100	100	99
Aminocyclpyrachlor + chlorsulfuron + 2,4-D + NIS	2 + 0.8 + 15.2 + 0.25%	89	97	100	100	99
Aminocyclpyrachlor + chlorsulfuron + picloram + NIS	2 + 0.8 + 8 + 0.25%	100	96	100	100	99
Aminocyclpyrachlor + chlorsulfuron + aminopyralid[c] + NIS	2 + 0.8 + 1.75 + 0.25%	100	100	100	100	99
Aminocyclpyrachlor + triclopyr + fluroxypyr[d] + NIS	2 + 0.8 + 12 + 4 + 0.25%	98	99	100	99	99
Aminocyclpyrachlor + metsulfuron + NIS	2 + 0.3 + 0.25%	99	100	100	99	99
Aminocyclpyrachlor + metsulfuron + 2,4-D + dicamba[e] + NIS	2 + 0.3 + 11.5 + 4.01 + 0.25%	98	86	100	99	98
Aminocyclpyrachlor + metsulfuron + picloram + 2,4-D[f] + NIS	2 + 0.3 + 2.1 + 8.1 + 0.25%	99	98	100	100	99
Aminocyclpyrachlor + metsulfuron + NIS in nitrogen carrier[g]	2 + 0.3 + 0.25 %	99	91	100	100	99
Aminocyclpyrachlor + metsulfuron + malathion + NIS	2 + 0.3 + 16 + 0.25 %	98	99	100	100	100
Untreated	● ● ●	0	0	0	0	0
LSD (0.05)		3	5	1	1	4

[a]Dispersible granule formulation - Perspective by E.I. duPont de Nemours and Company, 1007 Market Street, Wilmington, DE 19898.
[b]Surfactant Induce by Helena Chemical Co., 225 Schilling Blvd, Collierville, TN 38017.
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[d]Commercial formulation - Weedmaster by Nufarm Inc., 150 Harvester Drive, Burr Ridge, IL 60527.
[f]Nitrogen fertilizer 28-0-0.

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