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FOREWORD

The 2019 Research Progress Report of the Western Society of Weed Science (WSWS) is a compilation of research investigations contributed by weed scientists in the western United States of America. The objective of the Research Progress Report is to provide an avenue for presentation and exchange of on-going research to the weed science community. The information in this report is preliminary; therefore, it is not for the development of endorsements or recommendations.

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

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Research Progress Report Editor
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Table 1. Application and soil data.

Application date	November 7, 2016
Annual grass growth stage	1 leaf for all species
Air temperature (F)	64
Relative humidity (%)	48
Wind (mph, direction)	3, WNW
Cloud cover (%)	20
Soil temperature at 4 inches (F)	44
Soil pH	6.9
Soil texture	silt loam

Eight months after treatment, all treatments provided some level of control (43 to 100%) of annual grasses compared to the untreated check (Table 2). Weed control of over 90% was achieved with both rates of indaziflam + glyphosate, both rates of rimsulfuron, and both rates of indaziflam + rimsulfuron. Control levels at or near 100% were achieved with the high rate of indaziflam + glyphosate, the high rate of rimsulfuron, and indaziflam + rimsulfuron at both rates. However, these same treatments also had the lowest cover of perennial grasses: 2 to 10%. In contrast, perennial grass cover of 25% and 34% was observed with the low rate of rimsulfuron and the low rate of indaziflam + glyphosate, respectively. In comparison, the untreated check had 15% average cover of perennial grasses. Per visual evaluation, indaziflam + rimsulfuron at both the low and high rates caused 70 to 100% injury (symptom: chlorosis) in perennial grasses, primarily bluebunch wheatgrass (*Pseudoroegneria spicata*), but the plants survived (data not shown). The high rate of rimsulfuron and the high rate of indaziflam + glyphosate injured or killed tall oatgrass (*Arrhenatherum elatius*; data not shown). Glyphosate and both rates of indaziflam applied alone were least effective in controlling Japanese brome compared to control of ventenata and downy brome (data not shown).

Nineteen months after treatment, control levels at or near 100% were achieved with the three treatments that included the high rate of indaziflam; though the treatments with the low rate of indaziflam also provided control (78 to 87%; Table 2). Markedly, compared to the first evaluation date, at 19 MAT, percent control increased for both rates of indaziflam applied alone and decreased for both rates of rimsulfuron applied alone. While perennial grass cover was not significantly different between treatments 19 MAT ($p > 0.1$), the treatments that had 2-10% average cover on the first evaluation date increased to 6-28% average cover on the second evaluation date. In general, perennial bunchgrasses that appeared injured 8 MAT were mostly recovered upon evaluation 19 MAT (data not shown).

Table 2. Annual grass control and perennial grass cover following applications of indaziflam and rimsulfuron at different rates.[1]

Treatment[2]	Rate		Annual grass control		Perennial grass cover	
			8 MAT[3]	19 MAT[4]	8 MAT[3]	19 MAT[4]
	oz/A	lb ai/A	%			
Indaziflam + glyphosate	5 + 12	0.065 + 0.516	92 ab	87 ab	34 a	18
Indaziflam + glyphosate	7 + 12	0.092 + 0.516	100 a	98 a	6 bc	10
Rimsulfuron	3	0.047	91 abc	40 cde	25 ab	13
Rimsulfuron	4	0.063	99 a	41 bcde	10 bc	28
Indaziflam + rimsulfuron	5 + 3	0.065 + 0.047	100 a	84 abc	2 c	6
Indaziflam + rimsulfuron	7 + 4	0.092 + 0.063	100 a	100 a	10 bc	10
Imazapic	7	0.109	68 bcd	37 de	26 ab	21
Glyphosate	12	0.516	43 d	29 e	34 a	22
Indaziflam	5	0.065	61 cd	78 abcd	13 abc	15
Indaziflam	7	0.092	74 abc	98 a	10 bc	6
LSD (α = 0.05)			30	46	23	NS

[1]Within columns, means followed by the same letter are not statistically significantly different.
[2]All treatments were applied with a non-ionic surfactant at 0.25% v/v.
[3]Evaluation on July 7, 2017.
[4]Evaluation on June 6, 2018.

Invasive annual grass control with indaziflam in different tank mixes at natural sites. Lisa C. Jones and Timothy Prather. (Department of Plant Sciences, University of Idaho, Moscow, ID 83844-2333) A study was established in grassland to examine weed control of winter annual grasses near Lewiston, ID. In order of decreasing abundance, the site was invaded by Japanese brome, downy brome, and ventenata. Plots 10 by 20 ft were arranged in a randomized complete block design with three replications of nine treatments plus an untreated check. All herbicides were applied using a CO_2 pressurized backpack sprayer calibrated to deliver 20 gpa at 30 psi and 3 mph (Table 1). Perennial grasses were dormant at the time of application. Perennial plant injury and weed control were visually evaluated on July 6, 2017 (8 MAT) and June 6, 2018 (19 MAT), using reduction in foliar cover contrasted to the control as the dependent variable.

Table 1. Application and soil data.

Application date	November 7, 2016
Annual grass growth stage	1 leaf for all species
Air temperature (F)	54
Relative humidity (%)	64
Wind (mph, direction)	1, SSE
Cloud cover (%)	100
Soil temperature at 4 inches (F)	44
Soil pH	6.9
Soil texture	silt loam

Eight months after treatment, all treatments except propoxycarbazone provided some level of control (68 to 100%) of annual grasses compared to the untreated check (Table 2). Weed control of 89% and higher was achieved with indaziflam, rimsulfuron, indaziflam + propoxycarbazone, indaziflam + rimsulfuron, and indaziflam + glyphosate. Weed control and high bluebunch wheatgrass (*Pseudoroegneria spicata*) cover were achieved with indaziflam, rimsulfuron, and indaziflam + propoxycarbazone. While propoxycarbazone performed poorly when considering control of all annual grass weeds, it controlled Japanese brome (93% control on average) compared to downy brome (0% control; data not shown). Indaziflam + rimsulfuron caused approximately 30% injury (symptom: stunting and delayed flowering) to bluebunch wheatgrass, resulting in a reduction in foliar cover to 0% and 3% in two of the three replicates (data not shown). In contrast, adjacent plots maintained 13% and 28% cover of bluebunch wheatgrass.

Nineteen months after treatment, annual grass control significantly decreased in plots treated with rimsulfuron, imazapic, and glyphosate (Table 2). Treatments with indaziflam maintained better control (67 to 100%) at this evaluation date. While bluebunch wheatgrass cover was not significantly different between treatments 19 MAT ($p > 0.1$), overall cover either remained unchanged or decreased compared to the first evaluation date. In general, bluebunch wheatgrass that appeared injured 8 MAT were mostly recovered upon evaluation 19 MAT (data not shown).

Table 2. Annual grass control and bluebunch wheatgrass cover following applications of indaziflam with different tank mixtures.[1]

Treatment[2]	Rate		Annual grass control		Bluebunch wheatgrass cover	
			8 MAT[3]	19 MAT[4]	8 MAT[3]	19 MAT[4]
	oz/A	lb ai/A	------------------------------ % ------------------------------			
Indaziflam	7	0.092	89 ab	67 ab	32 a	4
Propoxycarbazone	1.2	0.044	6 d	28 bc	5 cd	1
Rimsulfuron	4	0.063	97 ab	28 bc	20 abc	2
Imazapic	7	0.109	68 c	19 c	20 abcd	10
Glyphosate	12	0.475	80 bc	5 c	17 abcd	2
Indaziflam + propoxycarbazone	7 + 1.2	0.092 + 0.044	94 ab	100 a	27 ab	3
Indaziflam + rimsulfuron	7 + 4	0.092 + 0.063	100 a	99 a	8 bcd	8
Indaziflam + imazapic	7 + 7	0.092 + 0.109	85 abc	96 a	19 abcd	13
Indaziflam + glyphosate	7 + 12	0.105 + 0.475	100 a	94 a	0 d	0
LSD (α = 0.05)			19	47	20	NS

[1]Within columns, means followed by the same letter are not statistically significantly different.
[2]All treatments were applied with a non-ionic surfactant at 0.25% v/v.
[3]Evaluations made July 6, 2017.
[4]Evaluations made June 6, 2018.

Medusahead control with different rates and timings of aminopyralid at natural sites. Lisa C. Jones and Timothy Prather. (Department of Plant Sciences, University of Idaho, Moscow, ID 83844-2333) A study was established on a pasture to examine medusahead control in Fenn, ID. Plots 10 by 30 ft were arranged in a randomized complete block design with three replications of seven treatments plus an untreated check. All herbicides were applied using a CO_2 pressurized backpack sprayer calibrated to deliver 20 gpa at 30 psi and 3 mph (Table 1). Perennial grasses were dormant at the time of treatment application. Perennial plant cover and weed control were visually evaluated on July 3, 2018 (2, 3, and 9 MAT), using reduction in foliar cover contrasted to the control as the dependent variable, using reduction in foliar cover contrasted to the control as the dependent variable.

Table 1. Application data.

Application timing	Fall 2017	Winter 2018	Spring 2018
Application date	September 28, 2017	March 20, 2018	April 26, 2018
Medusahead growth stage	Pre-emergent	Boot stage	Early reproductive stage
Air temperature (F)	71	56	77
Relative humidity (%)	39	40	34
Wind (mph, direction)	2, SSE	4, S	4, NE
Cloud cover (%)	0	20	0
Soil temperature at 2 inches (F)	64	50	58

Upon evaluation during the first growing season, both the low and high rates of aminopyralid applied in fall 2017 had the greatest control of medusahead (Table 2).

While not statistically significant (p = 0.08), average perennial bunchgrass cover between treatments ranged from 3 to 32% (data not shown). The greatest cover (>20%) was observed in plots with the fall 2017 aminopyralid treatment as well as the spring 2018 aminopyralid treatment that resulted in 65% medusahead control. The lowest cover (<7%) was observed in plots with the winter 2018 aminopyralid treatment and the spring 2018 aminopyralid treatment that resulted in 60% medusahead control. For comparison, the untreated plots averaged 15% cover of perennial bunchgrasses. Meadow foxtail (*Alopecurus pratensis*) was the dominant bunchgrass, followed by Kentucky bluegrass (*Poa pratensis*) and intermediate wheatgrass (*Thinopyrum intermedium*).

Table 2. Medusahead control following applications of aminopyralid at different rates and times.[1]

Treatment	Rate		Application timing[2]	Medusahead control[3]
	oz/A	lb ae/A[4]		%
Aminopyralid	7	0.092	Fall 2017	94 ab
Aminopyralid	7	0.092	Spring 2018	
Aminopyralid	14	0.184	Fall 2017	100 a
Aminopyralid	14	0.184	Spring 2018	
Aminopyralid	7	0.092	Spring 2018	60 c
Aminopyralid	7	0.092	Fall 2018	
Aminopyralid	14	0.184	Spring 2018	61 c
Aminopyralid	14	0.184	Fall 2018	
Aminopyralid	7	0.092	Fall 2017	96 ab
Aminopyralid	7	0.092	Fall 2018	
Aminopyralid	7	0.092	Spring 2018	65 bc
Aminopyralid	7	0.092	Spring 2019	
Aminopyralid + glyphosate	14 + 12	0.184 + 0.475	Winter 2018	59 c
Aminopyralid + glyphosate	14 + 12	0.184 + 0.475	Winter 2019	
LSD (α = 0.05)				32

[1]Within columns, means followed by the same letter are not statistically significantly different.
[2]Effects of the Fall 2018, Winter 2019, and Spring 2019 application timings are not included in this evaluation.
[3]Evaluations made July 3, 2018.
[4]Glyphosate is expressed as lb ai/A.

Comparison of pre-emergence herbicides for ventenata control at natural sites. Lisa C. Jones and Timothy Prather. (Department of Plant Sciences, University of Idaho, Moscow, ID 83844-2333) A study was established on Conservation Reserve Program land to examine ventenata control in Kendrick, ID. Plots 10 by 30 ft were arranged in a randomized complete block design with three replications of twelve treatments plus an untreated check. All herbicides were applied using a CO_2 pressurized backpack sprayer calibrated to deliver 18 gpa at 30 psi and 3 mph (Table 1). Perennial grasses were dormant at the time of treatment application. Perennial plant cover and weed control were visually evaluated on July 27, 2018 (10 MAT), using reduction in foliar cover contrasted to the control as the dependent variable.

Table 1. Application data.

Application date	September 27, 2017
Ventenata growth stage	Pre-emergent
Air temperature (F)	63
Relative humidity (%)	58
Wind (mph, direction)	3, SE
Cloud cover (%)	0
Soil temperature at 2 inches (F)	62

Ten months after treatment, most treatments performed poorly in control of ventenata except for those containing indaziflam, which had 100% control (Table 2). The next highest level of control, at 59%, was with the highest rate of metsulfuron methyl.

Differences in perennial grass cover between treatments were not statistically significant ($p = 0.17$). Treatments had an average perennial grass cover of 21 to 48% (data not shown). The most common perennial bunchgrasses were tall wheatgrass (*Thinopyrum ponticum*), meadow foxtail (*Alopecurus pratensis*), and mountain brome (*Bromus marginatus*).

Table 2. Ventenata control following applications of pre-emergent herbicides at different rates.[1]

Treatment	Rate		Ventenata control[2]
	oz/A	lb ai/A[3]	%
Aminopyralid	7	0.092	17 c
Aminopyralid	10	0.131	13 c
Aminopyralid	14	0.184	14 c
Metsulfuron methyl	3.3	0.147	29 bc
Metsulfuron methyl	4.7	0.209	17 c
Metsulfuron methyl	6.6	0.294	59 b
Aminopyralid + sulfosulfuron	7 + 0.66	0.092 + 0.001	8 c
Metsulfuron methyl + sulfosulfuron	3.3 + 0.66	0.147 + 0.001	28 bc
Aminopyralid + indaziflam	7 + 3	0.092 + 0.039	100 a
Metsulfuron methyl + indaziflam	3.3 + 3	0.147 + 0.039	100 a
Sulfosulfuron	0.66	0.001	13 c
Indaziflam	3	0.039	100 a
LSD ($\alpha = 0.05$)			38

[1]Within columns, means followed by the same letter are not statistically significantly different.
[2]Evaluations made July 27, 2018.
[3]Aminopyralid is expressed as lb ae/A.

Ventenata control with different rates of indaziflam/rimsulfuron compared to operational standards at natural sites. Lisa C. Jones and Timothy Prather. (Department of Plant Sciences, University of Idaho, Moscow, ID 83844-2333) A study was established on Conservation Reserve Program land to examine ventenata control in Moscow, ID. Plots 10 by 30 ft were arranged in a randomized complete block design with three replications of eight treatments plus an untreated check. All herbicides were applied using a CO_2 pressurized backpack sprayer calibrated to deliver 20 gpa at 30 psi and 3 mph (Table 1). Perennial grasses were dormant at the time of treatment application. Perennial plant cover and weed control were visually evaluated on June 15, 2016 (3 MAT), June 2, 2017 (16 MAT), and June 7, 2018 (27 MAT), using reduction in foliar cover contrasted to the control as the dependent variable.

Table 1. Application and soil data.

Application date	March 21, 2016
Ventenata growth stage	1 leaf
Air temperature (F)	68
Relative humidity (%)	47
Wind (mph, direction)	3, W
Cloud cover (%)	10
Soil temperature at 2 inches (F)	46
Soil pH	6.2
Soil texture	silt loam

Three months after treatment, all treatments except glyphosate controlled ventenata 57 to 100% compared to the untreated check (Table 2). The indaziflam + glyphosate treatments had worse control—57% and 75% for the respective low and high rates of indaziflam—than the remaining treatments at this early evaluation date. Differences in perennial grass cover between treatments were not statistically significant ($p = 0.14$). Treatments had an average perennial grass cover of 21 to 65% (data not shown).

Sixteen months after treatment, all treatments except glyphosate controlled ventenata 63 to 100% compared to the untreated check (Table 2). Ventenata control of 89% and higher was achieved with both rates of indaziflam + glyphosate, rimsulfuron at the high rate, indaziflam/rimsulfuron premixture at the high rate, and imazapic. Differences in perennial grass cover between treatments was not statistically significant ($p = 0.27$). Treatments had an average perennial grass cover of 28 to 58% (data not shown).

Twenty-seven months after application, all treatments except the low rate of rimsulfuron, imazapic, and glyphosate controlled ventenata 67 to 100% compared to the untreated check (Table 2). Ventenata control of 84% and higher was achieved with the four treatments that included indaziflam. Differences in perennial grass cover between treatments were not statistically significant ($p = 0.25$). Treatments had an average perennial grass cover of 12 to 43% (data not shown). Notably, upon evaluation 27 MAT, smooth brome (*Bromus inermus*) plants in plots treated with the high rate of indaziflam + glyphosate were observed to be taller and have more inflorescences compared to smooth brome plants in other plots.

Over time, percent control from the indaziflam + glyphosate treatments increased and percent control from the indaziflam/rimsulfuron treatments remained mostly unchanged. Conversely, percent control from both rates of rimsulfuron alone decreased over time, with control from the low rate decreasing more strongly.

Table 2. Ventenata control following applications of indaziflam and rimsulfuron at different rates. [1]

Treatment[2]	Rate		Ventenata control		
			3 MAT[3]	16 MAT[4]	27 MAT[5]
	oz/A	lb ai/A		%	
Indaziflam + glyphosate	5 + 12	0.065 + 0.516	57 b	94 ab	84 ab
Indaziflam + glyphosate	7 + 12	0.092 + 0.516	75 b	94 ab	93 ab
Rimsulfuron	3	0.047	97 a	63 b	33 c
Rimsulfuron	4	0.063	99 a	89 ab	67 b
Indaziflam/rimsulfuron	4.5	0.119	98 a	81 ab	96 ab
Indaziflam/rimsulfuron	6	0.158	100 a	100 a	100 a
Imazapic	7	0.109	100 a	90 ab	34 c
Glyphosate	12	0.516	13 c	9 c	9 c
LSD (α = 0.05)			22	34	30

[1]Within columns, means followed by the same letter are not statistically significantly different.
[2]All treatments were applied with a non-ionic surfactant at 0.25% v/v.
[3]Evaluations made June 15, 2016.
[4]Evaluations made June 2, 2017.
[5]Evaluations made June 7, 2018.

Ventenata control with different rates of indaziflam at natural sites. Lisa C. Jones and Timothy Prather. (Department of Plant Sciences, University of Idaho, Moscow, ID 83844-2333) A study was established on Conservation Reserve Program land to examine ventenata control in Moscow, ID. Plots 10 by 20 ft were arranged in a randomized complete block design with three replications of five treatments plus an untreated check. All herbicide treatments were applied using a CO_2 pressurized backpack sprayer calibrated to deliver 15 gpa at 30 psi and 3 mph (Table 1). Perennial grasses were dormant at the time of application. Perennial plant cover and weed control were visually evaluated on July 11, 2017 (8 MAT) and June 4, 2018 (19 MAT), using reduction in foliar cover contrasted to the control as the dependent variable.

Table 1. Application and soil data.

Application date	November 8, 2016
Ventenata growth stage	1 leaf
Air temperature (F)	64
Relative humidity (%)	48
Wind (mph, direction)	3, NW
Cloud cover (%)	0
Soil temperature at 4 inches (F)	47
Soil pH	5.5
Soil texture	silt loam

Eight months after application, all treatments except imazapic + glyphosate controlled ventenata 93 to 100% contrasted to the untreated check (Table 2). Differences in perennial grass cover between treatments were not statistically significant (p = 0.08). Treatments had an average perennial grass cover of 38 to 70% upon evaluation on July 11, 2017 (data not shown).

Nineteen months after treatment, the three treatments with indaziflam + glyphosate maintained control of ventenata at 99 to 100% contrasted to the untreated check (Table 2). The sulfosulfuron + glyphosate treatment that controlled ventenata the first year lost this effect at the second evaluation date. Differences in perennial grass cover between treatments were not statistically significant (p = 0.16). Treatments had an average perennial grass cover of 39 to 60% upon evaluation on June 4, 2018 (data not shown).

Table 2. Ventenata control following applications of indaziflam at different rates.[1]

			Ventenata control	
Treatment	Rate		8 MAT[3]	19 MAT[4]
	oz/A	lb ai/A	%	%
Indaziflam + glyphosate	3 + 6	0.039 + 0.238	99 a	99 a
Indaziflam + glyphosate	4 + 6	0.052 + 0.238	100 a	100 a
Indaziflam + glyphosate	5 + 6	0.065 + 0.238	100 a	100 a
Sulfosulfuron + glyphosate[2]	1.33 + 6	0.002 + 0.238	93 a	33 b
Imazapic + glyphosate[2]	6 + 6	0.093 + 0.238	21 b	35 b
LSD (α = 0.05)			31	39

[1]Means followed by the same letter are not statistically significantly different.
[2]Treatments were applied with a non-ionic surfactant at 0.25% v/v.
[3]Evaluations made July 11, 2017.
[4]Evaluations made June 4, 2018.

Ventenata control with different rates and timings of indaziflam and rimsulfuron at natural sites. Lisa C. Jones and Timothy Prather. (Department of Plant Sciences, University of Idaho, Moscow, ID 83844-2333) A study was established on Conservation Reserve Program land to examine ventenata control in Kendrick, ID. Plots 10 by 30 ft were arranged in a randomized complete block design with three replications of ten treatments plus an untreated check. All herbicides were applied using a CO_2 pressurized backpack sprayer calibrated to deliver 20 gpa at 30 psi and 3 mph (Table 1). Perennial grasses were dormant at the time of application. Perennial plant cover and weed control were visually evaluated on June 5, 2018 (7-9 MAT), using reduction in foliar cover contrasted to the control as the dependent variable.

Table 1. Application and soil data.

Application date	September 19, 2017	October 10, 2017	November 9, 2017
Ventenata growth stage	pre-emergent	1 leaf	2 leaf
Air temperature (F)	46	57	43
Relative humidity (%)	82	41	72
Wind (mph, direction)	1, S	5, SE	4, S
Cloud cover (%)	100	100	100
Soil temperature at 2 inches (F)	50	50	40
Soil pH		5.8	
Soil texture		silt loam	

At the June 5, 2018 evaluation, all treatments except imazapic controlled ventenata 100% (Table 2). While imazapic performed poorly overall, it was the least effective when applied at ventenata one leaf stage.

Differences in perennial grass cover between treatments were not statistically significant ($p = 0.22$). Treatments had an average perennial grass cover of 5 to 24% (data not shown). The lowest perennial grass cover occurred in plots treated with the low rate of indaziflam + rimsulfuron applied at the ventenata two leaf stage. In comparison, the control plots had an average of 22% perennial bunchgrass cover. In addition, approximately 80% injury to intermediate wheatgrass (*Thinopyrum intermedium*) in the form of stunting was observed in plots treated with the high rate of indaziflam + rimsulfuron applied at the ventenata two leaf stage (data not shown).

Table 2. Ventenata control following applications of indaziflam at different rates and times.[1]

Treatment[2]	Rate		Application timing	Ventenata control[3]
	oz/A	lb ai/A		%
Indaziflam	5	0.065	Sept 19	100 a
Indaziflam	7	0.092	Sept 19	100 a
Indaziflam/rimsulfuron	4.5	0.119	Sept 19	100 a
Imazapic	7	0.109	Sept 19	23 b
Indaziflam	5	0.065	Oct 10	100 a
Indaziflam	7	0.092	Oct 10	100 a
Indaziflam/rimsulfuron	4.5	0.119	Oct 10	100 a
Imazapic	7	0.109	Oct 10	8 c
Indaziflam + rimsulfuron	5 + 3	0.065 + 0.047	Nov 9	100 a
Indaziflam + rimsulfuron	7 + 4	0.092 + 0.063	Nov 9	100 a
LSD ($\alpha = 0.05$)				8

[1]Within columns, means followed by the same letter are not statistically significantly different.
[2]All treatments were applied with a non-ionic surfactant at 0.25% v/v.
[3]Evaluations made June 5, 2018.

High rates of amicarbazone in the late season for *Poa annua* control in overseeded turf. Kai Umeda (University of Arizona Cooperative Extension, Maricopa County, Phoenix, AZ 85040). Two small plot experiments were established for *Poa annua* control in overseeded perennial ryegrass over dormant bermudagrass turf on a fairway at Encanterra Golf Course in San Tan Valley, AZ and in a rough area at the TPC Stadium Golf Course in Scottsdale, AZ. Both experiments had treatment plots measuring 5 ft by 10 ft and replicated four times in a randomized complete block design. Amicarbazone 2SC formulation treatments were sprayed using a backpack CO_2 sprayer equipped with a hand-held boom with three flat fan 8002VS nozzles spaced 20-inches apart. The sprays were applied in 30 gpa water pressurized to 50 psi and treatments included a non-ionic surfactant, Latron CS-7 at 0.25% v/v. At Encanterra Golf Course on 19 April 2018, weather conditions were clear sky, air temperature at 66°F, no wind, and soil temperature at 58°F. The *P. annua* was abundant, mature and flowering in turf was mowed at 0.5-inch height. At the TPC Stadium Golf Course on 24 April 2018, the air temperature was 74°F, clear sky, wind at <2 mph and soil temperature at 70°F. The *P. annua* was abundant, mature, and flowering in turf that was infrequently mowed at 1.0-inch height.

Amicarbazone at 0.28 and 0.34 lb a.i./A performed similarly at both locations within 2 weeks after treatment (WAT) and then giving near complete control of *P. annua* at 1 month after treatment (MAT). On a shorter height of cut on a fairway, the 0.17 lb a.i./A rate performed similar to the higher rates at 2 WAT and at 1 MAT. Perennial ryegrass injury was more pronounced on the fairway and a rate response to increasing amicarbazone rates was observed at each rating date as spring transition was initiated. In the rough area, amicarbazone at up to 0.17 lb a.i./A was safe and turf quality was similar to the untreated check.

Table 1. High rates of amicarbazone for *P. annua* control and turfgrass quality, San Tan Valley, AZ, 2018

Amicarbazone treatment (lb a.i./A)	POANN Control				Turfgrass quality			
	26 Apr	02 May	07 May	17 May	26 Apr	02 May	07 May	17 May
	------------------- % ----------------------							
untreated check	0	0 d	0 d	55 c	7.5 a	6.8 a	7.0 a	3.0 a
0.14	10	70 c	84 c	86 b	6.3 b	5.8 b	6.3 a	3.0 a
0.17	10	81 b	93 b	96 a	5.8 bc	5.0 bc	4.5 b	2.5 ab
0.28	10	81 b	95 b	99 a	5.0 cd	4.8 cd	3.0 c	2.0 bc
0.34	10	88 a	98 a	99 a	4.8 d	4.0 d	2.5 c	1.8 c

Means followed by the same letter are not significantly different by Student's t-test α = 0.05.
Turfgrass quality = overall color, density, vigor of overseeded ryegrass 1-9 scale where 1 = poor, 9 = best.
Treatments applied on 19 April 2018 at Encanterra Golf Course

Table 2. High rates of amicarbazone for *P. annua* control and turfgrass quality, Scottsdale, AZ, 2018

Amicarbazone (lb a.i./A)	POANN Control		Turfgrass quality	
	08 May	24 May	08 May	24 May
	------------ % ------------			
untreated check	0 c	0 d	8.0 a	8.0 a
0.14	64 b	81 c	7.3 ab	8.0 a
0.17	69 b	86 b	7.3 ab	8.0 a
0.28	83 a	97 a	6.8 bc	7.5 b
0.34	84 a	97 a	6.0 c	7.0 c

Means within a column followed by the same letter are not significantly different by Student's t-test α = 0.05.
Turfgrass quality = overall color, density, vigor of overseeded ryegrass 1-9 scale where 1 = poor, 9 = best.
Treatments applied on 24 April 2018 at TPC Stadium Golf Course

Amicarbazone series of rates for *Poa annua* control in overseeded turf. Kai Umeda. (University of Arizona Cooperative Extension, Maricopa County, Phoenix, AZ 85040). A small plot field experiment was conducted at the Encanterra Golf Course in San Tan Valley, AZ on a fairway with bermudagrass overseeded with perennial ryegrass in the fall 2017. Each plot measured 5 ft by 10 ft and each treatment was replicated four times in a randomized complete block design. Amicarbazone 2SC formulation treatments were sprayed with a backpack CO_2 sprayer equipped with a hand-held boom with three flat fan 8002VS nozzles spaced 20-inches apart. The sprays were applied in 23 gpa water pressurized to 50 psi, and included an adjuvant, Latron CS-7 at 0.25% v/v. The first application was on 21 February 2018 when the air temperature was 46°F, clear sky, slight wind at 3-5 mph and soil temperature at 48°F. The sequential application was made 2 weeks later on 07 March with the air temperature at 67°F, calm wind, high overcast sky, and 52°F soil temperature. Visual ratings of *P. annua* control were conducted at 1- to 2-week intervals beginning 3 weeks after the final application.

Amicarbazone at 0.140 lb a.i./A and higher rates consistently and similarly controlled *P. annua* at 89% or better (Table 1). Amicarbazone at 0.094 and 0.125 lb a.i./A marginally controlled *P. annua* between 79 to 91%. Within the treated plots, perennial ryegrass was not visibly injured; however, at the end of the plots where the sprayer started and ended, ryegrass was severely burned and damaged.

Table 1. Amicarbazone rates for *P. annua* control in winter overseeded turf, San Tan Valley, AZ 2018

Amicarbazone Treatment (lb a.i./A)	POANN Control					
	28 Mar	04 Apr	19 Apr	26 Apr	02 May	07 May
	%					
Untreated check	0 d	0 c	0 c	0 d	0 d	0 c
0.094	86 c	79 b	85 b	85 c	83 c	84 b
0.125	89 bc	85 ab	88 b	88 bc	89 b	91 a
0.140	94 ab	91 ab	94 a	90 abc	89 b	93 a
0.156	94 ab	94 a	94 a	94 ab	93 ab	96 a
0.188	95 a	94 a	95 a	96 a	96 a	97 a

Means within a column followed by the same letter are not significantly different using Student's t-test at α=0.05.
Amicarbazone applied 21 February 2018 followed sequentially at 2 weeks on 07 March.
All treatments included Latron CS-7 at 0.25% v/v

Evaluation of postemergence herbicides of liverseedgrass control in turf. Kai Umeda and Zoe Castillo (University of Arizona Cooperative Extension, Maricopa County, Phoenix, AZ 85040). A small plot field experiment was conducted at the Greenwood Cemetery in Phoenix, AZ on common bermudagrass infested with maturing panic liverseedgrass. Treatment plots measured 5 ft x 10 ft and replicated four times in a randomized complete plot design. Sprays were applied using a backpack sprayer equipped with a hand-held boom with three 8002VS flat-fan nozzles spaced 20-inches apart. Sprays were delivered in 44 gpa water pressurized to 50 psi. All pinoxaden treatments included an adjuvant, A12127, at 0.5% v/v and all other treatments included a non-ionic surfactant, Latron CS-7 at 0.25% v/v. Initial treatments were applied on 12 June 2018 when the air temperature was 105°F, wind was calm, sky was clear, and soil temperature was 78°F. Sequential treatments were applied on 29 June, 17 days later, when the air temperature was 80°F, clear sky and very slight breeze at 1 mph, and soil temperature was 82°F. Weed control ratings were made at intervals following the applications.

The pre-mix product halosulfuron plus foramsulfuron plus thiencarbazone provided better than 81% control of liverseedgrass within 10 days of each application. The pre-mix product iodosulfuron plus dicamba plus thiencarbazone showed similar initial activity after each application but control was not acceptable at less than 80%. Pinoxaden and amicarbazone showed limited variable activity following applications.

Table. Postemergence herbicide control of liverseedgrass, Phoenix, AZ, 2018

		UROPA Control				
Treatment	Rate	22 Jun	29 Jun	06 Jul	10 Jul	17 Jul
	(lb a.i./A)	------------------------		%		----------------------------
Untreated check		0 b	0 c	0 c	0 e	0 b
Halosulfuron + foramsulfuron + thiencarbazone	0.062 + 0.04 + 0.02	81 a	74 a	75 a	85 a	79 a
Iodosulfuron + dicamba + thiencarbazone	0.004 + 0.13 + 0.02	79 a	35 b	35 b	63 b	26 b
Pinoxaden	0.06	61 a	10 c	21 b	9 de	3 b
Pinoxaden	0.12	78 a	15 bc	31 b	24 cd	3 b
Amicarbazone	0.24	18 b	15 bc	68 a	28 c	6 b

All treatments applied sequentially on 12 June 2018 followed by 29 June.
Pinoxaden treatments included adjuvant A12127 at 0.5% v/v, all other treatments included Latron CS-7 at 0.25% v/v.
Means followed by the same letter within a column are not significantly different by Tukey-Kramer HSD.

A13617v for ryegrass removal during spring transition of bermudagrass. Kai Umeda. (University of Arizona Cooperative Extension, Maricopa County, Phoenix, AZ 85040) Perennial ryegrass was fall overseeded into a Tifway 419 bermudagrass turf on a practice baseball field at the Diablo Stadium Complex in Tempe, AZ. Experimental small plots measured 5 ft by 10 ft and treatments were replicated four times in a randomized complete block design. Each treatment was applied using a backpack CO_2 sprayer equipped with a hand-held boom with three 8002VS flat fan nozzles spaced 20 inches apart. The sprays were applied in 44 gpa water pressurized to 50 psi. An adjuvant, A12127 at 0.5% v/v was added to all A13617v treatments and Latron C-7 at 0.25% v/v was added to penoxsulam treatments. The first of two timings of application of each treatment was applied on 10 May 2018 when the air temperature was 84F, clear sky, a slight breeze with an occasional gust at 2-5 mph from the east, and soil temperature at 70F. A second timing of application was made 2 weeks later on 24 May when the air temperature was 77F, clear sky, calm, and soil temperature at 70F. Observations for ryegrass removal and turfgrass quality were made at intervals following each of the applications.

At 7 and 14 days after treatment (DAT) of early and late timings of applications for ryegrass removal, different rates of A13617v were similar in showing ryegrass injury/growth reduction (Table). The penoxsulam treated ryegrass showed similar symptoms to a lesser degree. Following the early timing at 27 DAT, A13617v at 0.045 and 0.06 lb a.i./A removed ryegrass effectively 93 and 94%, respectively. Penoxsulam exhibited 78% injury that was intermediate to the A13617v at 0.03 lb a.i./A at 68% and the higher rates. At 13 DAT of the late timing, all A13617v treatments showed ryegrass removal at better than 93% compared to penoxsulam at 81%. On 28 June, penoxsulam early or late showed 88% ryegrass removal and A13617v at 0.03 lb a.i./A early was comparable. Bermudagrass transition was similar for most treatments except when A13617v showed less quality at 21 DAT of the early timing of applications compared to the untreated or penoxsulam treated turf. When most of the ryegrass was removed at the end of June, bermudagrass quality was similar among all treatments.

Table. Ryegrass removal and bermudagrass quality during spring transition. Tempe, AZ 2018.

Treatment	Rate (lb a.i./A)	Timing	Ryegrass removal 24 May	31 May	06 Jun	28 Jun	Turf quality 24 May	31 May	28 Jun
			---------------------- % --------------------------						
Untreated			15 b	12 c	23 c	83 c	6.3 a	7.3 a	3.0 a
A13617v	0.03	early	60 a	73 ab	68 b	89 bc	5.3 a	5.3 bc	3.8 a
A13617v	0.045	early	65 a	89 a	93 a	98 a	5.0 a	4.5 c	3.5 a
A13617v	0.06	early	65 a	88 a	94 a	98 a	5.0 a	4.5 c	3.3 a
Penoxsulam	0.055	early	48 ab	39 bc	78 ab	88 c	6.0 a	6.3 ab	3.3 a
A13617v	0.03	late		41 bc	94 a	97 ab		6.3 ab	2.8 a
A13617v	0.045	late		38 bc	95 a	97 ab		6.3 ab	2.8 a
A13617v	0.06	late		38 bc	93 a	99 a		6.3 ab	2.8 a
Penoxsulam	0.055	late		21 c	81 ab	88 c		6.8 ab	3.3 a

Applications made on 10 May 2018 (early) and on 24 May (late).
All A13617v treatments included adjuvant A12127 at 0.5% v/v.
Penoxsulam treatments included Latron C-7 at 0.25% v/v.
Bermudagrass quality ratings 1-9 (1-poor, 9-best).
Means within columns with same letters are not significantly different with Tukey's HSD at 0.5%

Quinoa tolerance to s-metolachlor, s-metolachlor+benoxacor, and ethofumesate. Ed Peachey and Pete Sturman, Horticulture Dept., Oregon State University, Corvallis, 97331. A study was established in Quinoa in 2018 at the Oregon State University Vegetable Research Farm to examine plant injury and seed yield response to S-metolachlor herbicide. Quinoa was seeded on April 26, 2018. Plots were 6.5 ft by 30 ft arranged in a randomized complete block design with three replications. All herbicide treatments were applied using a CO_2 backpack sprayer calibrated to deliver 20 GPA at 25 PSI. Quinoa injury and weed control were evaluated on May 18 and May 29. Quinoa seed was harvested with a small plot combine from 25 feet of row on September 6, 2018.

Table 1. Application and soil data.

Application Date	4/27/2018	5/15/2018
Quinoa growth stage	PRE	4 leaf
Weed growth stage	-	2 - 6 in
Air temperature (F)	63	56
Relative humidity (%)	61	75
Wind (mph, direction)	3-5, S	0.3 - 3.8 SW
Cloud cover (%)	0	0
Soil temperature at 2 inches (F)	58	58
pH	6.1	
OM%	3.5	
CEC	35	
Texture	Silt loam	

None of the quinoa treatments showed any visible phytotoxicity on May 18. All s-metolachlor and s-metolachlor II treatments, both PRE and POST, showed 15% to 22% stunting on May 18 and May 29. The S-metolachlor+ethofumesate tank mix applied PRE caused 33% stunting on May 18 and 20% on May 29. The ethofumesate only PRE treatment caused 10% and 3% stunting, respectively, on those dates. S-metolachlor II PRE and s-metolachlor POST did not affect quinoa seed yield compared to the untreated check plots. Both s-metolachlor POST and the S-metolachlor + ethofumesate PRE treatments suppressed seed yield with the ethofumesate-only PRE treatment causing the the largest reduction in seed yield.

Table 2. Tolerance of quinoa to s-metolachlor. N=3 for all treatments except trs 1, 2 and 3 where N=4.

	Herbicide	Timing	Rate	Emergence (18-May)	Phyto (18-May)	Stunting (18-May)	Stunting (29-May)	Weed control (18-May)	Weed control 29-May)	Seed yield (6-Sept)
			lb ai/A	no./6 ft of row	0-10	--------------------------	-------%	--------------------		lbs/A
1	Untreated (cultivated and hoed)			8	0	8	0	-	-	3387
2	S-metolachlor II	PRE	0.63	12	0	15	18	22	48	3449
3	S-metolachlor II	PRE	1.260	10	0	20	22	34	55	3368
4	S-metolachlor II	POST 4-lf	0.63	10	0	17	7	20	27	3158
5	S-metolachlor II	POST 4-lf	1.26	8	0	20	15	35	35	2958
6	S-metolachlor	POST 4-lf	0.63	13	0	17	0	17	40	3305
7	S-metolachlor	PRE	0.635	5	0	33	20	40	75	2983
	Ethofumesate	PRE	0.50							
8	Ethofumesate	PRE	1.00	13	0	10	3	53	63	2468
	PR>F			0.57	-	0.69	0.14	0.20	0.0003	0.08
	FPLSD(0.05)			ns	-	ns	ns	ns	31	620

Effect of fluroxypyr on radish when grown for seed. Ed Peachey, Horticulture Dept., Oregon State University, Corvallis OR, 97330. Trials were established in fields at Junction City (var. RA 402) and Talbot, Oregon (var. RA401) (Table 1) in the spring of 2018. Plots were 30 feet long and encompassed three rows of females and at least one row of males. Mayweed chamomile was the primary species present at Junction City. At Talbot, s-metolachlor and trifluralin were applied PPI by the grower, and weed density was very low with the exception of radish volunteers. Treatments were replicated 3 times. Radish plants were pulled from 20 ft of row in the center female row, and dried for two weeks on black plastic, with netting to hold the radish plants in place while drying. Seed was removed with a belt thresher and each sample was run through the thresher twice.

Table 1. Herbicide application data.

	Junction City		Talbot	
Date	April 20, 2018	May 01, 2018	April 25, 2018	May 03, 2018
Crop stage	Early 2-lf	4-lf, variable	75% 2-lf	2-6 lf, 50% 4 lf
Start/end time	6:45-7:15 AM	8:30-9:00 AM	8:15-8:30 AM	7:00-7:30 AM
Air temp/soil temp (2")/surface	43/45/42	59/54/55	64/54/59	64/53/54
Rel humidity	61%	63%	48%	60%
Wind direction/velocity	0	0	0	0
Cloud cover	0%	100%	0%	0%
Soil moisture	Damp	Very wet	Dry, soil crusted	Dry, soil crusted
Plant moisture	Dew	Dew	0	Dew
Sprayer/PSI	Backpack - 25	Backpack - 25	Backpack - 25	Backpack - 25
Mix size (mls)	2100	2100	2100	2100
Gallons H_20/acre	20	20	20	20
Nozzle number and type	5-XR8003	5-XR8003	4-XR8003	5-XR8003
Nozzle spacing and height (in.)	20/24	20/24	20/24	20/24

There was a slight indication of injury to radish shortly after application, but only when fluroxypyr was applied to 4-lf radish at the 12 oz/A (2x) rate. Seed yield trends across treatments differed between the two sites. At Junction City, data suggest (statistically inconclusive) that all fluroxypyr treatments reduced yield compared to the untreated check, and that yield may have been reduced the most when applied to 4-lf radish at 12 oz/A (Table 2). At Talbot, data suggest (again, statistically inconclusive) that seed yield increased with rate and with later timings. It is unclear why the two sites responded so differently to fluroxypyr. Weed competition was not a factor at either site. One possibility is that the two varieties responded differently to fluroxypyr, as has been noted in other studies, particularly when clopyralid was screened across a number of varieties in 2010 and 2011.

Table 2. Effect of fluroxypyr on radish grown for seed, Junction City, OR, 2018.

					Crop injury (males and females)					
					Phyto	Stunting	Phyto	Stunting	Weed	Seed
	Herbicide	Rate	Timing	Date	*1-May*	*1-May*	*9-May*	*9-May*	control	yield
		ai/A			0-10	%	0-10	%	%	lbs/A
1	Fluroxypyr	0.044	2 lf	20-Apr	0	0	0	0	63	434
2	Fluroxypyr	0.088	2 lf	20-Apr	0	0	0	0	76	405
3	Fluroxypyr	0.131	4 lf	1-May	0	0	0	0	58	396
4	Fluroxypyr	0.263	4 lf	1-May	0	0	2	10	87	324
5	Fluroxypyr +	0.044	2 lf	20-Apr	0	0	0	0	99	426
	Clopyralid	0.063								
6	Untreated		-	-	0	0	0	0	0	527
	FPLSD (0.05)				ns	ns	1	7	31	ns

Table 3. Effect of fluroxypyr on radish grown for seed, Talbot, OR, 2018.

	Herbicide	ai/A Rate	Timing	Date	Crop injury (males and females) Phyto *3-May*	Stunting *3-May*	Phyto *10-May*	Stunting *10-May*	Phyto *31-May*	Stunting *31-May*	Seed yield
					0-10	%	0-10	%	0-10	%	lbs/A
1	Fluroxypyr	0.044	2 lf	20-Apr	0	0	0	0	0	0	486
2	Fluroxypyr	0.088	2 lf	20-Apr	0	0	0	0	0	0	575
3	Fluroxypyr	0.131	4 lf	1-May	0	0	0	0	0	0	762
4	Fluroxypyr	0.263	4 lf	1-May	0	0	1	0	0	13	842
5	Untreated				0	0	0	0	0	0	684
FPLSD (0.05)					*ns*	*ns*	*1*	*7*	*31*	*ns*	*ns*

Dry bean response to cover crop removal method, herbicides and row spacing. Alexis M. Thompson, Don W. Morishita, Rabecka L. Hendricks. (Kimberly Research and Extension Center, University of Idaho, Kimberly, ID 83341). A field experiment was conducted at the University of Idaho Research and Extension Center near Kimberly, Idaho to: 1) compare the effectiveness of cover crop removal method on dry bean planted in different row spacing and weed density and 2) compare weed density and biomass in response to weed control treatments. Experimental design was a 2 by 2 by 4 factorial randomized complete block with four replications. Individual plots were 7.33 ft wide by 30 ft long. Dry bean was planted in 22-inch or 7.5-inch row spacing. Soil type was a Portneuf silt loam (19.0% sand, 60% silt, and 21% clay) with a pH of 8.3, 1.3% organic matter, and CEC of 28.4-meq/100 g soil. Austrian winter pea was planted as the cover crop at a rate of 80 lb/A on April 11, 2018 and cover crop removal was conducted on June 13. Cover crop removal methods were: 1) roller crimper only; 2) roller crimper with glyphosate + tribenuron; 3) roller crimper with glyphosate only; and 4) roller crimper with tribenuron only. Kidney bean (var. Red Zone) was planted June 18 in 22-inch rows at a rate of 100,000 seed/A and in 7.5-inch rows at a rate of 125,000 seeds/A. Common lambsquarters (CHEAL), redroot pigweed (AMARE), and shepherd's purse (CAPBP) were the major weeds present. Herbicides were applied broadcast with a CO_2-pressurized hand-held sprayer calibrated to deliver 15 gpa using 11001 flat fan nozzles. Additional environmental and application information is given in Table 1. Cover crop control was assessed visually 6 and 15 days after first herbicide application (DAFA) on June 19 and June 28. Weed counts were conducted 8 and 28 days after last application (DALA) on July 17 and August 6, respectively. Weed biomass was sampled by harvesting the weeds in two 0.5 m^2 quadrats in each plot on August 9. The center 4.88 feet of each plot was cut on October 16 and mechanically thrashed on November 7.

Table 1. Environmental conditions at application.

Application date	6/13/18	6/19/18	7/3/18	7/9/18
Application timing	7 days before planting	pre-emergence	unifoliate	1st trifoliate
Air temperature (F)	90	65	56	80
Soil temperature (F)	71	61	68	71
Relative humidity (%)	28	70	41	39
Wind velocity (mph)	6	4	6	3
Cloud cover (%)	5	80	10	40
Time of day	1415	1000	0850	1040

There was a significant weed control treatment by row spacing by cover crop removal method interaction for cover crop control on both evaluation dates (Table 2). Austrian winter pea removed with the roller crimper only averaged only 17% across the weed control treatment and row spacing at 6 DAFA. By 15 DAFA, cover crop control with the roller crimper only averaged only 7%. Using the roller crimper alone was ineffective. It may have been due to not having enough weight on the roller crimper. At 6 DAFA, there was not much difference in cover crop control with any of the herbicide combinations used with the roller crimper. However, at 15 DAFA cover control using tribenuron only with the roller crimper was not as good as glyphosate alone or glyphosate + tribenuron. Cover crop control 15 DAFA with the roller crimper and glyphosate alone or glyphosate + tribenuron was the best and ranged from 95 to 100% control. Weed densities were very low at each weed counting date. Nevertheless, there was a significant weed control treatment by row spacing interaction for common lambsquarters and redroot pigweed densities at 8 DALA. More common lambsquarters and redroot pigweed were counted in the 22-inch rows than the 7.5-inch rows. By 28 DALA however, there were no differences in common lambsquarters or redroot pigweed densities. Also at 28 DALA, shepherd's-purse density was higher where dimethenamid-P was applied postemergence compared to bentazon applied postemergence averaged across row spacing and cover crop removal method. Weed biomass responded with a significant weed control treatment by row spacing by cover crop removal method interaction. However, the interaction was in the roller crimper only removal method. Weed biomass was highest with dimethenamid-P applied postemergence compared in the 22-inch row spacing. Dry bean yield was different only in response to cover crop removal method. Dry bean yield was lowest with the roller crimper only removal method at 335 lb/A and the yield was highest using the roller crimper with glyphosate alone or glyphosate + tribenuron at 1,832 and 1,734 lb/A, respectively. These results indicate that bean yield is not affected by the row spacing or the weed control method as much as it is by the cover crop removal method.

Table 2. Dry bean yield, weed density, and weed biomass response to cover crop removal method, herbicides and row spacing.[1]

	Application		Cover crop removal[3]	Row	Cover crop control[4]		Weed counts[2]					Weed	Harvest
							CHEAL		AMARE		CAPBP	biomass	yield[5]
Treatment[6]	rate	date	6/13	spacing[7]	6/19	6/28	7/17	8/6	7/17	8/6	8/6	8/9	11/7
	lb ai/a				----------%----------		-----------------------plants/A-----------------------					kg/ha	lbs/A
EPTC +	2.63 +	6/19	RC only	22-inch	16 f	5 ef	4,047a	809 a	4,047 a	4,452 a	405 b	900 bc	355 c
ethalfluralin fb	1.13												
bentazon + adjuvant	0.3 + adjuvant	7/3											
EPTC +	2.63 +	6/19	RC only	22-inch	17 f	4 f	0 b	809 a	0 b	3,238 a	1,619 a	2,300 a	
ethalfluralin fb	1.13												
dimethenamid-P	0.84	7/9											
EPTC +	2.63 +	6/19	RC only	7.5-inch	19 ef	8 ef	0 b	809 a	0 ab	2,024 a		1,338 b	
ethalfluralin fb	1.13												
bentazon + adjuvant	0.3 + adjuvant	7/3											
EPTC +	2.63 +	6/19	RC only	7.5-inch	17 f	10 e	0 b	0 a	0 a	4,047 a		752 b	
ethalfluralin fb	1.13												
dimethenamid-P	0.84	7/9											
EPTC +	2.63 +	6/19	RC, GLY, TRI	22-inch	43 a-d	100 a						7 d	1,734 a
ethalfluralin fb	1.13												
bentazon + adjuvant	0.3 + adjuvant	7/3											
EPTC +	2.63 +	6/19	RC, GLY, TRI	22-inch	33 d	95 a						9 d	
ethalfluralin fb	1.13												
dimethenamid-P	0.84	7/9											
EPTC +	2.63 +	6/19	RC, GLY, TRI	7.5-inch	62 ab	100 a						127 cd	
ethalfluralin fb	1.13												
bentazon + adjuvant	0.3 + adjuvant	7/3											
EPTC +	2.63 +	6/19	RC, GLY, TRI	7.5-inch	16 f	99 a						200 cd	
ethalfluralin fb	1.13												
dimethenamid-P	0.84	7/9											
EPTC +	2.63 +	6/19	RC, GLY	22-inch	36 cd	100 a						136 cd	1,832 a
ethalfluralin fb	1.13												
bentazon + adjuvant	0.3 + adjuvant	7/3											
EPTC +	2.63 +	6/19	RC, GLY	22-inch	33 d	100 a						422 cd	
ethalfluralin fb	1.13												
dimethenamid-P	0.84	7/9											
EPTC +	2.63 +	6/19	RC, GLY	7.5-inch	58 ab	99 a						31 cd	
ethalfluralin fb	1.13												
bentazon + adjuvant	0.3 + adjuvant	7/3											

Table 2. continued.

Treatment[6]	Application rate	Application date	Cover crop removal[3] 6/5	Row spacing[7]	Cover crop control[4] 6/19	Cover crop control[4] 6/28	Weed density[2] CHEAL 7/17	Weed density[2] CHEAL 8/6	Weed density[2] AMARE 7/17	Weed density[2] AMARE 8/6	Weed density[2] CAPBP 8/6	Weed biomass 8/9	Harvest yield[5] 11/7
	lb ai/a				----------%----------		-----------------------plants/A-----------------------					kg/ha	lbs/A
EPTC +	2.63 +	6/19	RC, GLY	7.5-inch	63 ab	100 a						329 cd	
ethalfluralin fb	1.13												
dimethenamid-P	0.84	7/9											
EPTC +	2.63 +	6/19	RC, TRI	22-inch	30 de	19 d						374 cd	1,194 b
ethalfluralin fb	1.13												
bentazon + adjuvant	0.3 + adjuvant	7/3											
EPTC +	2.63 +	6/19	RC, TRI	22-inch	37 bcd	20 cd						384 cd	
ethalfluralin fb	1.13 +												
dimethenamid-P	0.84												
EPTC +	2.63 +	6/19	RC, TRI	7.5-inch	45 a-d	25 c						194 cd	
ethalfluralin fb	1.13												
bentazon + adjuvant	0.3 + adjuvant	7/3											
EPTC +	2.63 +	6/19	RC, TRI	7.5-inch	65 a	48 b						546 bcd	
ethalfluralin fb	1.13												
dimethenamid-P	0.84	7/9											

[1]Means followed by same letter within a column are not significantly different (P=0.05).
[2]Weed species counted were: common lambsquarters (CHEAL), redroot pigweed (AMARE), and shepherd's-purse (CAPBP). CHEAL and AMARE densities were significant weed control treatment by row spacing interaction on 7/17 only. CAPBP density responded only to weed control treatment.
[3]RC is a roller crimper, similar to one that is used for commercial farming, built by the UI. GLY is glyphosate used at a rate of 1 lb ae/A and sold as Roundup Power Max. TRI is tribenuron-methyl used at a rate of 0.0103 lb ai/A and is sold as Express.
[4]Cover crop control and weed biomass were significant weed control treatment by row spacing by cover crop removal method interactions. Cover crop was Austrian winter pea.
[5]Harvest yield responded only to cover crop removal method.
[6]EPTC is sold as Eptam 7E. Ethalfluralin is sold as Sonalan HFP. Bentazon is sold as Basagran 5L. Dimethenamid-P is sold as Outlook. Adjuvant included Class Act at 2.5% v/v and StrikeLock at 0.5 pt/A.
[7]22-inch rows were planted with a Monosem planter. 7.5-inch rows were planted with a Great Plains drill.

Comparing weed control in direct-seeded sugar beet with different herbicide treatments. Alexis M. Thompson, Don W. Morishita, Rabecka L. Hendricks. (Kimberly Research and Extension Center, University of Idaho, Kimberly, ID 83341). A field experiment was conducted at the University of Idaho Research and Extension Center near Kimberly, Idaho to compare weed control with soil-active herbicides applied with glyphosate to sugar beet planted in conventional tillage and direct seeding. Experimental design was a 2 by 7 factorial split block design with four replications. Main plots were the two tillage treatments. Herbicide treatments were the sub-plots and were four rows by 30 ft. Soil type was a Portneuf silt loam (16% sand, 64.1% silt, and 19.9% clay) with a pH of 8.1, 1.87% organic matter, and CEC of 18.3-meq/100 g soil. 'BTS2523MP' sugar beet was planted April 19, 2018 in 22-inch rows at a rate of 60,589 seed/A. Common lambsquarters (CHEAL), redroot pigweed (AMARE), and green foxtail (SETVI) were the major weed species present. Herbicides were applied broadcast with a CO_2-pressurized bicycle-wheel sprayer calibrated to deliver 15 gpa using 11001 flat fan nozzles. Additional environmental and application information is given in Table 1. Crop injury and weed control were evaluated visually 14, 27 and 97 days after the last herbicide application (DALA) on June 20, July 3 and September 11, respectively. The two center rows of each plot were harvested mechanically October 1.

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

Application date	5/14/2018	6/6/2018
Application timing	2 leaf	6 leaf
Air temperature (F)	70 F	64 F
Soil temperature (F)	59 F	61 F
Relative humidity (%)	27	56
Wind velocity (mph)	6 mph	2 mph
Cloud cover (%)	10	30
Time of day	1700	0830
Weed species/ft^2		
foxtail, green	70	77
lambsquarters, common	2	2
pigweed, redroot	2	2

Crop injury ranged from 0 to 2% at 14 and 28 DALA with no significant difference among herbicide treatments (data not shown). Between tillage treatments, there was a significant difference where CT averaged 1% and DS averaged 2%. At 14 DALA, there was a significant tillage by weed control treatment interaction for common lambsquarters control (Table 2). However, common lambsquarters control ranged from 94 to 100% in both tillage systems. There was no difference in common lambsquarters control among herbicide treatments averaged over tillage treatments 28 and 97 DALA and the control averaged 92% for all herbicide treatments. Redroot pigweed control 14 DALA ranged from 96 to 99% control. By 28 DALA, glyphosate + AMS alone and glyphosate + EPTC + AMS control was significantly lower at 83 and 77% control, respectively compared to the other herbicide treatments, which averaged 97% control. By 97 DALA, redroot pigweed control was influenced by a tillage and herbicide treatment. Glyphosate + EPTC was lower in the DS and averaged 86%, compared to the rest of the herbicide treatments, which averaged 94%. Green foxtail control 14 DALA was significantly different among herbicide treatments averaged across tillage treatments, but the control ranged from 93 to 97%. Green foxtail control with glyphosate + AMS alone was 93% and significantly lower than the other herbicide treatments except glyphosate + acetochlor + AMS. The greatest differences in green foxtail control were at 28 and 97 DALA. There was a significant tillage by herbicide treatment interaction with green foxtail control ranging from 54 to 95%. Glyphosate + *s*-metolachlor or dimethenamid-P provided the most consistent green foxtail control in both tillage treatments at both evaluation dates compared to the other treatments. All herbicide treatments had root and sucrose yields greater than the non-treated control and tillage treatment was not a factor in yield differences. Root and sucrose yields among the weed control treatments and averaged over the tillage treatments ranged from 16 to 36 ton/A and 4,646 to 10,615 lb/A, respectively. These yields were disappointingly low for reasons unknown. Sugar beet yield in adjacent studies averaged >40 ton/A with good weed control. Compared to using glyphosate alone, only glyphosate + *s*-metolachlor had root and sucrose yields that were significantly higher. Not surprisingly, there were no differences in sugar content, nitrates or conductivity among the herbicide or tillage treatments. These results further confirm sugar beet root and sucrose yield potential in direct-seeded sugar beets is equal to conventionally tilled sugar beets.

Table 2. Comparing weed control in sugar beet grown in conventional tillage (CS) vs direct seed (DS) with different herbicide.[1]

		Weed control[2]																	
		CHEAL				AMARE				SETVI									
	Application	6/20						9/11			7/3		9/11		Yield		Quality		
Treatment[3]	rate	CT	DS	7/3	9/11	6/20	7/3	CT	DS	6/20	CT	DS	CT	DS	Root	Sucrose	Conductivity	Nitrate	Sugar
	lb ai/A	%													ton/A	lb/A	mmohs/cm	ppm	%
Control		-	-	-	-	-	-	-	-	-	-	-	-	-	16 c	4,646 c	0.795 a	315 a	16.3 a
Glyphosate	1.0 lb ae/A	95 bc	96 bc	91 a	93 a	96 b	83 c	95 a	93 a	93 c	54 e	78 bcd	63 ef	73 de	28 b	8,505 b	0.661 a	210 a	16.8 a
Ethofumesate	1.0	98 ab	95 bc	93 a	92 a	99 a	99 a	95 a	95 a	95 b	84 abc	69 d	85 abc	73 de	32 ab	9,715 ab	0.704 a	220 a	17.1 a
S-metolachlor	1.2	96 bc	96 bc	92 a	94 a	98 ab	96 ab	93 a	95 a	95 b	94 a	95 a	89 ab	91 a	36 a	10,615 a	0.746 a	254 a	17.0 a
Dimethenamid-P	0.8416	95 bc	100 a	93 a	93 a	99 a	98 ab	93 a	96 a	97 a	90 ab	94 a	90 ab	89 ab	34 ab	10,102 ab	0.694 a	279 a	16.8 a
Acetochlor	1.125	95 bc	100 a	92 a	93 a	96 b	94 b	95 a	95 a	94 bc	76 bcd	70 cd	80 bcd	61 f	31 ab	9,260 ab	0.671 a	217 a	17.0 a
EPTC	3.0	94 c	95 bc	84 a	91 a	96 b	77 c	93 a	86 b	95 b	78 b-d	85 ab	78 cd	75 cd	30 ab	9,143 ab	0.698 a	185 a	17.0 a
P-value		0.0051		0.0524	0.646	0.019	.0001	0.0472		0.0016	0.188		0.0123		0.0002	0.0001	0.127	0.5348	0.5334

[1]Means followed by same letter within a column are not significantly different according to Fisher's protected LSD (P=0.05).

[2]Glyphosate + ammonium sulfate (AMS) was applied alone over all treatments except the control at 1 lb ae/A + 8.5 lb N/100 gal on May 14, 2018. One June 6, glyphosate + AMS was applied with ethofumesate, *s*-metolachlor, dimethenamid-P, acetochlor and EPTC. Glyphosate is sold as Roundup PowerMax. AMS is sold as Bronc Max. Ethofumesate is sold as Norton SC; *s*-metolachlor is sold as Dual Magnum; dimethenamid-P is sold as Outlook; acetochlor is sold as Warrant and EPTC is sold as Eptam 7E.

[3]Weed species evaluated for control were: common lambsquarters (CHEAL), redroot pigweed (AMARE), and green foxtail (SETVI). Abbreviations: CT, conventional tillage; DS, direct seed.

Comparison of sugar beet tolerance to three herbicides with and without fluxofenim herbicide safener . Rabecka, L Hendricks, Don W. Morishita, Alexis M. Thompson. (Kimberly Research and Extension Center, University of Idaho, Kimberly, ID 83341). A field experiment was conducted at the University of Idaho Research and Extension Center near Kimberly, Idaho to compare two sugar beet cultivar responses to three soil-active herbicides applied to planted seed treated with herbicide safener. Experimental design was a 2 by 2 by 4 split plot randomized complete block with four replications. The main plot was cultivar. The sub-plot was herbicide treatment, which included ethofumesate, *s*-metolachlor, and pendimethalin. The sub-sub plot was safener, which consisted of seed treated with or without fluxofenim. Individual sub-sub plots were two rows by 30 ft. Soil type was a rad silt loam (16% sand, 64.1% silt, and 19.9% clay) with a pH of 8.1% organic matter, and CEC of 18.3-meq/100 g soil. The two coded cultivars were planted May 4, 2018 in 22-inch rows at a rate of 114,000 seed/A. Stand counts were taken when sugar beet was in the cotyledon stage and again at the 2 to 3 leaf stage before thinning by hand. Herbicides were applied broadcast with a CO_2-pressurized bicycle-wheel sprayer calibrated to deliver 15 GPA using 11001 flat fan nozzles on May 4. Application began at 1440 and ended at 1500. The air temperature was 80 F, soil temperature was 62 F, relative humidity was 15%, wind speed was 4 mph, and cloud cover was 30%. Weeds in the study site were controlled with glyphosate at 1.0 lb ae/A plus ammonium sulfate (AMS) at 8.5 lb N/100 gallons spray applied at the 2-leaf growth stage. A second application of glyphosate + AMS at the same rate with dimethenamid-P at 0.82 lb ai/A was made at the 6-leaf stage. The plots were handweeded throughout the remainder of the growing season to maintain a weed-free condition. Crop injury was evaluated visually when sugar beets was in at the 2 to 3 leaf stage before thinning, and again 14 days after the 2-3 leaf evaluation on June 6, and June 25, respectively. The two center rows of each plot were harvested mechanically October 1.

There was a significant herbicide by safener treatment interaction for plant stand at the stand counts taken May 26 when sugar beet was in the cotyledon stage (Table 1). Comparing herbicide treatments with and without safener showed no differences, with the exception of the non-treated control. Fewer plants emerged in the non-treated control without safener. Stand counts taken 6 days later were not affected by safener treatment. However, stand counts in the pendimethalin treatment were lower than all other treatments, regardless of safener treatment. Crop injury averaged across cultivar and safener treatment with pendimethalin at 1.91 lb ai/A was 82% compared to *s*-metolachlor and ethofumesate, which had injury ranging from 3 to 19% (Table 2). The crop injury with pendimethalin translated into root and sucrose yield loss. There was no difference in root or sucrose yield, conductivity, nitrates, sugar content or tare among the other herbicide treatments averaged across cultivar and safener treatment. Crop injury response to fluxofenim-treated beets and non-treated beets was equal averaged across cultivars and herbicide treatments (Table 3). Averaged across cultivars and herbicide treatments, sugar beet root and sucrose yield was significantly better with the safener treatment compared to no safener. No differences were observed between safener and no safener in conductivity, nitrates, sugar content, or tare averaged across cultivars and herbicides. This one year study indicates that addition of the safener seed treatment benefitted root and sucrose yield. It is not clear if the safener improved the safety of ethofumesate or *s*-metolachlor. It was apparent that the safener had no effect on reducing crop injury potential to the pendimethalin treatment.

Table 1. Sugar beet stand establishment in response to herbicides and safener pooled across cultivars[1].

Herbicide	May 26 stand count		June 1 stand count
	with safener	without safener	
	---------------------------------------Plants/A---------------------------------------		
S-metolachlor	55,537 bc	58,863 abc	53,696 a
Ethofumesate	61,180 a	59,992 ab	63,764 a
Pendimethalin	59,398 ab	58,804 abc	18,979 b
Non-treated control	61,774 a	56,606 bc	58,952 a
P>F	0.023		0.0002

[1]Means followed by the same letter within each counting date (May 26 and June 1) are not significantly different using Fisher's Protected LSD (P≥0.05)

Table 2. Sugar beet yield and quality response to herbicide treatments pooled across cultivars and safener[1].

Treatment[2]	Application Rate	Application Date	Crop injury	Yield root	Yield sucrose	Conductivity	Nitrate	Sugar content	Tare
	lb ai/A		%	ton/A	lb/A	mmohs/cm	ppm	-----------%-----------	
S-metolachlor	1.33	5/4	19 b	30.1 a	9365 a	0.59 a	141 a	15.56 a	2.6 a
Ethofumesate	1.0	5/4	3 b	29.7 a	9455 a	0.68 a	167 a	18.21 a	2.5 a
Pendimethalin	1.91	5/4	82 a	4.8 b	1584 b	-	-	-	-
Non-treated control			--	30.6 a	9746 a	0.65 a	165 a	18.13 a	3.0 a
P>F			0.0007	0.001	0.0007	NS	NS	NS	NS

[1]Means followed by same letter within a column are not significantly different using Fisher's Protected LSD (P≥0.05).
[2]*S*-metolachlor is sold as Dual Magnum, ethofumesate is sold as Etho SC, and pendimethalin is sold as Prowl H_2O.

Table 3. Sugar beet yield and quality response to safener treatments pooled across cultivars and herbicides[1].

Treatment[2]	Crop injury	Yield root	Yield sucrose	Conductivity	Nitrate	Sugar content	Tare
	%	ton/A	lb/A	mmohs/cm	ppm	----------%--------	
Fluxofenim	37 a	25.8 a	8166 a	0.44 a	63 a	13.48 a	2.0 a
No fluxofenim	32 a	21.7 b	6909 b	0.35 a	42 a	13.59 a	2.2 a
P>F	NS	0.0028	0.0079	NS	NS	NS	NS

[1]Means followed by same letter within a column are not significantly different using Fisher's Protected LSD (P≥0.05).
[2]Fluxofenim is a commercially-available herbicide safener.

Kentucky bluegrass tolerance to pyroxasulfone. Traci A. Rauch and Joan M. Campbell. (Crop and Weed Science Division, University of Idaho, Moscow, ID 83844-2333) A study was conducted in a Kentucky bluegrass new seeding to evaluate tolerance near Southwick, Idaho. 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). The study was over sprayed with pyrasulfotole/bromoxynil at 0.217 lb ai/A and fluroxypyr at 0.14 lb ai/A for broadleaf weed control. Crop injury was evaluated visually during the growing season. Kentucky bluegrass was swathed on June 27 and harvested with a small plot combine on July 11, 2018.

Table 1. Application and soil data.

Variety and planting date		'Wild Horse' – 11/6/16	
Application timing	early fall	late fall	spring
Application date	10/16/2017	10/31/2017	5/8/2018
Growth stage			
Kentucky bluegrass	40% dormant	60% dormant	3 to 6 inch regrowth
Air temperature (F)	58	72	67
Relative humidity (%)	68	44	68
Wind (mph, direction)	2, E	1, SE	4, E
Cloud cover (%)	0	100	5
Next moisture occurred	10/20/2017	11/3/2017	5/9/2018
Soil moisture	good	good	good
Soil temperature at 2 inch (F)	50	38	58
pH		5.0	
OM (%)		5.6	
CEC (meq/100g)		13.0	
Texture		silt loam	

On April 28, 2018, Kentucky bluegrass was injured with all early fall treatments 10 to 22% (Table 2). By May 8, pyroxasulfone plus dimethenamid and the early fall application of pyroxasulfone at 0.16 lb ai/A injured Kentucky bluegrass 21 and 30%, respectively. Kentucky bluegrass injury was greatest with the same treatments on June 7. Seed yield was greatest with the untreated check and the halauxifen/florasulam treatment but did not differ from diuron plus metribuzin and pyroxasulfone at the 0.08 lb ai/A rate applied late fall. Pyroxasulfone plus dimethenamid reduced yield 46% compared to the untreated check. Pyroxasulfone at 0.08 and 0.16 lb ai/A applied early fall reduced seed yield 32 to 43%, respectively, compared to the untreated check. Seed yield of pyroxasulfone treatments applied late fall averaged 1301 lb/A compared to early fall pyroxasulfone treatments that averaged 906 lb/A.

Table 2. Kentucky bluegrass response to pyroxasulfone near Southwick, ID in 2018.

		Application	Kentucky bluegrass injury			Seed yield
Treatment[1]	Rate	timing	April 28	May 8	June 6	(not cleaned)
	lb ai/A		%	%	%	1b/A
Pyroxasulfone	0.08	early fall	10	12	10	985
Pyroxasulfone	0.16	early fall	12	30	25	826
Pyroxasulfone	0.08	late fall	0	2	2	1411
Pyroxasulfone	0.16	late fall	7	10	12	1191
Dimethenamid	0.98	early fall	11	5	8	1045
Pyroxasulfone +	0.08					
dimethenamid	0.188	early fall	22	21	20	783
Diuron +	1					
metribuzin	0.19	late fall	1	0	0	1341
Halauxifen/florasulam	0.0096	spring	-	-	0	1478
Untreated check	--	--	--	--	--	1444
LSD (0.05)			14	11	10	233

[1]Halauxifen/florasulam was applied with non-ionic surfactant (R-11) at 0.5% v/v.

Vetch control in crimson clover grown for seed. Kyle C. Roerig, Andrew G. Hulting, Daniel W. Curtis, and Carol Mallory-Smith. (Crop and Soil Science, Oregon State University, Corvallis, OR 97331) Crimson clover grown for seed is an important crop in some areas of western Oregon. For grass seed and wheat growers, it is a dicot rotational crop in a system dominated by monocots that provides good economic returns. To sustain good economic returns, seed purity is important. Vetch is a problem in crimson clover grown for seed because it competes for resources, reducing crimson clover yield, and vetch contaminates clover seed decreasing its value and increasing losses at the seed cleaner. Controlling vetch in crimson clover grown for seed is especially difficult because both are annual legumes with similar growth habits.

Two herbicides with suspected crop safety in crimson clover were evaluated. An untreated check and a grower standard, imazamox + bentazon, were also included. Crimson clover injury was 20-23% eleven weeks after application (data not shown) when 2,4-DB was applied November 1st at the higher two rates. By May 5th injury was no longer visible and the plots yielded equivalent to the untreated and grower standard (table). Vetch was not controlled by 2,4-DB, but since crop injury and yield were acceptable 2,4-DB could be a useful tool for controlling other important weeds in crimson clover. Flumetsulam was applied November 1st and March 20th at two rates. Neither rate or timing of the flumetsulam injured the crimson clover and yield was equal to or greater than the untreated check or grower standard (table). The vetch control with both rates and timings was 70-83% and were equivalent (at p-value 0.05). The control observed was primarily the stunting of the vetch plants and the suppression of flowering. Since one of the primary objectives is seed purity and currently registered herbicides provide inadequate control of vetch, flumetsulam would be a valuable tool if it were registered for use in crimson clover.

Table

	Rate		Applied	Vetch	Crimson clover	
				5/15/2018		6/26/2018
				Control	Injury	Seed yield
				---------------%---------------		lb/a
Untreated				0	0	442
Imazamox	0.039	lb ai/a	11/1/2017	0	0	447
+ bentazon	0.625	lb ai/a	11/1/2017			
2,4-DB	0.500	lb ae/a	11/1/2017	10	0	464
2,4-DB	1.000	lb ae/a	11/1/2017	0	0	461
2,4-DB	1.500	lb ae/a	11/1/2017	10	0	419
Flumetsulam	0.067	lb ai/a	11/1/2017	75	0	527
Flumetsulam	0.133	lb ai/a	11/1/2017	83	0	456
Flumetsulam	0.067	lb ai/a	3/20/2018	70	0	503
Flumetsulam	0.133	lb ai/a	3/20/2018	75	0	545
LSD P=0.05				16	-	73

<u>Glyphosate and glufosinate comparisons in irrigated corn.</u> R. S. Currie and P. W. Geier. (Kansas State University Southwest Research-Extension Center, 4500 E. Mary Street, Garden City, KS 67846) An experiment was conducted at the Kansas State University Southwest Research-Extension Center near Garden City to compare glufosinate to glyphosate as postemergence (POST) treatments following various preemergence (PRE) treatments in corn. All treatments were applied using a tractor-mounted, compressed CO_2 sprayer delivering 19.4 gpa at 3.0 mph and 30 psi. Application, environmental, crop, and weed information is given in Table 1. Natural weed populations were supplemented by overseeding the experimental area with quinoa (to simulate common lambsquarters), domesticated sunflower (to simulate common sunflower), and domesticated crabgrass (to simulate large crabgrass). Plots were 10 by 35 feet and arranged in a randomized complete block with four replications. Soil for the experiment was a Ulysses silt loam with pH 7.6 and 2.4% organic matter. Visual weed control was determined on June 6, 2018, which was 31 days after the PRE treatments (31 DA-A), and on July 25, 2018 which was 43 days after the POST treatments (43 DA-B). Yields were determined on October 5, 2018 by mechanically harvesting the center two rows of each plot and adjusting grain weights to 15.5% moisture.

Table 1. Application information.

Application timing	Preemergence	Postemergence
Application date	May 11, 2018	June 12, 2018
Air temperature (F)	89	74
Relative humidity (%)	32	63
Soil temperature (F)	77	73
Wind speed (mph)	0 to 4	4 to 6
Wind direction	South	East-southeast
Soil moisture	Good	Good
Corn		
Height (inch)	---	8 to 12
Leaves (no.)	0	5 to 6
Palmer amaranth		
Height (inch)	---	2 to 3
Density (plants/m^2)	0	1
Kochia		
Height (inch)	---	1 to 3
Density (plants/m^2)	0	8
Russian thistle		
Height (inch)	---	1 to 4
Density (plants/m^2)	0	1
Common sunflower		
Height (inch)	---	2 to 4
Density (plants/m^2)	0	1
Quinoa		
Height (inch)	---	2 to 3
Density (plants/m^2)	0	1
Green foxtail		
Height (inch)	---	1 to 2
Density (plants/m^2)	0	1
Crabgrass		
Height (inch)	---	---
Density (plants/m^2)	0	0

All herbicides controlled green foxtail 95 to 100%, common sunflower 96 to 100%, and quinoa 100% regardless of evaluation date, and did not differ between treatments (data not shown). Likewise, all PRE herbicides controlled kochia and Palmer amaranth similarly at 31 DA-A (Table 2). Kochia control was slightly less with saflufenacil/dimethenamid and atrazine PRE followed by glyphosate and atrazine POST compared to other treatments at 43 DA-B. Palmer amaranth control at 43 DA-B was 96% or more with all herbicides except when saflufenacil/dimethenamid plus atrazine PRE was followed by glyphosate with atrazine or glufosinate with atrazine POST. Although minor differences between PRE herbicides occurred for Russian thistle control at 31 DA-A, control did not differ between any herbicide at 43 DA-B. Preemergence herbicides controlled crabgrass 95% or more at 31 DA-A, and only the treatments of saflufenacil/dimethenamid plus atrazine PRE followed by glyphosate with atrazine or glufosinate with atrazine POST provided less than 94% crabgrass control at 43 DA-B. All herbicide-treated corn yielded 56 to 79 bu/A more grain than nontreated corn (Table 2), and yield was greatest from corn receiving *S*-metolachlor/atrazine/mesotrione/bicyclopyrone PRE followed by glufosinate plus atrazine POST (194 bu/A).

Table 2. Glyphosate and glufosinate comparisons in corn.

Treatment	Rate	Timing[a]	Kochia 31 DA-A[b]	Kochia 43 DA-B[c]	Palmer amaranth 31 DA-A	Palmer amaranth 43 DA-B	Russian thistle 31 DA-A	Russian thistle 43 DA-B	Crabgrass 31 DA-A	Crabgrass 43 DA-B	Corn yield
	per A		— % Visual —		— % Visual —		— % Visual —		— % Visual —		bu/A
Isoxaflutole	4.0 oz	PRE	99	100	94	96	99	98	95	96	181.1
Atrazine	32 oz	PRE									
Glufosinate	32 oz	POST									
Tembotrione/ Thiencarbazone	3.0 oz	POST									
Atrazine	16 oz	POST									
Ammonium sulfate	1.0 %	POST									
Isoxaflutole/ Thiencarbazone	4.0 oz	PRE	100	100	95	96	96	100	96	94	179.7
Atrazine	32 oz	PRE									
Glufosinate	32 oz	POST									
Dicamba/ Tembotrione	24 oz	POST									
Atrazine	16 oz	POST									
Ammonium sulfate	1.0%	POST									
Acetochlor/ Mesotrione	2.5 qt	PRE	98	100	98	99	94	100	100	98	179.0
Atrazine	32 oz	PRE									
Glyphosate	32 oz	POST									
Atrazine	16 oz	POST									
Ammonium sulfate	1.0 %	POST									
Acetochlor/ Mesotrione	2.5 qt	PRE	100	100	98	98	98	100	100	95	178.3
Atrazine	32 oz	PRE									
Glufosinate	32 oz	POST									
Atrazine	16 oz	POST									
Ammonium sulfate	1.0 %	POST									
Acetochlor/ Clopyralid/ Mesotrione	2.5 qt	PRE	100	100	100	98	100	100	99	94	185.9
Atrazine	32 oz	PRE									
Glyphosate	32 oz	POST									
Atrazine	16 oz	POST									
Ammonium sulfate	1.0 %	POST									
Acetochlor/ Clopyralid/ Mesotrione	2.5 qt	PRE	100	100	100	99	100	100	100	94	171.7
Atrazine	32 oz	PRE									
Glufosinate	32 oz	POST									
Atrazine	16 oz	POST									
Ammonium sulfate	1.0 %	POST									
Saflufenacil/ Dimethenamid	14 oz	PRE	96	94	99	93	94	95	98	90	171.1
Atrazine	32 oz	PRE									
Glyphosate	32 oz	POST									
Atrazine	16 oz	POST									

Ammonium sulfate	1.0 %	POST								
Saflufenacil/ Dimethenamid	14 oz	PRE	99	100	98	88	93	98	99	93	186.5
Atrazine	32 oz	PRE									
Glufosinate	32 oz	POST									
Atrazine	16 oz	POST									
Ammonium sulfate	1.0 %	POST									
S-metolachlor/ Atrazine/ Mesotrione/ Bicyclopyrone	2.5 qt	PRE	100	98	100	99	100	100	100	99	187.0
Glyphosate	32 oz	POST									
Atrazine	16 oz	POST									
Ammonium sulfate	1.0 %	POST									
S-metolachlor/ Atrazine/ Mesotrione/ Bicyclopyrone	2.5 qt	PRE	100	100	99	100	99	99	100	96	194.4
Glufosinate	32 oz	POST									
Atrazine	16 oz	POST									
Ammonium sulfate	1.0 %	POST									
Isoxaflutole	4.0 oz	PRE	98	100	99	99	100	100	95	100	184.2
Atrazine	32 oz	PRE									
S-metolachlor/ Glyphosate/ Mesotrione	3.6 pt	POST									
Dicamba/ Diflufenzopyr	5.0 oz	POST									
Ammonium sulfate	1.0 %	POST									
Isoxaflutole	4.0 oz	PRE	98	100	93	100	99	98	100	100	190.2
Atrazine	32 oz	PRE									
S-metolachlor/ Glyphosate/ Mesotrione	3.6 pt	POST									
Glufosinate	32 oz	POST									
Ammonium sulfate	1.0 %	POST									
Untreated	---	---	---	---	---	---	---	---	---	---	114.6
LSD (0.05)			NS	3	NS	5	6	NS	4	5	18.1

[a] Timings were PRE = preemergence and POST = postemergence.
[b] DA-A = days after the preemergence applications
[c] DA-B = days after the postemergence applications.

Terbuthylazine and atrazine rate comparisons in irrigated corn. R. S. Currie and P. W. Geier. (Kansas State University Southwest Research-Extension Center, 4500 E. Mary Street, Garden City, KS 67846) An experiment conducted at the Kansas State University Southwest Research & Extension Center near Garden City compared terbuthylazine and atrazine rates applied preemergence for weed control in corn. Herbicides were applied using a tractor-mounted, compressed CO_2 sprayer delivering 19.4 gpa at 4.1 mph and 30 psi. All preemergence (PRE) herbicides were followed by glyphosate at 22 oz/A plus ammonium sulfate at 1.0% late postemergence (POST). Application, environmental, weeds, and crop information is given in Table 1. Natural weed populations were supplemented by overseeding the experimental area with domesticated sunflower (to simulate common sunflower) and domesticated crabgrass (to simulate large crabgrass). Plots were 10 by 35 feet and arranged in a randomized complete block design replicated four times. Soil was a Beeler silt loam with 2.4% organic matter and pH of 7.6. Residual weed control of the preemergence treatments were visually estimated on June 13, 2018, which was 40 days after the preemergence applications (40 DA-A). Late season weed control following the postemergence treatments were determined on August 13, 2018, 56 days after the glyphosate application (56 DA-B). Yields were determined on October 4, 2018 by mechanically harvesting the center two rows of each plot and adjusting weights to 15.5% moisture.

Table 1. Application information.

Application timing	Preemergence	Postemergence
Application date	May 4, 2018	June 18, 2018
Air temperature (F)	54	77
Relative humidity (%)	59	58
Soil temperature (F)	53	72
Wind speed (mph)	4 to 6	6 to 9
Wind direction	West	West-southwest
Soil moisture	Good	Good
Corn		
Height (inch)	---	18 to 24
Leaves (no.)	0	5 to 7
Palmer amaranth		
Height (inch)	---	6 to 9
Density (plants/m^2)	0	5
Kochia		
Height (inch)	---	3 to 9
Density (plants/m^2)	0	3
Russian thistle		
Height (inch)	---	4 to 10
Density (plants/m^2)	0	3
Common sunflower		
Height (inch)	---	3 to 6
Density (plants/m^2)	0	1
Green foxtail		
Height (inch)	---	2 to 6
Density (plants/m^2)	0	3
Crabgrass		
Height (inch)	---	2 to 4
Density (plants/m^2)	0	2

No differences between herbicides occurred for Russian thistle control (90% or more) and common sunflower (93% or more) regardless of rating date (data not shown). Kochia control at 40 DA-A exceeded 90% with all herbicides except terbuthylazine at 22 oz/A and atrazine at 16 oz/A (Table 2). By 56 DA-B, terbuthylazine alone at 15.5, 23, 31 oz/A and atrazine at any rate alone provided less kochia control than treatments with the best kochia control (100%). Terbuthylazine at 15.5 oz/A alone and atrazine at 24 oz/A alone controlled Palmer amaranth 83 to 85% at 40 DA-A. However only plots receiving atrazine alone at 16 or 32 oz/A PRE provided less than 90% Palmer amaranth control at 56 DA-B. Green foxtail and crabgrass control at 40 DA-A was 85% or less with terbuthylazine at 15.5, 23, and 31 oz/A and atrazine at any rate alone PRE, and crabgrass control remained less than 85% for these treatments at 56 DA-B. However, the POST treatment of glyphosate increased green foxtail control to 98% or more with all treatments by 56 DA-B. Differences among herbicides in weed control did not translate into grain yield differences in this study. Herbicide-treated plots yielded 160 to 171 bu/A, and did not differ from the nontreated plots (148 bu/A) (data not shown).

Table 2. Terbuthylazine comparisons in corn.

Treatment	Rate	Timing[a]	Kochia 40 DA-A[b]	Kochia 56 DA-B[c]	Palmer amaranth 40 DA-A	Palmer amaranth 56 DA-B	Green foxtail 40 DA-A	Green foxtail 56 DA-B	Crabgrass 40 DA-A	Crabgrass 56 DA-B
	per A		% Visual		% Visual		% Visual		% Visual	
Terbuthylazine	15.5 oz	PRE	91	83	83	90	80	98	80	73
Glyphosate	22 oz	POST								
Ammonium sulfate	1.0 %	POST								
Terbuthylazine	23 oz	PRE	90	86	95	90	85	98	85	78
Glyphosate	22 oz	POST								
Ammonium sulfate	1.0 %	POST								
Terbuthylazine	31 oz	PRE	94	88	95	95	83	100	83	80
Glyphosate	22 oz	POST								
Ammonium sulfate	1.0 %	POST								
Terbuthylazine	46 oz	PRE	93	93	90	95	88	100	93	83
Glyphosate	22 oz	POST								
Ammonium sulfate	1.0 %	POST								
Terbuthylazine	23 oz	PRE	99	95	99	100	95	100	99	89
Metolachlor	27 oz	PRE								
Glyphosate	22 oz	POST								
Ammonium sulfate	1.0 %	POST								
Atrazine	16 oz	PRE	85	83	88	83	79	98	86	70
Glyphosate	22 oz	POST								
Ammonium sulfate	1.0 %	POST								
Atrazine	24 oz	PRE	93	83	85	94	83	100	85	80
Glyphosate	22 oz	POST								
Ammonium sulfate	1.0 %	POST								
Atrazine	32 oz	PRE	98	88	93	85	80	98	80	78
Glyphosate	22 oz	POST								
Ammonium sulfate	1.0 %	POST								
Atrazine	48 oz	PRE	97	90	100	97	76	100	79	80
Glyphosate	22 oz	POST								
Ammonium sulfate	1.0 %	POST								
Atrazine	24 oz	PRE	96	92	100	100	98	100	97	88
Metolachlor	27 oz	PRE								
Glyphosate	22 oz	POST								
Ammonium sulfate	1.0 %	POST								
Metolachlor/ Atrazine/ Mesotrione	3.0 qt	PRE	100	99	100	98	95	100	100	94
Glyphosate	22 oz	POST								
Ammonium sulfate	1.0 %	POST								
SA-0070128	3.0 qt	PRE	100	100	100	94	99	100	99	91
Glyphosate	22 oz	POST								
Ammonium sulfate	1.0 %	POST								
SA-0070129	3.0 qt	PRE	100	100	100	96	95	100	99	94

Glyphosate	22 oz	POST								
Ammonium sulfate	1.0 %	POST								
LSD (0.05)			9	9	12	10	13	NS	11	7

[a] Timings were PRE = preemergence and POST = postemergence.
[b] DA-A = days after the preemergence applications
[c] DA-B = days after the postemergence applications.

<u>Application timing efficacy of 2,4-D/glyphosate in irrigated corn.</u> R. S. Currie and P. W. Geier. (Kansas State University Southwest Research-Extension Center, 4500 E. Mary Street, Garden City, KS 67846) An experiment at the Kansas State University Southwest Research & Extension Center near Garden City, KS evaluated the premix of 2,4-D/glyphosate at two rates and two application timings in corn. The premix was applied at 3.5 or 4.67 pt/A when corn was at the 4 leaf stage (V4) following preemergence application of acetochlor/flumetsulam/clopyralid at 2.0 pt/A. The premix was also applied at the same rates early postemergence when corn was in the 2 leaf stage (V2) and included the treatment of acetochlor/flumetsulam/clopyralid at 2.0 pt/A. All treatments were applied using a tractor-mounted, compressed-CO_2 sprayer delivering 19.4 gpa at 30 psi and 4.1 mph. Application, environmental, crop, and weed information are shown in Table 1. Natural weed populations were supplemented by overseeding the experimental area with quinoa (to simulate common lambsquarters) and domesticated sunflower (to simulate common sunflower). Plots were 10 by 32 feet and arranged in a randomized complete block with four replications. Soil was a Beeler silt loam with 2.4% organic matter and pH 7.6. Visual weed control was determined on June 11 and August 2, 2018, which was 12 days after the V2 applications (12 DA-B) and 51 days after the V4 applications (51 DA-C), respectively. Grain yields were determined October 5, 2018 by mechanically harvesting the center two rows of each plot and adjusting weights to 15.5% moisture.

Table 1. Application information.

Application timing	Preemergence	V2	V4
Application date	May 9, 2018	May 30, 2018	June 12, 2018
Air temperature (F)	92	89	82
Relative humidity (%)	20	32	57
Soil temperature (F)	71	80	74
Wind speed (mph)	5 to 9	3 to 5	2 to 4
Wind direction	South-southwest	Southeast	East-southeast
Soil moisture	Good	Good	Good
Corn			
Height (inch)	---	5 to 8	8 to 12
Leaves (no.)	0	1 to 2	4 to 5
Kochia			
Height (inch)	---	1 to 2	3 to 5
Density (plants/m^2)	0	50	20
Palmer amaranth			
Height (inch)	---	0.5 to 1	2 to 4
Density (plants/m^2)	0	5	2
Russian thistle			
Height (inch)	---	1 to 2	2 to 5
Density (plants/m^2)	0	5	5
Common sunflower			
Height (inch)	---	1 to 2	2 to 4
Density (plants/m^2)	0	2	2
Quinoa			
Height (inch)	---	1 to 2	2 to 3
Density (plants/m^2)	0	2	3
Green foxtail			
Height (inch)	---	1 to 2	2 to 4
Density (plants/m^2)	0	2	2

Control of Palmer amaranth, Russian thistle, common sunflower, and quinoa was 90% or more with all herbicides at 12 DA-B and 51 DA-C, and did not differ between treatments (data not shown). Kochia control at 12 DA-B was 14% greater when 2,4-D/glyphosate was included with acetochlor/flumetsulam/clopyralid at the V2 stage compared to acetochlor/flumetsulam/clopyralid alone preemergence (Table 2). However, by 51 DA-C, kochia control was best when 2,4-D/glyphosate was applied at the V4 stage, and no differences occurred between rates for kochia control.

Similarly, 2,4-D/glyphosate applied at the V2 stage increased johnsongrass control compared to acetochlor/flumetsulam/clopyralid alone preemergence at 12 DA-B, but johnsongrass control was best at 51 DA-C when 2,4-D/glyphosate application was made at the V4 stage. Increasing the 2,4-D/glyphosate rate from 3.5 to 4.67 pt/A did not improve johnsongrass control with either application timing at 51 DA-C. Corn receiving herbicide treatment at the V2 stage yielded 81 to 84 bu/A more grain than untreated corn, whereas corn treated at the V4 stage yielded 114 to 118 bu/A more grain than the control plots. Grain yields did not differ between 2,4-D/glyphosate rates within applications timings.

Table 2. 2,4-D/glyphosate application timing efficacy in irrigated corn.

Treatment	Rate	Timing[a]	Kochia 12 DA-B[b]	Kochia 51 DA-C[c]	Johnsongrass 12 DA-B	Johnsongrass 51 DA-C	Corn yield
	per A		% visual		% visual		bu/A
Acetochlor/ Flumetsulam/ Clopyralid	2.0 pt	PRE	65	89	68	89	187.1
2,4-D/ Glyphosate	3.5 pt	V4					
Ammonium sulfate	2.5%	V4					
Acetochlor/ Flumetsulam/ Clopyralid	2.0 pt	PRE	70	93	80	94	191.5
2,4-D/ Glyphosate	4.67 pt	V4					
Ammonium sulfate	2.5%	V4					
Acetochlor/ Flumetsulam/ Clopyralid	2.0 pt	V2	79	70	98	65	153.6
2,4-D/ Glyphosate	3.5 pt	V2					
Ammonium sulfate	2.5%	V2					
Acetochlor/ Flumetsulam/ Clopyralid	2.0 pt	V2	84	75	93	73	157.1
2,4-D/ Glyphosate	4.67 pt	V2					
Ammonium sulfate	2.5%	V2					
Untreated			---	---	---	---	72.8
LSD (0.05)			11	6	11	8	17.5

[a] Timings were PRE = preemergence, V2 = corn with two visible leaf collars, and V4 = corn with four visible leaf collars.
[b] DA-B is days after the V2 application timing.
[c] DA-C is days after the V4 application timing.

<u>Pyroxasulfone/fluthiacet tank mixture comparisons in irrigated corn.</u> R. S. Currie and P. W. Geier. (Kansas State University Southwest Research-Extension Center, 4500 E. Mary Street, Garden City, KS 67846) An experiment was conducted at the Kansas State University Southwest Research-Extension Center compared the premix of pyroxasulfone/fluthiacet with various herbicides for preemergence (PRE), early postemergence (EPOST), or sequential (PRE followed by postemergence (POST)) efficacy in corn. All herbicide treatments were applied using a tractor-mounted, compressed CO_2 sprayer delivering 19.4 gpa at 3.0 mph and 4.1 mph. Application, environmental, crop, and weed information is given in Table 1. Natural weed populations were supplemented by overseeding the experimental area with domesticated sunflower (to simulate common sunflower). Plots were 10 by 35 feet and arranged in a randomized complete block with four replications. Soil was a Beeler silt loam containing 2.4% organic matter and pH 7.6. Weed control was visually determined on May 18 and July 25, 2018. These dates were 21 days after the PRE treatments (21 DA-A) and 55 days after the POST treatments (55 DA-C), respectively. Since Palmer amaranth emerged later than the other weeds in the trial, it was evaluated on June 7 (7 DA-C) and July 25, 2018 (55 DA-C). Corn yields were determined October 4, 2018 by mechanically harvesting the center two rows of each plot and adjusting grain weights to 15.5% moisture.

Table 1. Application information.

Application timing	Preemergence	Early postemergence	Postemergence
Application date	April 27, 2018	May 22, 2018	May 31, 2018
Air temperature (F)	62	63	87
Relative humidity (%)	34	79	35
Soil temperature (F)	51	64	78
Wind speed (mph)	5 to 8	7 to 10	2 to 5
Wind direction	West-southwest	South	South
Soil moisture	Good	Good	Good
Corn			
Height (inch)	---	3 to 5	6 to 9
Leaves (no.)	0	2 to 3	3 to 4
Palmer amaranth			
Height (inch)	---	1 to 2	2 to 3
Density (plants/m^2)	0	1	1
Kochia			
Height (inch)	---	1 to 4	2 to 4
Density (plants/m^2)	0	2	2
Russian thistle			
Height (inch)	---	3 to 5	3 to 5
Density (plants/m^2)	0	3	2
Common sunflower			
Height (inch)	---	2 to 4	1 to 3
Density (plants/m^2)	0	1	1
Quinoa			
Height (inch)	---	2 to 5	---
Density (plants/m^2)	0	3	0
Green foxtail			
Height (inch)	---	1 to 3	1 to 2
Density (plants/m^2)	0	2	2

Only the treatments of pyroxasulfone/fluthiacet plus isoxaflutole and atrazine PRE and pyroxasulfone/fluthiacet plus mesotrione, clopyralid/flumetsulam, and atrazine PRE provided less than 100% common sunflower control at 21 DA-A (data not shown). However, sunflower control was complete regardless of treatment by 55 DA-C. All PRE herbicides controlled kochia 100%, Russian thistle 95 to 100%, and green foxtail 85 to 100% at 21 DA-A (Table 2).

When *S*-metolachlor/glyphosate/mesotrione was applied alone EPOST, kochia, Russian thistle and green foxtail control was 91, 86, and 89%, respectively, at 55 DA-C. This treatment also provided the least Palmer amaranth control at 7 and 55 DA-C (94 and 83%, respectively). Herbicide-treated corn yielded 21 to 47 bu/A more grain than the nontreated controls (Table 2), except when *S*-metolachlor/glyphosate/mesotrione alone was applied EPOST.

Table 2. Pyroxasulfone/fluthiacet comparisons in corn.

Treatment	Rate	Timing[a]	Kochia 21 DA-A[b]	Kochia 55 DA-C[c]	Palmer amaranth 7 DA-C	Palmer amaranth 55 DA-C	Russian thistle 21 DA-A	Russian thistle 55 DA-C	Green foxtail 21 DA-A	Green foxtail 55 DA-C	Corn yield
	per A		% Visual		% Visual		% Visual		% Visual		bu/A
Pyroxasulfone/ Fluthiacet	4.0 oz	PRE	100	100	100	100	100	100	85	100	166.8
Atrazine	32 oz	PRE									
Mesotrione	4.0 oz	POST									
Atrazine	16 oz	POST									
Glyphosate	22 oz	POST									
Crop oil concentrate	1.0 %	POST									
Ammonium sulfate	1.0 %	POST									
Pyroxasulfone/ Fluthiacet	4.0 oz	PRE	100	100	100	100	100	100	95	100	180.6
Mesotrione	5.0 oz	PRE									
Atrazine	32 oz	PRE									
Dicamba/ Diflufenzopyr	3.0 oz	POST									
Atrazine	16 oz	POST									
Glyphosate	22 oz	POST									
Crop oil concentrate	1.0 %	POST									
Ammonium sulfate	1.0 %	POST									
Pyroxasulfone/ Fluthiacet	4.0 oz	PRE	100	100	100	100	100	100	95	100	179.6
Isoxaflutole	3.0 oz	PRE									
Atrazine	32 oz	PRE									
Dicamba/ Diflufenzopyr	3.0 oz	POST									
Atrazine	16 oz	POST									
Glyphosate	22 oz	POST									
Crop oil concentrate	1.0 %	POST									
Ammonium sulfate	1.0 %	POST									
Pyroxasulfone/ Fluthiacet	4.0 oz	PRE	100	100	100	100	95	100	95	100	169.8
Clopyralid/ Flumetsulam	4.0 oz	PRE									
Atrazine	32 oz	PRE									
Mesotrione	3.0 oz	POST									
Atrazine	16 oz	POST									
Glyphosate	22 oz	POST									
Crop oil concentrate	1.0 %	POST									
Ammonium sulfate	1.0 %	POST									
Pyroxasulfone/ Fluthiacet	4.0 oz	PRE	100	100	98	100	100	98	95	93	181.6
Mesotrione	5.0 oz	PRE									
Atrazine	48 oz	PRE									
Pyroxasulfone/ Fluthiacet	4.0 oz	PRE	100	100	100	100	95	98	95	99	179.1
Isoxaflutole	3.0 oz	PRE									
Atrazine	48 oz	PRE									

Pyroxasulfone/ Fluthiacet	4.0 oz	PRE	100	100	100	100	100	98	100	100	160.8
Clopyralid/ Flumetsulam	4.0 oz	PRE									
Atrazine	48 oz	PRE									
S-metolachlor/ Atrazine/ Mesotrione/ Bicyclopyrone	2.5 qt	PRE	100	100	100	98	100	100	100	93	168.4
Acetochlor/ Clopyralid/ Mesotrione	2.5 qt	PRE	100	94	100	100	100	100	100	100	186.9
Pyroxasulfone/ Fluthiacet	4.0 oz	PRE	100	95	100	96	100	93	100	98	171.4
Mesotrione	6.0 oz	PRE									
Clopyralid/ Flumetsulam	4.0 oz	PRE									
Atrazine	48 oz	PRE									
Pyroxasulfone/ Fluthiacet	4.0 oz	EPOST	---	100	100	100	---	100	---	95	176.5
Mesotrione	3.0 oz	EPOST									
Atrazine	32 oz	EPOST									
Glyphosate	22 oz	EPOST									
Crop oil concentrate	1.0 %	EPOST									
Ammonium sulfate	1.0 %	EPOST									
S-metolachlor/ Glyphosate/ Mesotrione	3.6 pt	EPOST	---	91	94	83	---	86	---	89	160.1
Nonionic surfactant	0.25 %	EPOST									
Ammonium sulfate	1.0 %	EPOST									
S-metolachlor/ Atrazine/ Mesotrione/ Bicyclopyrone	2.0 qt	EPOST	---	100	100	100	---	98	---	95	175.4
Glyphosate	22 oz	EPOST									
Crop oil concentrate	1.0 %	EPOST									
Untreated	---	---	---	---	---	---	---	---	---	---	139.5
LSD (0.05)			NS	5	3	4	NS	5	NS	7	20.9

[a] Timings were PRE = preemergence, EPOST = early postemergence, and POST = postemergence.
[b] DA-A = days after the preemergence applications
[c] DA-C = days after the postemergence applications.

Efficacy of sequential herbicide applications in glufosinate- and glyphosate-resistant corn. R. S. Currie and P. W. Geier. (Kansas State University Southwest Research-Extension Center, 4500 E. Mary Street, Garden City, KS 67846) An experiment was conducted at the Kansas State University Southwest Research-Extension Center to compare *S*-metolachlor/mesotrione as a preemergence (PRE) or postemergence (POST) treatment with glufosinate or glyphosate for efficacy in corn. All plots also received a late postemergence (LPOST) application of glufosinate or glyphosate. Herbicides were applied using a tractor-mounted, compressed CO_2 sprayer delivering 19.4 gpa at 4.2 mph and 30 psi. Application, environmental, crop, and weed information is shown in Table 1. Natural weed populations were supplemented by overseeding the experimental area with domesticated sunflower to simulate common sunflower. Plots were 10 by 32 feet and arranged in a randomized complete block with four replications. Soil was a Beeler silt loam with 2.4% organic matter and pH 7.6. Visual weed control was determined on May 30, June 26, and August 2, 2018. These dates were 14 days after the PRE treatments (14 DA-A), and 13 and 50 days after the LPOST treatments (13 and 50 DA-C). Corn yields were determined on October 5, 2018 by mechanically harvesting the center two rows of each plot and adjusting grain weights to 15.5% moisture.

Table 1. Application information.

Application timing	Preemergence	Postemergence	Late postemergence
Application date	May 16, 2018	May 31, 2018	June 13, 2018
Air temperature (F)	88	71	86
Relative humidity (%)	31	57	39
Soil temperature (F)	71	65	76
Wind speed (mph)	2 to 5	2 to 4	3 to 5
Wind direction	South-southeast	Southwest	East-southeast
Soil moisture	Good	Good	Good
Corn			
Height (inch)	---	2 to 4	9 to 12
Leaves (no.)	0	1 to 2	4 to 5
Johnsongrass			
Height (inch)	---	1 to 4	1 to 4
Density (plants/m^2)	0	50	25
Common sunflower			
Height (inch)	---	1 to 2	---
Density (plants/m^2)	0	1	0
Russian thistle			
Height (inch)	---	---	---
Density (plants/m^2)	0	0	0

All herbicides controlled common sunflower and Russian thistle 95% or more regardless, of rating date, and did not differ between treatments (data not shown). At 14 DA-A, *S*-metolachlor/mesotrione plus metribuzin and metribuzin plus pendimethalin controlled johnsongrass similarly, 73 to 78%, when applied PRE (Table 2). Johnsongrass control was 95% or more with all herbicides except metribuzin/pendimethalin PRE followed by *S*-metolachlor/mesotrione plus glufosinate POST and glufosinate LPOST at 13 DA-C. By 50 DA-C, only those plots receiving glyphosate POST and LPOST had greater than 80% johnsongrass control. Grain yields were 50 to 69 bu/A greater with herbicide-treated corn compared to the nontreated controls, but yields did not differ between treatments (Table 2).

Table 2. Glufosinate and glyphosate applications in corn.

Treatment	Rate	Timing[a]	Johnsongrass			Corn
			14 DA-A[b]	13 DA-C[c]	50 DA-C	yield
	per A		% Visual			bu/A
S-metolachlor/ Mesotrione	2.0 qt	PRE	78	95	79	131.1
Metribuzin	5.3 oz	PRE				
Glufosinate	29 oz	POST				
Ammonium sulfate	2.0 %	POST				
Glufosinate	29 oz	LPOST				
Ammonium sulfate	2.0 %	LPOST				
S-metolachlor/ Mesotrione	2.0 qt	PRE	78	100	89	136.4
Metribuzin	5.3 oz	PRE				
Glyphosate	24 oz	POST				
Ammonium sulfate	2.0 %	POST				
Glyphosate	24 oz	LPOST				
Ammonium sulfate	2.0 %	LPOST				
Metribuzin	5.3 oz	PRE	78	89	76	122.2
Pendimethalin	3.0 pt	PRE				
S-metolachlor/ Mesotrione	2.0 qt	POST				
Glufosinate	29 oz	POST				
Nonionic surfactant	0.25 %	POST				
Ammonium sulfate	2.0 %	POST				
Glufosinate	29 oz	LPOST				
Ammonium sulfate	2.0 %	LPOST				
Metribuzin	5.3 oz	PRE	73	99	89	141.0
Pendimethalin	3.0 pt	PRE				
S-metolachlor/ Mesotrione	2.0 qt	POST				
Glyphosate	24 oz	POST				
Ammonium sulfate	2.0 %	POST				
Glyphosate	24 oz	LPOST				
Ammonium sulfate	2.0 %	LPOST				
Untreated	---	---	---	---	---	71.8
LSD (0.05)			NS	5	10	29.2

[a] Timings were PRE = preemergence, POST = early postemergence, and LPOST = late postemergence.
[b] DA-A = days after the preemergence treatments.
c DA-C is days after the late postemergence treatments.

Pyraflufen alone and in tank mixtures for kochia control in fallow. R. S. Currie and P. W. Geier. (Kansas State University Southwest Research-Extension Center, 4500 E. Mary Street, Garden City, KS 67846) An experiment was conducted at the Kansas State University Southwest Research & Extension Center near Garden City, KS to compare pyraflufen alone and in tank mixtures to standard treatments for postemergence kochia control in fallow. Herbicides were applied using a tractor-mounted, compressed CO2 sprayer delivering 19.4 gpa at 30 psi and 4.1 mph. Application, environmental, and weed information are shown in Table 1. Plots were 10 by 32 feet and arranged in a randomized complete block design with four replications. Soil was a Ulysses silt loam with 3.4% organic matter and pH of 7.9. Kochia control was visually estimated on June 22, July 3, and July 16, 2018. These dates were 4, 15, and 28 days after treatment (DAT), respectively.

Table 1. Application information.

Application date	June 18, 2018
Air temperature (F)	97
Relative humidity (%)	28
Soil temperature (F)	87
Wind speed (mph)	7 to 10
Wind direction	South
Soil moisture	Dry
Kochia	
Height (inch)	6 to 15
Density (plants/m^2)	>100

Pyraflufen alone provided no more than 33% kochia control regardless of rating date (Table 2), and was no better than glyphosate, 2,4-D amine, or dicamba alone. The tank mixture of pyraflufen plus paraquat and sulfentrazone provided the best kochia control at 4, 15, and 28 DAT (58, 97, and 97%, respectively). Tank mixing of these three herbicides increased kochia control 11 to 74% compared to the individual herbicides applied alone. Pyraflufen plus paraquat and sulfentrazone was the only treatment to control kochia more than 90% at 28 DAT.

Table 2. Kochia control with pyraflufen in fallow.

Treatment	Rate	Kochia		
		4 DAT[a]	15 DAT	28 DAT
	oz/A	% Visual		
Pyraflufen	2.0	10	23	33
Crop oil concentrate	0.5 %			
Ammonium sulfate	2.0 %			
Pyraflufen	2.0	17	33	40
Glyphosate	22			
2,4-D amine	8.0			
Ammonium sulfate	2.0 %			
Pyraflufen	2.0	45	79	79
Paraquat	32			
Nonionic surfactant	0.25 %			
Ammonium sulfate	2.0 %			
Pyraflufen	2.0	28	50	60
Glyphosate	22			
Dicamba	16			
Ammonium sulfate	2.0 %			
Glyphosate	22	18	35	40
Ammonium sulfate	1.0 %			
2,4-D amine	8.0	13	20	33
Nonionic surfactant	0.25 %			
Paraquat	32	43	85	86
Nonionic surfactant	0.25 %			
Dicamba	16	28	50	50
Nonionic surfactant	0.25 %			
Ammonium sulfate	2.0 %			
Pyraflufen	2.0	30	65	65
Sulfentrazone	6.0			
Crop oil concentrate	0.5 %			
Ammonium sulfate	2.0 %			
Pyraflufen	2.0	35	69	69
Sulfentrazone	6.0			
Glyphosate	22			
Ammonium sulfate	2.0 %			
Pyraflufen	2.0	30	70	68
Sulfentrazone	6.0			
2,4-D amine	8.0			
Nonionic surfactant	0.25 %			
Ammonium sulfate	2.0 %			
Pyraflufen	2.0	58	97	97
Sulfentrazone	6.0			
Paraquat	32			
Nonionic surfactant	0.25 %			
Ammonium sulfate	2.0 %			
Pyraflufen	2.0	23	38	35
Glyphosate	22			
Ammonium sulfate	2.0 %			
Sulfentrazone	6.0	30	70	70
Crop oil concentrate	0.5 %			
LSD (0.05)		6	8	9

[a] DAT = days after treatment.

Fall planted pea tolerance to broadleaf herbicides. Joan Campbell and Traci Rauch. (Plant Sciences Department, University of Idaho, Moscow, ID 83844-2333) A study was initiated at the University of Idaho Kambitsch Farm near Genesee, Idaho to evaluate fall planted 'Koyote' pea tolerance to herbicides. Herbicide treatments were applied using a CO_2 pressurized backpack sprayer (Table 1). The experiment was a randomized complete block design with four replications and plot size was 8 by 25 ft. Visual injury, chlorosis and delayed flowering were rated on May 31. Stunting, stand reduction, and chlorosis were rated June 4. Plant height was measured on June 8. Pea seed was harvested at maturity.

Table 1. Application and soil data.

Fall pea seeding date	10/11/17	
Application date	10/16/17	5/22/18
Pea growth stage	Imbibed seed	6 nodes/10 inch tall
Spray volume (gal/a)	10	20
Air temperature (F)	60	75
Relative humidity (%)	37	59
Wind (mph, direction)	5, SE	2, East
Cloud cover (%)	0	0
Next rain occurred	10/20/17	5/9/18
Soil moisture	dry	wet
Soil temperature at 2 inch (F)	49	72
pH	5.4	
OM (%)	4.4	
CEC (meq/100g)	8.3	
Texture	silt loam	

All treatments shortened the fall planted pea plants compared to the untreated check (Table 2). Pea plants had some level of chlorosis with all treatments except sulfentrazone and flumioxazin alone and sulfentrazone plus flumioxazin or diuron. Chlorosis on plants treated with sulfentrazone + metribuzin (3.8%), sulfentrazone + MCPA amine (11.3%), and sulfentrazone + MCPA amine + metribuzin (5%) disappeared within 4 days. Pea seed yield from the sulfentrazone + pyridate treatment was 501 lb/acre compared to the untreated at 3385 lb/a. All other treatments ranged from 2552 to 3283 lb/acre. Clethodim was applied early spring to control grass weeds, but a late flush of wild oats in one part of the field caused variability in yield unrelated to the herbicide treatments.

Table. Crop response of fall 2017 fall planted peas to broadleaf herbicides.

Treatment[1]	Rate	Time of application	Injury	Flowering	Chlorosis May 31	Stunting	Stand	Chlorosis June 6	Height	Yield
	lb ai/a		%	%	%	%	%	%	cm	lb/acre
Untreated		--	--	100 a	--	--	--	--	64.8 a	3385 a
Sulfentrazone	0.25	PostPlantPre	15.0 e[3]	92 ab	0.0 e	12.5 cde	8.8 b	0.0 c	56.6 bc	2985 ab
Flumioxazin	0.064	PostPlantPre	16.3 e	93 ab	0.0 e	10.0 de	10.0 b	0.0 c	56.0 bc	2897 ab
Sulfentrazone Flumioxazin	0.25 0.064	PostPlantPre PostPlantPre	31.3 bc	92 ab	0.0 e	15.0 cde	16.3 a	0.0 c	51.8 cd	2949 ab
Sulfentrazone Metribuzin	0.25 0.234	PostPlantPre PostPlantPre	18.8 de	90 b	3.8 d	12.5 cde	11.3 ab	0.0 c	50.8 de	2917 ab
Sulfentrazone Acifluorfen NIS[1]	0.25 0.188 0.32[2]	PostPlantPre Post Emerge Post Emerge	28.8 bcd	90 b	21.3 b	16.3 bcd	16.3 a	6.3 b	45.9 ef	2552 b
Sulfentrazone Acifluorfen metribuzin NIS[1]	0.188 0.188 0.234 0.32[2]	PostPlantPre Post Emerge Post Emerge Post Emerge	30.0 bc	6 de	21.3 b	22.5 b	16.3 a	6.3 b	43.4 f	3283 a
Sulfentrazone Pyridate	0.25 0.94	PostPlantPre Post Emerge	75.0 a	1 e	72.5 a	35.0 a	0.0 c	72.5 a	22.2 g	501 c
MCPA amine metribuzin	0.463 0.234	Post Emerge Post Emerge	12.5 e	14 d	2.5 de	8.8 e	8.8 b	2.5 c	49.8 de	3073 ab
Sulfentrazone MCPA amine	0.25 0.463	PostPlantPre Post Emerge	35.0 b	12 d	11.3 c	22.5 b	16.3 a	0.0 c	44.3 f	2889 ab
Diuron Sulfentrazone	1.4 0.25	PostPlantPre PostPlantPre	16.3 e	94 ab	0.0 e	11.3 cde	12.5 ab	0.0 c	57.0 b	3137 ab
Sulfentrazone MCPA amine Metribuzin	0.25 0.463 0.234	PostPlantPre Post Emerge Post Emerge	22.5 cde	65 c	5.0 d	17.5 bc	10.0 b	0.0 c	47.5 def	2912 ab

[1] R11 nonionic surfactant
[2] Rate expressed as fl oz/gal.
[3] Means followed by the same letter within a column are not statistically different at P=0.10

Crop safety of saflufenacil and saflufenacil tank-mixes applied to peppermint at various growth stages. Kyle C. Roerig, Andrew G. Hulting, Daniel W. Curtis, and Carol Mallory-Smith. (Crop and Soil Science, Oregon State University, Corvallis, OR 97331) Previous trials have shown saflufenacil to be a safe and effective herbicide on dormant peppermint. The objective of this trial was to evaluate applications of saflufenacil to dormant peppermint with possible tank-mix partners and applications of saflufenacil as the peppermint was coming out of dormancy. Treatments were applied on three dates. The March 5 application was made to dormant mint with little above ground foliage. The April 18 and May 1 applications were made to mint which had 1-3 and 2-10 inches of regrowth, respectively. Saflufenacil application results in the necrosis and death of all exposed peppermint foliage, however established peppermint has a robust root system and spring growth is rapid. Each application caused severe crop injury, but the peppermint quickly recovered and by harvest no injury was visible. None of the treatments affected yield (at p-value 0.05). These results suggest that saflufenacil applications could extend past the dormant period without impacting oil yield, which could allow for better control of emerging summer annual weeds.

Table. Peppermint injury and crop yield with applications of saflufenacil.

			Peppermint				
			Injury				Yield
Treatment	Rate	Applied[1]	4/10/18	5/14/18	6/5/18	8/20/18	8/28/18
	lb ai/a[2]		-----------------------	%	-----------------------		lb oil/a
Untreated			0	0	8	0	52.9
Oxyfluorfen	0.500	3/5/18	28	0	18	0	45.7
+ paraquat	0.500	3/5/18					
+ NIS	0.250	3/5/18					
Saflufenacil	0.045	3/5/18	45	15	10	0	52.1
+ MSO	1.000	3/5/18					
+ AMS	1.670	3/5/18					
Saflufenacil	0.089	3/5/18	63	18	15	0	50.9
+ MSO	1.000	3/5/18					
+ AMS	1.670	3/5/18					
Saflufenacil	0.134	3/5/18	70	18	20	0	50.6
+ MSO	1.000	3/5/18					
+ AMS	1.670	3/5/18					
Saflufenacil	0.045	3/5/18	63	8	5	0	47.9
+ sulfentrazone	0.313	3/5/18					
+ MSO	1.000	3/5/18					
+ AMS	1.670	3/5/18					
Flumioxazin	0.128	3/5/18	70	33	18	5	46.7
+ saflufenacil	0.045	3/5/18					
+ MSO	1.000	3/5/18					
+ AMS	1.670	3/5/18					
Pyroxasulfone	0.090	3/5/18	68	13	13	0	48.9
+ saflufenacil	0.045	3/5/18					
+ MSO	1.000	3/5/18					
+ AMS	1.670	3/5/18					
Saflufenacil	0.045	4/18/18		90	50	5	58.3
+ MSO	1.000	4/18/18					
+ AMS	1.670	4/18/18					
Saflufenacil	0.045	5/1/18		95	65	0	50.4
+ MSO	1.000	5/1/18					
+ AMS	1.670	5/1/18					
LSD P=0.05			15	18	19	NS	NS

[1]3/5/18 = dormant application, 4/18/18 = "Greenup", 5/1/18 = two weeks after "Greenup"

[2]The rate is %V/V for MSO

<u>Post-harvest application of pyridate in double-cut peppermint.</u> Kyle C. Roerig, Andrew G. Hulting, Daniel W. Curtis, and Carol Mallory-Smith. (Crop and Soil Science, Oregon State University, Corvallis, OR 97331) Pyridate is a photosystem II inhibitor that is rapidly absorbed by leaves, but poorly translocated. Pyridate was registered for use in peppermint in the late 1990's, but the registration was canceled in the early 2000's. In 2018, pyridate use in peppermint was again permitted under a Section 18 Emergency Use Exemption. This study was conducted to assess crop safety and weed control of pyridate and pyridate tank-mixes in double cut peppermint after the first cutting in a field infested with redroot pigweed. Treatments were applied July 18, 2018, before the first post-harvest irrigation. Peppermint had 0-2 inches of regrowth and newly emerging redroot pigweed plants were 1-4 inches in size. Pyridate + saflufenacil was applied with 1% v/v MSO and 1.67 lb/a AMS, pyridate + clopyralid was applied with 0.25% v/v NIS, and all other treatments included 1% v/v COC. The plots were harvested September 17, 2018 and the oil was removed by steam distillation.

Pyridate alone controlled 94% of redroot pigweed. Redroot pigweed control was reduced when applied with clethodim. When pyroxasulfone and sulfentrazone were added to pyridate redroot pigweed control was 98 and 99%, respectively. Oil yield was significantly reduced (at p-value=0.05) as compared to the highest yielding treatment when saflufenacil or bromoxynil was added to pyridate. Controlling redroot pigweed is important to maintain high yield and oil quality. Oil yield in the untreated plot was 76% lower than the plot where pyridate was applied. Pyridate could be a valuable tool for controlling small redroot pigweed.

Table. Post-harvest applications of pyridate in double-cut peppermint, Independence, Oregon

		Peppermint injury		Redroot pigweed control	Peppermint oil yield
		7/31/18	9/17/18	9/17/18	9/17/18
	lb ai/a	%			lb/a
Untreated		0	0	0	13
Pyridate	0.940	20	0	94	55
Pyridate	0.940	18	0	73	48
+ clethodim	0.243				
Pyridate	0.940	18	0	85	55
+ bentazon	1.000				
Pyridate	0.940	34	0	91	40
+ bromoxynil	0.375				
Pyridate	0.940	18	0	95	58
+ terbacil	1.200				
Pyridate	0.940	71	0	97	36
+ saflufenacil	0.045				
Pyridate	0.940	29	4	86	48
+ carfentrazone	0.030				
Pyridate	0.940	35	0	96	51
+ MCPB	0.500				
Pyridate	0.940	18	0	91	47
+ clopyralid	0.188				
Pyridate	0.940	23	0	98	57
+ pyroxasulfone	0.190				
Pyridate	0.940	55	8	99	44
+ sulfentrazone	0.313				
Pyridate	0.940	50	0	90	47
+ bentazon	1.000				
+ bromoxynil	0.375				
LSD		17	6	15	17

Weed management in carbon-seeded perennial ryegrass with preemergence herbicides. Daniel W. Curtis, Kyle C. Roerig, Andrew G. Hulting and Carol Mallory-Smith. (Department of Crop and Soil Science, Oregon State University, Corvallis OR, 97331) A study conducted in perennial ryegrass grown for seed evaluated crop safety and control of diuron resistant annual bluegrass (*Poa annua*) following applications of preemergence herbicides. 'APR 2190' perennial ryegrass was planted in 12-inch rows, 0.25 inches deep with a 1-inch wide band of activated carbon sprayed over the seed rows at 300 lb/A on October 10, 2017. Study design was a randomized complete block with four replications. Plots were 8 x 35 ft with 24 rows of carbon-seeded perennial ryegrass and had a 24 inch wide band of diuron resistant *Poa annua* planted in a fallow area within the front portion of the plots without carbon. Seedbed preparation included use of a heavy roller to compact the surface to help obtain shallow, uniform seed placement. Application of the treatments was made with a bicycle sprayer delivering 20 GPA at 20 psi (Table 1). The study consisted of 6 herbicide treatments which included a grower standard of diuron plus pronamide and an untreated check (Table 2). The study area received 0.07 inches of rain the evening following the application, and 1.11 inches during the following 4 days. The crop was swathed on July 4, and threshed with a small plot combine on July 13, 2018. Seed was cleaned with a Clipper Cleaner and yields were quantified (Table 2).

Table 1. Application and soil data

Planting date	October 10, 2017
Application date	October 10, 2017
Crop growth stage	preemergence
Poa annua growth stage	preemergence
Air temperature (F)	57
Relative humidity (%)	78
Wind (mph, direction)	0-4, S
Cloud cover (%)	80
First moisture (inches)	October 10 (0.07)
Soil temperature at 2 inches (F)	54
Soil pH	6.4
Soil OM (%)	5.3
Soil CEC (meq/100g)	7
Soil texture	silty clay loam

This study shows the potential for management of diuron resistant *Poa annua* with herbicide treatments utilizing carbon seeding. *Poa annua* control ranged from 86 – 100%. Despite the visual injury observed at the higher rate of indaziflam the perennial ryegrass was able to compensate and average yield was comparable to other treatments. Clean seed yields with all herbicide treatments were equivalent to the untreated check and the grower standard treatment. Pyroxasulfone/flumioxazin, which just received a label for this use, as well as indaziflam and rimsulfuron all have potential to provide greater *Poa annua* control than the grower standard in years where pronamide doesn't perform as well as expected due to dry, warm conditions.

Table 2. Control of *Poa annua*, crop injury and clean seed yield with herbicide treatments in carbon-seeded perennial ryegrass, Corvallis Oregon, 2017-2018

	Rate	*Poa annua* control	Crop injury	Clean seed yield
	lb ai/A	%	%	lb/A
Untreated check	0	0	0	884
Pyroxasulfone/flumioxazin	0.07	86	0	890
Pyroxasulfone/flumioxazin	0.14	94	5	974
Indaziflam	0.01	95	1	924
Indaziflam	0.03	99	28	813
Rimsulfuron +	0.05	89	0	1023
pronamide	0.13			
Diuron +	1.6	65	0	951
pronamide	0.26			
LSD (P = 0.05)		10	6	NS
CV		9	84	10

Crop injury and *Poa annua* control evaluated on May 25, 2018

Preplant herbicides for residual weed control in grain sorghum. R. S. Currie and P. W. Geier. (Kansas State University Southwest Research-Extension Center, 4500 E. Mary Street, Garden City, KS 67846) An experiment was conducted at the Kansas State University Southwest Research-Extension Center compared various premix herbicides for residual weed control in sorghum. All herbicides were applied 14 days prior to sorghum planting using a tractor-mounted, compressed CO_2 sprayer delivering 19.4 gpa at 30 psi and 4.1 mph. Application and environmental information is shown in Table 1. Plots were 10 by 35 feet and arranged in a randomized complete block with four replications. Soil was a Ulysses silt loam containing 3.4% organic matter and pH 7.9. Visual weed control was evaluated on June 27 and August 14, 2018. These dates were 26 and 74 days after sorghum planting (DAP), respectively. Sorghum yields were determined on October 29, 2018 by mechanically harvesting the middle two rows of each plot and adjusting grain weights to 14% moisture.

Table 1. Application information.

Application date	May 13, 2018
Air temperature (F)	66
Relative humidity (%)	74
Soil temperature (F)	67
Wind speed (mph)	4 to 7
Wind direction	South-southeast
Soil moisture	Fair

Flumioxazin at 1 and 2 oz/A were the only treatments to control buffalobur less than 90% at 26 DAP (data not shown). However, no differences between herbicides occurred for buffalobur control at 74 DAP (83 to 100%). All herbicides controlled velvetleaf 95% or more at 26 and 74 DAP (data not shown). Acetochlor/flumetsulam/clopyralid and *S*-metolachlor/atrazine/mesotrione/bicyclopyrone generally provided the best control of Palmer amaranth, puncturevine, and green foxtail throughout the season (Table 2). *S*-metolachlor/atrazine, *S*-metolachlor/atrazine/mesotrione, and acetochlor/atrazine also controlled Palmer amaranth and green foxtail well regardless of rating date. Flumioxazin at 1 or 2 oz/A provided 70% or less puncturevine and green foxtail control at 74 DAP. Although all herbicide-treated sorghum yielded more grain than the nontreated controls, yields were best when *S*-metolachlor/atrazine/mesotrione/bicyclopyrone at 2.0 or 2.5 qt/A or *S*-metolachlor/atrazine/mesotrione at 2.7 qt/A were used. These treatments yielded more grain than sorghum receiving flumioxazin at 1 or 2 oz/A.

Table 2. Efficacy of herbicides applied 14 days preplant in sorghum.

Treatment	Rate	Palmer amaranth		Puncturevine		Green foxtail		Sorghum yield
		26 DAP[a]	74 DAP	26 DAP	74 DAP	26 DAP	74 DAP	
	per A	% Visual		% Visual		% Visual		bu/A
S-metolachlor/ Atrazine/ Mesotrione/ Bicyclopyrone	2.0 qt	98	93	95	85	93	80	89.3
S-metolachlor/ Atrazine/ Mesotrione/ Bicyclopyrone	2.5 qt	100	95	99	90	94	90	90.6
S-metolachlor/ Atrazine/ Mesotrione	2.7 qt	99	95	87	78	90	88	90.2
Acetochlor/ Flumetsulam/ Clopyralid	1.5 qt	99	95	100	91	98	90	86.1
Flumioxazin	1.0 oz	90	78	73	65	68	38	60.0
Flumioxazin	2.0 oz	89	88	75	70	70	53	74.8
S-metolachlor/ Atrazine	1.5 qt	100	90	80	68	89	85	80.7
Acetochlor/ Atrazine	2.25 qt	100	95	80	75	89	83	82.9
Untreated	---	---	---	---	---	---	---	40.7
LSD (0.05)		8	11	6	8	9	9	13.8

[a] DAP is days after sorghum planting.

Efficacy of nicosulfuron application timings in irrigated acetolactase synthase-resistant grain sorghum. R. S. Currie and P. W. Geier. (Kansas State University Southwest Research-Extension Center, 4500 E. Mary Street, Garden City, KS 67846) An experiment conducted at the Kansas State University Southwest Research-Extension Center evaluated nicosulfuron-containing herbicide treatments for efficacy and crop tolerance in acetolactase synthase-resistant grain sorghum. Herbicides were applied preemergence (PRE), PRE followed by postemergence (POST), or early postemergence (EPOST). A tractor-mounted, compressed-CO_2 sprayer delivering 19.4 gpa at 3.0 mph and 30 psi was used to apply all herbicides. Application, environmental, crop, and weed information are given in Table 1. Natural weed populations were supplemented by overseeding the experimental area with quinoa (to simulate common lambsquarters). Soil was a Ulysses silt loam containing 3.4% organic matter and pH 7.9. Plots were 10 by 32 feet and arranged in a randomized complete block with four replications. Weed control was visually determined on July 16 and August 16, 2018, which were 6 and 37 days after the POST treatments (DA-C). Grain sorghum necrosis was determined on July 6 and July 16, 2018, which was 3 days after the EPOST treatments (DA-B) and 6 DA-C, respectively. Grain yields were determined October 29, 2018 by mechanically harvesting the center two rows of each plot and adjusting weights to 14.0% moisture.

Table 1. Application information.

Application timing	Preemergence	Early Postemergence	Postemergence
Application date	June 6, 2018	July 3, 2018	July 10, 2018
Air temperature (F)	67	80	80
Relative humidity (%)	68	47	52
Soil temperature (F)	69	75	77
Wind speed (mph)	5 to 8	4 to 6	2 to 5
Wind direction	South	South	South
Soil moisture	Good	Good	Good
Grain sorghum			
Height (inch)	---	3 to 6	5 to 9
Leaves (no.)	0	2 to 4	4 to 6
Palmer amaranth			
Height (inch)	---	1 to 4	1 to 5
Density (plants/m^2)	0	25	10
Puncturevine			
Height (inch)	---	1 to 5	1 to 3
Density (plants/m^2)	0	10	3
Quinoa			
Height (inch)	---	1 to 3	---
Density (plants/m^2)	0	2	0
Kochia			
Height (inch)	---	1 to 3	---
Density (plants/m^2)	0	2	0
Green foxtail			
Height (inch)	---	1 to 3	1 to 3
Density (plants/m^2)	0	10	2

All herbicides controlled kochia 88 to 100% and quinoa 98 to 100% regardless of evaluation date, and did not differ between herbicides (data not shown). Palmer amaranth control was best when *S*-metolachlor/atrazine was applied PRE alone or when *S*-metolachlor plus rimsulfuron and thifensulfuron PRE was followed by nicosulfuron POST (Table 2). At 37 DA-C, puncturevine control exceeded 90% with all herbicides except *S*-metolachlor/atrazine alone PRE or rimsulfuron plus thifensulfuron and atrazine PRE followed by nicosulfuron and atrazine POST. All herbicide combinations that included nicosulfuron either EPOST or POST controlled green foxtail 93% or more at 37 DA-C. Grain sorghum necrosis at 3 DA-B was 18% with the EPOST treatment of *S*-metolachlor/atrazine, nicosulfuron, and atrazine, but decreased to 6% by 6 DA-C (Table 3). Necrosis was also less than 10% with the other nicosulfuron treatments at 6 DA-C. Grain yields increased 22 to 43 bu/A with most herbicide treatments compared to the nontreated controls (Table 3). However, sorghum receiving rimsulfuron plus thifensulfuron and atrazine PRE followed by nicosulfuron and atrazine POST, yielded similarly to the nontreated controls.

Table 2. Weed control with nicosulfuron application timings in sorghum.

			Palmer amaranth		Puncturevine		Green foxtail	
Treatment	Rate	Timing[a]	6 DA-C[b]	37 DA-C	6 DA-C	37 DA-C	6 DA-C	37 DA-C
	per A		—— % Visual ——		—— % Visual ——		—— % Visual ——	
S-metolachlor/ Atrazine	3.2 pt	PRE	79	84	78	73	91	78
Rimsulfuron	1.0 oz	PRE	50	50	100	78	91	93
Thifensulfuron	0.25 oz	PRE						
Atrazine	0.75 qt	PRE						
Nicosulfuron	0.67 oz	POST						
Atrazine	0.75 qt	POST						
Crop oil concentrate	2.0 %	POST						
Ammonium sulfate	2.0 lb	POST						
S-metolachlor	1.33 pt	PRE	78	81	83	97	93	100
Rimsulfuron	1.0 oz	PRE						
Thifensulfuron	0.25 oz	PRE						
Nicosulfuron	0.67 oz	POST						
Crop oil concentrate	2.0 %	POST						
Ammonium sulfate	2.0 lb	POST						
S-metolachlor/ Atrazine	2.0 pt	PRE	78	83	100	94	91	100
Nicosulfuron	0.67 oz	POST						
Atrazine	0.75 qt	POST						
Crop oil concentrate	2.0 %	POST						
Ammonium sulfate	2.0 lb	POST						
S-metolachlor/ Atrazine	3.2 pt	EPOST	60	53	83	94	91	98
Nicosulfuron	0.67 oz	EPOST						
Atrazine	0.75 qt	EPOST						
Crop oil concentrate	2.0 %	EPOST						
Ammonium sulfate	2.0 lb	EPOST						
LSD (0.05)			9	7	7	12	NS	7

[a] Timings were PRE = preemergence, EPOST = early postemergence, and POST = postemergence.
[b] DA-C = days after the postemergence treatments.

Table 3. Crop response to nicosulfuron application timings in grain sorghum.

Treatment	Rate	Timing[a]	Leaf necrosis 3 DA-B[b]	Leaf necrosis 6 DA-C[c]	Grain yield
	per A		% Visual	% Visual	bu/A
S-metolachlor/ Atrazine	3.2 pt	PRE	0	0	55.1
Rimsulfuron	1.0 oz	PRE	0	5	23.7
Thifensulfuron	0.25 oz	PRE			
Atrazine	0.75 qt	PRE			
Nicosulfuron	0.67 oz	POST			
Atrazine	0.75 qt	POST			
Crop oil concentrate	2.0 %	POST			
Ammonium sulfate	2.0 lb	POST			
S-metolachlor	1.33 pt	PRE	0	1	57.4
Rimsulfuron	1.0 oz	PRE			
Thifensulfuron	0.25 oz	PRE			
Nicosulfuron	0.67 oz	POST			
Crop oil concentrate	2.0 %	POST			
Ammonium sulfate	2.0 lb	POST			
S-metolachlor/ Atrazine	2.0 pt	PRE	0	9	55.1
Nicosulfuron	0.67 oz	POST			
Atrazine	0.75 qt	POST			
Crop oil concentrate	2.0 %	POST			
Ammonium sulfate	2.0 lb	POST			
S-metolachlor/ Atrazine	3.2 pt	EPOST	18	6	36.2
Nicosulfuron	0.67 oz	EPOST			
Atrazine	0.75 qt	EPOST			
Crop oil concentrate	2.0 %	EPOST			
Ammonium sulfate	2.0 lb	EPOST			
Untreated	---	---	0	0	14.0
LSD (0.05)			2	4	10.9

[a] Timings were PRE = preemergence, EPOST = early postemergence, and POST = postemergence.
[b] DA-B = days after the early postemergence treatments.
[c] DA-C = days after the postemergence treatments.

Split applications of mesotrione-based premixes for efficacy in grain sorghum. R. S. Currie and P. W. Geier. (Kansas State University Southwest Research-Extension Center, 4500 E. Mary Street, Garden City, KS 67846) An experiment was conducted near the Kansas State University Southwest Research & Extension Center to compare single and sequential applications of mesotrione-based herbicides in grain sorghum. Treatments were applied at full rates 14 days preplant (DPP), or as split applications with half the rate applied 14 DPP and the other half applied preemergence (PRE). All treatments were applied using a tractor-mounted, compressed CO_2 sprayer delivering 19.4 gpa at 4.2 mph and 30 psi. Application and environmental information is shown in Table 1. Natural weed populations were supplemented by overseeding the experimental area with domesticated sunflower to simulate common sunflower. Plots were 10 by 35 feet and arranged in a randomized complete block with four replications. Soil was a Ulysses silt loam with pH 7.9 and 3.4% organic matter. Visual weed control was estimated on July 12 and August 13, 2018. These dates were 41 and 73 days after sorghum planting (DAP). Sorghum yields were determined on October 29, 2018 by mechanically harvesting the center two rows of each plot and adjusting grain weights to 14.0% moisture.

Table 1. Application information.

Application timing	14 days preplant	Preemergence
Application date	May 18, 2018	June 5, 2018
Air temperature (F)	66	67
Relative humidity (%)	74	68
Soil temperature (F)	67	69
Wind speed (mph)	4 to 6	5 to 8
Wind direction	South-southeast	South
Soil moisture	Fair	Good

All herbicides controlled velvetleaf and common sunflower similarly (95% or more) at 41 and 73 DAT, and did not differ between treatments (data not shown). Palmer amaranth control at 41 DAP was greater than 95% when the split application of *S*-metolachlor/mesotrione plus atrazine was applied 14 DPP and PRE, and when the full rate of *S*-metolachlor/mesotrione/atrazine was applied PRE (Table 2). The split application of *S*-metolachlor/mesotrione plus atrazine was more efficacious at this date than the full rate applied PRE. By 73 DAP, the split application of the three-way premix *S*-metolachlor/mesotrione/atrazine controlled Palmer amaranth better than any of the 14 DPP treatments alone. The split application of *S*-metolachlor/mesotrione/atrazine controlled kochia better than the single preplant application of the same herbicide at 41 and 73 DAP, while no differences occurred between the single and split applications of *S*-metolachlor/mesotrione plus atrazine. Both herbicide combinations evaluated in this study controlled puncturevine more effectively when applied as split application compared to single applications. Although differences between herbicides and application timing were not significant for green foxtail control at 41 DAP, the split application of *S*-metolachlor/mesotrione/atrazine provided better foxtail control than either single application at 73 DAP. Grain sorghum yields were similar among the herbicides evaluated, but all herbicides increased yields 40 to 51 bu/A compared to the nontreated controls (Table 2).

Table 2. Mesotrione-based premixes in sorghum.

Treatment	Rate	Timing[a]	Palmer amaranth		Kochia		Puncturevine		Green foxtail		Sorghum yield
			41 DAP[b]	73 DAP	41 DAP	73 DAP	41 DAP	73 DAP	41 DAP	73 DAP	
	qt/A		-—— % Visual ———		-—— % Visual ———		-—— % Visual ———		-—— % Visual ———		bu/A
S-metolachlor/ Mesotrione	2.0	14 DPP	86	81	88	78	63	48	81	73	66.4
Atrazine	0.65	14 DPP									
S-metolachlor/ Mesotrione	1.0	14 DPP	98	89	95	85	78	68	88	78	62.1
Atrazine	0.325	14 DPP									
S-metolachlor/ Mesotrione	1.0	PRE									
Atrazine	0.325	PRE									
S-metolachlor/ Mesotrione/ Atrazine	2.5	14 DPP	96	86	85	78	65	55	88	75	71.2
S-metolachlor/ Mesotrione/ Atrazine	1.25	14 DPP	94	95	96	90	73	75	78	85	60.2
S-metolachlor/ Mesotrione/ Atrazine	1.25	PRE									
Untreated	---	---	---	---	---	---	---	---	---	---	20.1
LSD (0.05)			8	8	9	8	7	13	NS	8	19.2

[a] 14 DPP is 14 days preplant, PRE is preemergence.
[b] DAP is days after sorghum planting.

Preemergence herbicides for residual weed control in grain sorghum. R. S. Currie and P. W. Geier. (Kansas State University Southwest Research-Extension Center, 4500 E. Mary Street, Garden City, KS 67846) An experiment conducted near the Kansas State University Southwest Research & Extension Center evaluated various preemergence herbicide treatments for residual efficacy in grain sorghum. All herbicides were applied the day after sorghum planting using a tractor-mounted, compressed CO_2 sprayer delivering 19.4 gpa at 30 psi and 4.2 mph. Application and environmental information is shown in Table 1. To supplement natural weed populations, the experimental area was overseeded with quinoa to simulate common lambsquarters. Plots were 10 by 35 feet and arranged in a randomized complete block replicated four times. Soil was Ulysses silt loam with pH 7.9 and 3.4% organic matter. Visual weed control was determined on June 27 and August 15, 2018, which corresponded to 33 and 82 days after treatment (DAT). Sorghum yields were determined October 29, 2018 by mechanically harvesting the center two rows of each plot and adjusting grain weights to 14.0% moisture.

Table 1. Application information.

Application date	May 25, 2018
Air temperature (F)	72
Relative humidity (%)	67
Soil temperature (F)	67
Wind speed (mph)	2 to 5
Wind direction	Southeast
Soil moisture	Good

Velvetleaf control was 95 to 100% and 88 to 100% at 33 and 82 DAT, respectively, and did not differ among herbicides (data not shown). *S*-metolachlor/atrazine at 1.5 qt/A and acetochlor at 2.0 qt/A controlled quinoa 93 and 88% at 33 DAT, which was slightly less than herbicides that provided 100% control (data not shown). However, by 82 DAT, quinoa control did not differ between any treatments. Palmer amaranth control at 33 DAT was best (88% or more) with acetochlor/atrazine, *S*-metolachlor/mesotrione/glyphosate plus atrazine, and mesotrione plus atrazine plus *S*-metolachlor (Table 2). By 82 DAT, only the three-way mixtures containing *S*-metolachlor, atrazine, and mesotrione controlled Palmer amaranth 85% or more. These three-way mixes, along with saflufenacil/dimethenamid plus dimethenamid generally provided the best puncturevine control at 33 and 82 DAT. However, puncturevine control did not exceed 81% with any treatment by 82 DAT. Acetochlor alone was the only treatment to provided less than 93% kochia control at 33 DAT. At 82 DAT, kochia control was 88% or more with all herbicides except acetochlor, *S*-metolachlor, metolachlor, and mesotrione, each applied alone. Green foxtail control was less than 80% with atrazine alone, mesotrione alone, and the tank mixture of atrazine and mesotrione early in the season. Foxtail control declined by 82 DAT such that only saflufenacil/dimethenamid plus dimethenamid and mesotrione plus atrazine plus *S*-metolachlor were the only herbicides to provide 80% or more control. All herbicides except mesotrione alone increased sorghum yield compared to the nontreated controls (Table 2). Yields were improved the most when acetochlor/atrazine and *S*-metolachlor, mesotrione, and atrazine was applied, with or without glyphosate.

Table 2. Efficacy of herbicides applied preemergence in sorghum.

Treatment	Rate	Palmer amaranth		Puncturevine		Kochia		Green foxtail		Sorghum yield
		33 DAP[a]	82 DAP	33 DAP	82 DAP	33 DAP	82 DAP	33 DAP	82 DAP	
	per A	— % Visual —		— % Visual —		— % Visual —		— % Visual —		bu/A
Atrazine	1.0 qt	68	45	60	45	100	88	65	58	56.5
S-metolachlor/ Atrazine	1.6 qt	83	75	70	63	98	95	80	75	72.7
S-metolachlor/ Atrazine	1.5 qt	80	70	75	55	95	95	80	73	69.1
Acetochlor/ Atrazine	2.25 qt	88	80	73	68	99	88	83	75	86.6
S-metolachlor	1.5 pt	75	78	70	53	93	78	80	70	70.3
Metolachlor	1.47 pt	70	60	63	50	93	80	85	68	55.5
Acetochlor	2.0 qt	70	60	65	58	85	80	80	65	56.4
Saflufenacil/ Dimethenamid	10 oz	80	78	83	73	100	91	90	88	76.3
Dimethenamid	10 oz									
Mesotrione	6.0 oz	70	60	63	58	100	75	65	55	51.8
Mesotrione	6.0 oz	83	73	85	60	100	98	74	68	73.0
Atrazine	1.0 qt									
Mesotrione	6.0 oz	96	96	88	80	100	99	80	80	93.2
Atrazine	1.0 qt									
S-metolachlor	1.5 pt									
S-metolachlor/ Mesotrione/ Glyphosate	6.0 pt	93	85	84	81	100	98	84	79	78.8
Nonionic surfactant	0.25 %									
Atrazine	1.0 qt									
Untreated	---	---	---	---	---	---	---	---	---	37.9
LSD (0.05)		12	12	7	10	9	12	10	8	14.8

[a] DAP is days after sorghum planting.

Nicosulfuron efficacy and crop response in two acetolactase synthase-resistant grain sorghum hybrids. R. S. Currie and P. W. Geier. (Kansas State University Southwest Research-Extension Center, 4500 E. Mary Street, Garden City, KS 67846) Two experiments were conducted at the Kansas State University Southwest Research-Extension Center in 2018 to determine the efficacy of and tolerance to nicosulfuron applications timings in two acetolactase synthase-tolerant sorghum hybrids. One study was planted to sorghum hybrid XSA5527 (Hybrid 1) while the second study was planted to hybrid XSA4820 (Hybrid 2). All herbicide treatments were applied using a tractor-mounted, compressed CO2 sprayer delivering 19.4 gpa at 4.1 mph and 30 psi. Application, environmental, crop, and weed information is given in Table 1. Natural weed populations were supplemented by overseeding the experimental area with quinoa (to simulate common lambsquarters) and domesticated sunflower (to simulate common sunflower). Soil was a Ulysses silt loam with 3.4% organic matter and pH of 7.9 for both experiments. Grain sorghum necrosis was evaluated visually on July 16, 2018 and stunting was visually estimated on August 16, 2018. These dates were 6 and 37 days after the final herbicide applications (DA-C), respectively. Visual weed control was determined on August 16, 2018 (37 DA-C) as well. Grain yields were measured on October 29, 2018 by mechanically harvesting the center two rows of each plot and adjusting weights to 14.0% moisture.

Table 1. Application information.

Application timing	Preemergence		Early postemergence		Postemergence	
Hybrid	XSA5527	XSA4820	XSA5527	XSA4820	XSA5527	XSA4820
Application date	June 5	June 5	July 3	July 3	July 10	July 10
Air temperature (F)	67	67	80	80	80	80
Relative humidity (%)	68	68	47	47	52	52
Soil temperature (F)	69	69	75	75	77	77
Wind speed (mph)	5 to 8	5 to 8	3 to 6	3 to 6	2 to 5	2 to 5
Wind direction	South	South	South	South	South	South
Soil moisture	Good	Good	Good	Good	Good	Good
Grain sorghum						
Height (inch)	---	---	3 to 6	1 to 4	5 to 9	5 to 9
Leaves (no.)	0	0	2 to 4	2 to 4	4 to 6	4 to 6
Palmer amaranth						
Height (inch)	---	---	1 to 3	1 to 4	1 to 5	1 to 5
Density (plants/m^2)	0	0	25	50	10	10
Puncturevine						
Height (inch)	---	---	1 to 5	2 to 6	1 to 3	1 to 3
Density (plants/m^2)	0	0	10	10	3	3
Kochia						
Height (inch)	---	---	1 to 2	1 to 3	1 to 3	1 to 3
Density (plants/m^2)	0	0	2	1	1	1
Green foxtail						
Height (inch)	---	---	1 to 3	1 to 4	1 to 3	1 to 2
Density (plants/m^2)	0	0	25	1	3	1
Velvetleaf						
Height (inch)	---	N/A[a]	1 to 3	N/A	1 to 3	N/A
Density (plants/m^2)	0	N/A	2	N/A	1	N/A
Common sunflower						
Height (inch)	N/A	---	N/A	1 to 3	N/A	1 to 3
Density (plants/m^2)	N/A	0	N/A	1	N/A	1

[a] N/A = weed species not present in that experiment

Trends for weed control and crop response were similar between experiments. Kochia, quinoa, and common sunflower control was 90% to 100% and did not differ between herbicides (data not shown), nor did velvetleaf control (88 to 99%). Palmer amaranth control was best when *S*-metolachlor/atrazine was applied preemergence (PRE) or when followed by nicosulfuron plus atrazine postemergence (POST) (Table 2). Nicosulfuron plus atrazine applied early postemergence (EPOST) controlled Palmer amaranth only 50%. *S*-metolachlor/atrazine applied alone PRE provided no more than 78% puncturevine and green foxtail control, whereas any nicosulfuron treatment applied EPOST or POST controlled these weeds 93 to 100%. Minor sorghum necrosis (6 DA-C) and stunting (37 DA-C) occurred with each hybrid with POST treatments of nicosulfuron plus atrazine (Table 3). Yields were best when *S*-metolachlor/atrazine was applied alone PRE or followed by nicosulfuron plus atrazine POST (Table 3). Sorghum receiving nicosulfuron plus atrazine EPOST yielded no more than nontreated sorghum, and this was likely do to the poor Palmer amaranth control with this treatment.

Table 2. Efficacy of nicosulfuron in two acetolactase synthase-resistant hybrids[a].

Treatment	Rate	Timing[b]	Palmer amaranth Hybrid 1[c]	Palmer amaranth Hybrid 2[d]	Puncturevine Hybrid 1	Puncturevine Hybrid 2	Green foxtail Hybrid 1	Green foxtail Hybrid 2
	per A		% Visual		% Visual		% Visual	
S-metolachlor/ Atrazine	3.2 pt	PRE	80	83	78	65	78	73
S-metolachlor/ Atrazine	2.0 pt	PRE	79	79	98	100	100	93
Nicosulfuron	0.67 oz	POST						
Atrazine	0.75 qt	POST						
Crop oil concentrate	2.0 %	POST						
Ammonium sulfate	2.0 lb	POST						
S-metolachlor/ Atrazine	2.0 pt	PRE	79	78	99	98	100	94
Nicosulfuron	1.33 oz	POST						
Atrazine	0.75 qt	POST						
Crop oil concentrate	2.0 %	POST						
Ammonium sulfate	2.0 lb	POST						
Nicosulfuron	0.67 oz	EPOST	50	50	100	100	100	90
Atrazine	0.75 qt	EPOST						
Crop oil concentrate	2.0 %	EPOST						
Ammonium sulfate	2.0 lb	EPOST						
LSD (0.05)			11	12	6	6	8	11

[a] Weed control ratings taken on August 16, 2018 which was 37 days after postemergence applications.
[b] Timings were PRE = preemergence, EPOST = early postemergence, and POST = postemergence.
[c] Hybrid 1 was Pioneer XSA5527.
[d] Hybrid 2 was Pioneer XSA4820.

Table 3. Crop response of two acetolactase synthase-resistant hybrids receiving nicosulfuron treatments.

Treatment	Rate	Timing[d]	Necrosis[a]		Stunting[b]		Grain yield[c]	
			Hybrid 1[e]	Hybrid 2[f]	Hybrid 1	Hybrid 2	Hybrid 1	Hybrid 2
	per A		% Visual		% Visual		bu/A	
S-metolachlor/ Atrazine	3.2 pt	PRE	0	0	0	0	55.8	32.0
S-metolachlor/ Atrazine	2.0 pt	PRE	6	10	4	4	42.6	34.9
Nicosulfuron	0.67 oz	POST						
Atrazine	0.75 qt	POST						
Crop oil concentrate	2.0 %	POST						
Ammonium sulfate	2.0 lb	POST						
S-metolachlor/ Atrazine	2.0 pt	PRE	9	9	6	6	47.7	31.9
Nicosulfuron	1.33 oz	POST						
Atrazine	0.75 qt	POST						
Crop oil concentrate	2.0 %	POST						
Ammonium sulfate	2.0 lb	POST						
Nicosulfuron	0.67 oz	EPOST	1	0	0	0	26.4	14.4
Atrazine	0.75 qt	EPOST						
Crop oil concentrate	2.0 %	EPOST						
Ammonium sulfate	2.0 lb	EPOST						
Untreated	---	---	0	0	0	0	22.6	12.3
LSD (0.05)			5	2	NS	5	14.6	7.0

[a] Necrosis evaluated July 16, 2018 which was 6 days after the postemergence treatments.
[b] Stunting evaluated August 16, 2018 which was 37 days after the postemergence treatments.
[c] Yields determined October 29, 2018.
[d] Timings were PRE = preemergence, EPOST = early postemergence, and POST = postemergence.
[e] Hybrid 1 was Pioneer XSA5527.
[f] Hybrid 2 was Pioneer XSA4820.

Broadleaf weed control in wheat with halauxifen/florasulam. Traci A. Rauch and Joan M. Campbell. (Weed Science, University of Idaho, Moscow, ID 83844-2333) Two studies were established to evaluate broadleaf weed control and crop response with halauxifen/florasulam in winter and spring wheat near Moscow, Idaho. These 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). The winter wheat study was oversprayed with pinoxaden at 0.05 lb ai/A to control grass weeds and with propiconazole at 0.11 and fluxapyroxad/pyraclostrobin at 0.13 lb ai/A to control stripe rust on May 11, 2018. The spring wheat study was oversprayed with propiconazole at 0.11 and fluxapyroxad/pyraclostrobin at 0.13 lb ai/A to control stripe rust on June 6, 2018. Crop response and weed control were evaluated visually during the growing season.

Table 1. Application and soil data.

Location	Winter wheat	Spring wheat
Application date	5/2/18	5/28/18
Wheat variety -seeding date	Brundage96 – 10/6/17	WB 9518 – 4/26/18
Growth stage		
Spring wheat	--	2 tiller
Winter wheat	3 tiller	--
Mayweed chamomile	4 leaf, 2 inches tall	--
Common lambsquarters	--	12 leaf, 4 inches tall
Yellow mustard	--	6 leaf, 6 inches tall
Air temperature (F)	63	63
Relative humidity (%)	64	75
Wind (mph), direction	0	1, W
Dew present?	yes	yes
Next moisture occurred	5/9/18	6/4/18
Cloud cover (%)	5	0
Soil moisture	adequate	adequate
Soil temperature at 2 inch (F)	60	60
pH	4.7	5.1
OM (%)	4.0	3.8
CEC (meq/100g)	13.2	26.5
Texture	silt loam	silt loam

In the winter wheat study, no treatment injured winter wheat (data not shown). Bicyclopyrone/bromoxynil alone and pyrasulfotole/bromoxynil alone or combined with halauxifen/florasulam controlled mayweed chamomile 79 to 87% (Table 2). All other treatments controlled mayweed chamomile greater than 90%. Grain yield and test weight did not differ among treatments including the untreated check.

In the spring wheat study, no treatment injured winter wheat (data not shown). All treatments, except clopyralid/fluroxypyr alone, controlled yellow mustard 87 to 99% (Table 3). All treatments, except florasulam/fluroxypyr and clopyralid/fluroxypyr alone, controlled common lambsquarters 86 to 99%. Florasulam/fluroxypyr and clopyralid/fluroxypyr alone only suppressed common lambsquarters 46 and 70%, respectively.

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Table 2. Mayweed chamomile control and winter wheat response with halauxifen/florasulam near Moscow, ID in 2018.

Treatment[1]	Rate	Mayweed chamomile control[2]	Winter wheat Yield	Winter wheat Test weight
	lb ai/A	%	lb/A	lb/bu
Halauxifen/florasulam	0.0096	96	8094	62.8
Halauxifen/florasulam +	0.0096			
pyrasulfotole/bromoxynil	0.217	96	8022	62.7
Halauxifen/florasulam +	0.0096			
bromoxynil/MCPA	0.5	86	7827	62.7
Halauxifen/florasulam	0.0096			
bicyclopyrone/bromoxynil +	0.19			
sodium bicarbonate	0.058	96	8336	62.8
Halauxifen/florasulam +	0.0096			
fluroxypyr	0.14	95	8129	62.8
Pyrasulfotole/bromoxynil	0.217	79	7996	62.8
Bicyclopyrone/bromoxynil +	0.19			
sodium bicarbonate +	0.058			
crop oil concentrate	1% v/v	87	7873	62.6
Florasulam/fluroxypyr	0.092	91	7690	62.7
Clopyralid/fluroxypyr	0.188	94	7639	62.7
Untreated check	--	--	7653	62.6
LSD (0.05)		6	NS	NS
Density (plants/ft^2)		2		

[1]NIS was applied with all halauxifen/florasulam treatments at 0.5% v/v.
[2]Evaluation 30 DAT.

Table 3. Broadleaf weed control in spring wheat with halauxifen/florasulam near Moscow, ID in 2018.

Treatment[1]	Rate	Weed control[2] Yellow mustard	Weed control[2] Common lambsquarters
	lb ai/A	%	%
Halauxifen/florasulam	0.0096	87	86
Halauxifen/florasulam +	0.0096		
clopyralid/fluroxypyr	0.188	91	97
Clopyralid/fluroxypyr +	0.188		
thifensulfuron/tribenuron[3]	0.0125	99	99
Clopyralid/fluroxypyr +	0.188		
thifensulfuron/tribenuron[4]	0.0188	99	99
Clopyralid/fluroxypyr	0.188	49	70
Florasulam/fluroxypyr	0.092	98	46
Pyrasulfotole/bromoxynil	0.217	99	99
LSD (0.05)		18	28
Density (plants/ft^2)		2	2

[1]All treatments, except clopyralid/fluroxypyr alone and florasulam/fluroxypyr, were applied with ammonium sulfate at 1.52 lb ai/A and nonionic surfactant (NIS) at 0.25% v/v. Pyrasulfotole/bromoxynil was not applied with NIS.
[2]Evaluation 30 DAT.
[3]Thifensulfuron/tribenuron was Affinity BroadSpec which is a 1:1 ratio.
[4]Thifensulfuron/tribenuron was Affinity Tankmix which is a 4:1 ratio.

Evaluation of bicyclopyrone/bromoxynil in tank mix combinations for crop safety and downy brome control in Clearfield® Plus winter wheat. Henry Wetzel and Drew Lyon. (Dept. of Crop & Soil Sciences, Washington State Univ., Pullman, WA 99164-6420) A field study was conducted at Buck Farms near Almota, WA to evaluate crop safety and downy brome (BROTE) control with bicyclopyrone/bromoxynil in tank mix combinations with group 2 herbicides including imazamox, mesosulfuron and pyroxsulam. In addition, some treatments contained urea ammonium nitrate (UAN) at 1.5 gal/A. The field, in which the study was conducted, had been in a two-year rotation of winter wheat and chickpea. The winter wheat variety 'UI Magic CL +' was seeded at the rate of 117 lb/A with a Krause drill on a 7.5-inch row spacing at 1.25 inch depth between October 7 and 17, 2017. Plots were 10 ft by 33 ft and arranged in a randomized complete block design with four replications. On April 3, 2018, herbicides were applied with a CO_2-powered backpack sprayer set to deliver 10 gpa at 43 psi at 2.3 mph (Table 1). Crop injury ratings were taken every seven days after treatment until May 3rd. Visual ratings of BROTE control were assessed on May 10th and 29th when BROTE seedheads were visible above the crop canopy. Wheat seed was harvested with a small plot combine on July 23rd.

Table 1. Application and soil data.

Location	Buck Farms, Almota, Washington
Application date	April 3, 2018
Wheat growth stage	Beginning of stem elongation
Downy brome density	1.9 plants per ft^2
Air temperature (F)	50
Relative humidity (%)	27
Wind (mph, direction)	4, west
Cloud cover (%)	100
Soil temperature at 6 in (F)	39
pH	5.1
OM (%)	4.3
Texture	silt loam

We observed crop injury in plots treated with bicyclopyrone/bromoxynil + sodium bicarbonate + UAN + NIS (0.19 lb ae/A + 0.057 lb ai/A + 1.5 gal/A + 0.25% v/v) and bicyclopyrone/bromoxynil + sodium bicarbonate + imazamox + UAN + NIS (0.19 lb ae/A + 0.057 lb ai/A + 0.047 lb ae/A + 1.5 gal/A + 0.25% v/v). Injury was not observed until 15 DAT and it consisted of longitudinal bleached streaks on the leaf blades. It appeared that the newest emerged leaf that was present at the time of application was the one affected. Crop injury was not noted in leaves that emerged after the spray application. April was a cool month and crop injury symptoms persisted for about one month after application. The addition of UAN appeared to aid bicyclopyrone/bromoxynil movement into the plant, but the herbicide does not appear to be entering the vascular system and translocating. It seems that when mesosulfuron and pyroxsulam are tank mixed with bicyclopyrone/bromoxynil and UAN, those products provide a sufficient safener load and crop injury was not noted. It was observed that UAN was essential for the mesosulfuron to provide acceptable BROTE control. The level of BROTE control provided by imazamox and pyroxsulam was not compromised when tank mixed with bicyclopyrone/bromoxynil, however, BROTE control was reduced when bicyclopyrone/bromoxynil was tank mixed with mesosulfuron. None of the treatments in this study affected crop yield or test weight when compared to the nontreated check. The average yield and test weight were 138 bu/A and 60.8 lb/bu, respectively.

Table 2. Crop injury and BROTE control in 'UI Magic CL+' winter wheat with herbicides near Almota, Washington in 2018.

		Crop injury		BROTE control	
		4/18	5/3	5/10	5/29
		15 DAT	30 DAT	37 DAT	56 DAT
	lb ae/A				
Nontreated check	--	--	--	--	--
Bicyclopyrone/bromoxynil[2]	0.19	0	0	5	5
Bicyclopyrone/bromoxynil[2,3]	0.19	19	4	3	3
Imazamox[3]	0.047	0	0	85	99
Mesosulfuron[3]	0.013 lb ai	0	0	72	84
Pyroxsulam[3]	0.016 lb ai	0	0	83	100
Bicyclopyrone/bromoxynil + imazamox[2]	0.19 + 0.047	0	0	80	91
Bicyclopyrone/bromoxynil + imazamox[2,3]	0.19 + 0.047	14	4	88	100
Bicyclopyrone/bromoxynil + mesosulfuron[2]	0.19 + 0.013 lb ai	0	0	13	5
Bicyclopyrone/bromoxynil + mesosulfuron[2,3]	0.19 + 0.013 lb ai	0	0	69	70
Bicyclopyrone/bromoxynil + pyroxsulam[2]	0.19 + 0.016 lb ai	0	0	76	90
Bicyclopyrone/bromoxynil + pyroxsulam[2,3]	0.19 + 0.016 lb ai	0	0	91	100
LSD (0.05)		4	1	15	15

[1]All treatments were tank mixed with a 90% nonionic surfactant (R-11) at 0.25% v/v
[2]Treatment was tank mixed with sodium bicarbonate (0.057 lb ai/A)
[3]Treatment was tank mixed with urea ammonium nitrate (UAN) at 1.5 gal/A

Downy brome control in winter wheat. Traci A. Rauch and Joan M. Campbell. (Weed Science, University of Idaho, Moscow, ID 83844-2333) Three studies were established in 'Brundage96' winter wheat to evaluate downy brome control with bicyclopyrone/bromoxynil combinations plus grass herbicides and fertilizer, mesosulfuron/thiencarbazone combined with pyroxasulfone or flufenacet/metribuzin, and glyphosate combinations plus sulfosulfuron prior to planting near Moscow, ID. The plots were arranged in a randomized complete block design with four replications. All herbicide treatments were applied using a CO_2 pressurized backpack sprayer (Table 1). On May 10, 2018, the bicyclopyrone/bromoxynil study was oversprayed for stripe rust with propiconazole/azoxystrobin at 0.24 lb ai/A. The mesosulfuron/thiencarbazone and glyphosate combination studies were oversprayed on May 11, 2018 with pyrasulfotole/bromoxynil at 0.19, thifensulfuron/tribenuron at 0.025, and fluroxypyr at 0.13 lb ai/A at for broadleaf weed control and propiconazole at 0.11 and fluxapyroxad/pyraclostrobin at 0.13 lb ai/A for stripe rust control. Crop injury and downy brome control were evaluated visually during the growing season.

Table 1. Application and soil data.

	Bicyclopyrone/bromoxynil study	Mesosulfuron/thiencarbazone study	
Winter wheat seeding date	10/10/17	10/10/17	
Application date	4/22/18	10/10/17	4/20/17
Growth stage			
Winter wheat	1 to 3 tiller	postplant pre	2 tiller
Downy brome (BROTE)	3 leaf to 3 tiller	pre	2 to 3 tiller
GPA	10	10	10
PSI	32	32	32
MPH	3	3	3
Air temperature (F)	56	65	66
Relative humidity (%)	52	32	58
Wind (mph, direction)	3, W	3, E	2, W
Cloud cover (%)	5	100	15
Soil moisture	dry	dry	dry
Soil temperature at 2 inch (F)	55	51	60
Next rain occurred	5/9/18	10/11/17	5/9/18
pH	5.0		
OM (%)	2.8		
CEC (meq/100g)	12.7		
Texture	silt loam		

	Glyphosate plus sulfosulfuron prior to planting study	
Winter wheat seeding date	10/10/17	
Application date	10/9/17	10/11/17
Growth stage		
Winter wheat	preplant	dry seed
Downy brome (BROTE)	spike	spike
GPA	20	20
PSI	38	38
MPH	3	3
Air temperature (F)	58	56
Relative humidity (%)	36	57
Wind (mph, direction)	5, ESE	5, W
Cloud cover (%)	40	60
Soil moisture	dry	adequate
Soil temperature at 2 inch (F)	53	52
Next rain occurred	10/11/17	10/12/17
pH	4.5	
OM (%)	3.0	
CEC (meq/100g)	13.9	
Texture	loam	

In the bicyclopyrone/bromoxynil study, comparisons of bicyclopyrone/bromoxynil were made with and without the addition of UAN in combination with grass herbicides. The bicyclopyrone/bromoxynil label states that it cannot be combined with ammonium sulfate (AMS) due to possible increased crop injury, but many grass herbicides require the addition of a fertilizer. Bicyclopyrone/bromoxynil alone plus urea ammonium nitrate (UAN) injured winter wheat 16% at 11 DAT (days after treatment) (Table 2). By 31 DAT, pyroxsulam and mesosulfuron alone or combined with bicyclopyrone/bromoxynil without UAN injured wheat 16 to 25%. Downy brome control was best with pyroxsulam treatments (81 to 88%). Wheat grain yield was lowest with treatments without any grass herbicides and pyroxsulam or mesosulfuron alone. Grain test weight was lowest for pyroxsulam and mesosulfuron alone. Wheat grain yield and test weight was decreased with pyroxsulam and mesosulfuron treatments due to wheat injury (chlorosis, necrosis, and vigor). The addition of bicyclopyrone/bromoxynil safened the grass herbicide plus UAN mixtures and did not reduce wheat grain yield or test weight.

In the mesosulfuron/thiencarbazone study, mesosulfuron/thiencarbazone alone or combined with flufenacet/metribuzin or pyrasulfotole/bromoxynil injured winter wheat 11 to 30% (Table 3). Temperatures below freezing before and after mesosulfuron/thiencarbazone application enhanced injury. All treatments controlled downy brome 91 to 99%, except mesosulfuron/thiencarbazone alone.

In the glyphosate plus sulfosulfuron study, downy brome control was 91 and 98% with the pyroxasulfone treatments (Table 4). Glyphosate plus sulfosulfuron at the high rate suppressed downy brome 75%. Wheat grain yield was lowest with glyphosate alone, but did not differ from the glyphosate plus flucarbazone treatment. Pyroxasulfone treatments had lower grain test weight compared to glyphosate alone (the standard). This was most likely due to higher late season moisture availability from increased downy brome control.

This work was supported by the USDA National Institute of Food and Agriculture, Hatch project IDA01588.

Table 2. Downy brome control and wheat response with bicyclopyrone/bromoxynil combined with grass herbicides and fertilizer near Moscow, ID in 2018.

Treatment[1]	Rate	Wheat injury 11 DAT	Wheat injury 31 DAT	BROTE[2] control	Wheat Yield[3]	Wheat Test weight
	lb ai/A	%	%	%	lb/A	lb/bu
Bicyclopyrone/bromoxynil +	0.193					
sodium bicarbonate +	0.058					
NIS	0.25% v/v	0	0	0	1151	61.4
Bicyclopyrone/bromoxynil +	0.193					
sodium bicarbonate +	0.058					
UAN	15% v/v					
NIS	0.25% v/v	16	0	0	1462	61.6
Bicyclopyrone/bromoxynil +	0.193					
sodium bicarbonate +	0.058					
pyroxsulam	0.0164					
NIS	0.25% v/v	0	16	81	3079	61.6
Bicyclopyrone/bromoxynil +	0.193					
sodium bicarbonate +	0.058					
pyroxsulam	0.0164					
UAN	15% v/v					
NIS	0.25% v/v	0	9	88	2963	61.5
Bicyclopyrone/bromoxynil +	0.193					
sodium bicarbonate +	0.058					
mesosulfuron	0.0134					
NIS	0.25% v/v	0	19	53	2042	61.9
Bicyclopyrone/bromoxynil +	0.193					
sodium bicarbonate +	0.058					
mesosulfuron	0.0134					
UAN	15% v/v					
NIS	0.25% v/v	0	6	55	3438	61.6
Pyroxsulam	0.0164					
UAN	15% v/v					
NIS	0.25% v/v	0	24	82	1813	60.4
Mesosulfuron	0.0134					
UAN	15% v/v					
NIS	0.25% v/v	0	25	55	1806	60.6
LSD (0.05)		1	11	26	1058	0.7
Density (plants/ft^2)				15		

[1]Sodium bicarbonate was used as a buffer. NIS is nonionic surfactant. UAN is urea ammonium nitrate (fertilizer).
[2]BROTE = downy brome.
[3]Rep 2 not include due to a non-uniform wheat stand.

Table 3. Winter wheat injury and downy brome control with mesosulfuron/thiencarbazone combined with pyroxasulfone or flufenacet/metribuzin near Moscow, ID in 2018.

Treatment[1]	Rate	Application timing[2]	Winter wheat injury[3]	Downy brome control[3]
	lb ai/A		%	%
Pyroxasulfone	0.08	preemergence	0	95
Flufenacet/metribuzin	0.34	preemergence	11	91
Pyroxasulfone +	0.08	preemergence		
mesosulfuron/thiencarbazone	0.0178	2 to 3 tiller	11	99
Flufenacet/metribuzin +	0.34	preemergence		
mesosulfuron/thiencarbazone	0.0178	2 to 3 tiller	30	99
Pyroxasulfone +	0.08	preemergence		
mesosulfuron/thiencarbazone +	0.0178	2 to 3 tiller		
pyrasulfotole/bromoxynil	0.217	2 to 3 tiller	15	99
Flufenacet/metribuzin +	0.34	preemergence		
mesosulfuron/thiencarbazone +	0.0178	2 to 3 tiller		
pyrasulfotole/bromoxynil	0.217	2 to 3 tiller	20	99
Mesosulfuron/thiencarbazone	0.0178	2 to 3 tiller	28	52
LSD (0.05)			16	5
Density (plants/ft^2)				15

[1]All mesosulfuron/thiencarbazone treatments were applied with a non-ionic surfactant at 0.25% v/v and urea ammonium nitrate at 5% v/v.
[2]Application timing based on winter wheat growth stage.
[3]Evaluation date May 23, 2018.

Table 4. Downy brome control and winter wheat response with glyphosate combined with sulfosulfuron near Moscow, ID in 2018.

Treatment[1]	Rate	Application timing	Downy brome control[2]	Winter wheat Yield	Winter wheat Test weight
	lb ai/A		%	lb/A	lb/bu
Glyphosate	1	preplant	0	991	58.5
Glyphosate +	1	preplant			
pyroxasulfone +	0.08	preplant			
sulfosulfuron	0.031	preplant	91	1713	56.9
Glyphosate +	1	preplant			
flucarbazone	0.0214	preplant	2	1560	59.4
Glyphosate +	1	preplant			
sulfosulfuron	0.0134	preplant	42	1850	58.4
Glyphosate +	1	preplant			
sulfosulfuron	0.0310	preplant	75	2105	57.6
Glyphosate +	1	preplant			
flucarbazone +	0.0214	preplant			
sulfosulfuron	0.0134	preplant	38	1881	58.6
Glyphosate +	1	preplant			
pyroxasulfone +	0.08	postplant pre			
sulfosulfuron	0.031	postplant pre	98	1617	55.9
LSD (0.05)			12	584	1.5
Density (plants/ft^2)			20		

[1]All treatments at each timing were applied with a non-ionic surfactant at 0.25% v/v and dry ammonium sulfate at 2.5 lb/A.
[2]Evaluation date July 10, 2018.

Rattail fescue and downy brome control in winter wheat. Traci A. Rauch and Joan M. Campbell. (Weed Science, University of Idaho, Moscow, ID 83844-2333) A study was established to evaluate rattail fescue and downy brome control with pyroxasulfone containing herbicides alone or in combination in 'Brundage96' winter wheat at University of Idaho Parker Plant Science Farm near Moscow, ID. The plots were arranged in a randomized complete block design with four replications and included an untreated check. All herbicide treatments were applied using a CO_2 pressurized backpack sprayer calibrated to deliver 10 gpa at 32 psi and 3 mph (Table 1). The site was over sprayed with fluroxypyr at 0.13 lb ai/A, pyrasulfotole/bromoxynil at 0.9 lb ai/A, and thifensulfuron/tribenuron at 0.031 lb ai/A for broadleaf weed control and with propiconazole at 0.11 lb ai/A and fluxapyroxad/pyraclostrobin at 0.13 lb ai/A for stripe rust control on May 11, 2018. Crop injury and grass weed control were evaluated visually during the growing season. Grain was harvested with a small plot combine on August 8, 2018.

Table 1. Application and soil data.

Winter wheat seeding date	10/10/17	
Application date	10/14/17	4/26/18
Growth stage		
Winter wheat	imbibed	2 tiller
Rattail fescue (fall treated, spring treated)	pre	1 to 2 tiller, 3 to 6 tiller
Downy brome (fall treated, spring treated)	pre	2 to 3 leaf, 1 to 2 tiller
Air temperature (F)	52	74
Relative humidity (%)	64	34
Wind (mph, direction)	2, SW	0
Cloud cover (%)	40	0
Next rain occurred	10/20/17	5/9/18
Soil moisture	wet	dry
Soil temperature at 2 inch (F)	47	63
pH	4.5	
OM (%)	3.6	
CEC (meq/100g)	16	
Texture	silt loam	

No treatment visibly injured winter wheat (data not shown). Rattail fescue was controlled 89 to 98% by all treatments except pyroxsulam and sulfosulfuron applied alone postemergence (55 and 78%) (Table 2). All treatments, except flucarbazone alone, controlled downy brome 91% or better. Flucarbazone alone suppressed downy brome 78%. Grain yield in the untreated check tended to be lower compared to all other treatments. Grain yield was confounded likely by a non-uniform wheat stand.

This work was supported by the USDA National Institute of Food and Agriculture, Hatch project IDA01588.

Table 2. Rattail fescue and downy brome control and winter wheat response with pyroxasulfone combinations in 2018.

Treatment[1]	Rate	Application timing[2]	Weed control: Rattail fescue[3]	Weed control: Downy brome[3]	Winter wheat: Yield	Winter wheat: Test weight
	lb ai/A		%	%	bu/A	lb/bu
Flufenacet/metribuzin	0.425	pre	89	94	77	60.3
Pyroxasulfone	0.08	pre	89	94	74	59.6
Pyroxasulfone/fluthiacet	0.091	pre	89	94	67	59.0
Flucarbazone	0.027	2 tiller	90	78	85	61.0
Pyroxsulam	0.016	2 tiller	55	91	68	60.0
Sulfosulfuron	0.031	2 tiller	78	94	96	61.1
Flufenacet/metribuzin +	0.34	pre				
flucarbazone	0.027	2 tiller	89	94	73	59.7
Flufenacet/metribuzin +	0.34	pre				
pyroxsulam	0.016	2 tiller	98	99	83	60.4
Flufenacet/metribuzin +	0.34	pre				
sulfosulfuron	0.031	2 tiller	89	94	71	59.6
Pyroxasulfone +	0.08	pre				
flucarbazone	0.027	2 tiller	89	94	79	59.7
Pyroxasulfone +	0.08	pre				
pyroxsulam	0.016	2 tiller	89	94	78	59.9
Pyroxasulfone +	0.08	pre				
sulfosulfuron	0.031	2 tiller	89	94	83	60.4
Pyroxasulfone/fluthiacet +	0.091	pre				
flucarbazone	0.027	2 tiller	97	99	92	61.1
Pyroxasulfone/fluthiacet +	0.091	pre				
pyroxsulam	0.016	2 tiller	89	94	78	59.8
Pyroxasulfone/fluthiacet +	0.091	pre				
sulfosulfuron	0.031	2 tiller	89	94	86	60.0
Untreated check	--	--	-	--	60	61.1
LSD (0.05)			17	9	NS	NS
Density (plants/ft^2)			10	5		

[1]All postemergence treatments were applied with a non-ionic surfactant at 0.25% v/v and ammonium sulfate at 1 lb ai/A.
[2]Application timing based on winter wheat growth stage.
[3]Evaluation date June 1, 2018.

This work was supported by the USDA National Institute of Food and Agriculture, Hatch project IDA01588.

Grass and broadleaf weed control in winter wheat with mesosulfuron/thiencarbazone. Traci A. Rauch and Joan M. Campbell. (Dept. of Plant Sciences, University of Idaho, Moscow, ID 83844-2333) A study was established to evaluate rattail fescue, downy brome, and mayweed chamomile control with mesosulfuron/thiencarbazone alone or in combination in 'Brundage96' winter wheat at University of Idaho Parker Plant Science Farm near Moscow, ID. The plots were arranged in a randomized complete block design with four replications and included an untreated check. All herbicide treatments were applied using a CO_2 pressurized backpack sprayer calibrated to deliver 10 gpa at 32 psi and 3 mph (Table 1). The site was over sprayed with azoxystrobin/propiconazole at 0.24 lb ai/A for stripe rust control on May 10, 2018. Crop injury and weed control were evaluated visually during the growing season. Grain was harvested with a small plot combine on August 7, 2018.

Table 1. Application and soil data.

Winter wheat seeding date	10/10/2017
Application date	4/27/2018
Growth stage	
Winter wheat	2 tiller
Rattail fescue	4 tiller
Downy brome	3 tiller
Mayweed chamomile	1 inch
Air temperature (F)	77
Relative humidity (%)	55
Wind (mph, direction)	0
Cloud cover (%)	0
Next moisture occurred	5/9/2018
Soil moisture	dry
Soil temperature at 2 inch (F)	67
pH	4.9
OM (%)	3.6
CEC (meq/100g)	15.9
Texture	silt loam

Mesosulfuron without thiencarbazone combined with pyrasulfotole/bromoxynil and bromoxynil/MCPA visibly injured winter wheat 10% on May 9, 2018 (Table 2). All other treatments injured winter wheat 0 to 6%. Rattail fescue was controlled 86 to 96% with all treatments containing thiencarbazone. Flucarbazone and mesosulfuron with thiencarbazone did not control rattail fescue (20 and 61%). In prior research, flucarbazone has suppressed rattail fescue, averaging 79% control over 10 observations, but it performed poorly in this study most likely due to poor crop competition from non-uniform wheat stand. Mesosulfuron without thiencarbazone controlled downy brome 90%. At 35 DAT, mayweed chamomile control was 93 to 97% with all treatments except mesosulfuron/thiencarbazone alone or combined with pyrasulfotole/bromoxynil and bromoxynil/MCPA or halauxifen/florasulam (68 to 85%). By 60 DAT, all treatments controlled mayweed chamomile 97 to 99% except mesosulfuron/thiencarbazone alone. Grain yield was lower in the untreated check compared to all other treatments except mesosulfuron without thiencarbazone and bicyclopyrone/bromoxynil treatments. Test weight did not differ among all treatments including the untreated check.

This work was supported by the USDA National Institute of Food and Agriculture, Hatch project IDA01588.

Table 2. Weed control and winter wheat response with mesosulfuron/thiencarbazone combinations in 2018.

Treatment[1]	Rate	Weed control				Winter wheat		
				Mayweed chamomile				
		Rattail fescue[2]	Downy brome[2]	35 DAT	60 DAT	Injury[3]	Yield	Test weight
	lb ai/A	%	%	%	%	%	bu/A	lb/bu
Mesosulfuron/thiencarbazone	0.0178	88	69	68	68	1	82	60.9
Mesosulfuron/thiencarbazone +	0.0178							
pyrasulfotole/bromoxynil	0.217	95	78	94	98	2	85	60.9
Mesosulfuron/thiencarbazone +	0.0178							
pyrasulfotole/bromoxynil +	0.217							
florasulam/fluroxypyr	0.092	95	41	97	99	2	79	60.9
Mesosulfuron/thiencarbazone +	0.0178							
pyrasulfotole/bromoxynil +	0.217							
bromoxynil/MCPA	0.5	96	82	85	98	6	82	60.8
Mesosulfuron/thiencarbazone +	0.0178							
pyrasulfotole/bromoxynil +	0.217							
clopyralid/fluroxypyr	0.188	93	52	93	98	2	78	60.7
Mesosulfuron/thiencarbazone +	0.0178							
pyrasulfotole/bromoxynil +	0.217							
halauxifen/florasulam	0.0096	86	76	78	98	1	78	60.5
Mesosulfuron/thiencarbazone +	0.0178							
bicyclopyrone/bromoxynil +	0.221							
sodium bicarbonate	0.0675	86	41	97	99	0	73	60.4
Mesosulfuron +	0.0134							
pyrasulfotole/bromoxynil +	0.217							
bromoxynil/MCPA	0.5	61	90	97	98	10	77	60.5
Flucarbazone +	0.0273							
pyrasulfotole/bromoxynil +	0.217							
bromoxynil/MCPA	0.5	20	35	97	97	0	78	60.6
Untreated check	--	--	--	--		--	70	60.9
LSD (0.05)		13	29	18	13	7	8	NS
Density (plants/ft^2)		10	4		1			

[1]All treatments were applied with a non-ionic surfactant at 0.25% v/v and urea ammonium nitrate at 5% v/v.
[2]35 days after treatment.
[3]12 days after treatment.

The effect of disturbance on Italian ryegrass control with pyroxasulfone in winter wheat. Traci A. Rauch and Joan M. Campbell. (Weed Science, University of Idaho, Moscow, ID 83844-2333) A study was established near Moscow, ID to evaluate wheat response and Italian ryegrass (LOLMU) control with pyroxasulfone and pyroxasulfone/carfentrazone in winter wheat applied at four application times: pre-fertilization, post fertilization, postplant preemergence pre-germination, and postplant preemergence post-germination. Dry fertilizer was applied with a shank style applicator. Pyroxasulfone (0.08 lb ai) and pyroxasulfone/carfentrazone (0.10 lb ai of pyroxasulfone) were applied at the 2015 highest labeled rate for this soil type. The plots were arranged in a randomized complete block design with four replications and included an untreated check. All herbicide treatments were applied using a CO_2 pressurized backpack sprayer calibrated to deliver 10 gpa at 32 psi and 3 mph (Table 1).

The study area was oversprayed with glyphosate at 0.75 lb ai/A on September 21 and thifensulfuron/tribenuron at 0.031 lb ai/A, pyrasulfotole/bromoxynil at 0.193 lb ai/A, and florasulam/fluroxypyr at 0.092 lb ai/A for broadleaf weed control and azoxystrobin/propiconazole at 0.131 lb ai/A for stripe rust control on May 13, 2018. Wheat injury and Italian ryegrass control were evaluated visually during the growing season. Grain was harvested with a small plot combine on August 11.

Table 1. Application and soil data.

Wheat variety – seeding date	WB 1529 – 9/30/17			
Application date	9/21/17	9/30/17	10/2/17	10/11/17
Application timing	pre-fertilization	post-fertilization	postplant pre- no germ	postplant pre- germ
Wheat	preplant	preplant	no germination	1 in root/ 0.25 in shoot
Italian ryegrass	pre	pre	pre	germinating
Air temperature (F)	53	45	57	49
Relative humidity (%)	85	55	47	68
Wind (mph, direction)	3, W	5, NNW	1, WNW	4, WSW
Cloud cover (%)	100	50	100	90
Soil moisture	adequate	dry	dry	adequate
Soil temperature at 2 inch (F)	60	49	52	48
Next rain occurred	10/11/17	10/11/17	10/11/17	10/12/17
pH	5.7			
OM (%)	5.6			
CEC (meq/100g)	13.6			
Texture	silt loam			

No winter wheat injury was visible at any evaluation date (data not shown). Italian ryegrass control tended to be the best with pyroxasulfone (88%) or pyroxasulfone/carfentrazone (94%) at the postplant no germination timing but did not differ from any pyroxasulfone treatment at any timing (Table 2). Flufenacet/metribuzin did not control Italian ryegrass most likely due to a resistant population which will be tested in the greenhouse. Similar weed control across all application timings was likely due to a low population of Italian ryegrass and adequate rainfall to activate the herbicide within 20 days. Pyroxasulfone active ingredient rate was critical compared to the effect of disturbance. Italian ryegrass control was 92 versus 83% with 0.08 and 0.10 lb ai/A pyroxasulfone, respectively.

Winter wheat grain yield and test weight did not differ among treatments including the untreated check. Wheat grain yield tended to be lowest with the untreated check. Average grain yield for pyroxasulfone alone was 4599 lb/A and for pyroxasulfone/carfentrazone was 4814 lb/A which was mostly like due to the pyroxasulfone active ingredient rate being higher in the pyroxasulfone/carfentrazone.

This work was supported by the USDA National Institute of Food and Agriculture, Hatch project IDA01588.

Table 2. Winter wheat response and Italian ryegrass control with pyroxasulfone treatments applied at four times near Moscow, ID in 2018.

Treatment	Rate	Application timing[1]	Adequate rainfall[2]	LOLMU control[3]	Wheat	
					Yield	Test weight
	lb ai/A		(DAA)	%	lb/A	lb/bu
Pyroxasulfone	0.08	pre-fert	20	81	4816	63.6
Pyroxasulfone/carfentrazone	0.109	pre-fert	20	93	5004	63.9
Pyroxasulfone	0.08	post-fert	11	80	4461	63.4
Pyroxasulfone/carfentrazone	0.109	post-fert	11	90	4503	63.6
Pyroxasulfone	0.08	postplant-no germ	9	88	4567	63.7
Pyroxasulfone/carfentrazone	0.109	postplant-no germ	9	94	4900	63.9
Pyroxasulfone	0.08	germination	1	84	4551	63.3
Pyroxasulfone/carfentrazone	0.109	germination	1	90	4850	64.1
Flufenacet/metribuzin	0.425	germination	1	49	4756	63.5
Untreated check			--	--	3890	63.4
LSD (0.05)				15	NS	NS
Density (plants/ft^2)				5	--	--

[1]Pre-fert = Before fertilization. Post-fert= After shank applied dry fertilizer. Postplant = Wheat planted but not germinated.

[2]Rainfall over 0.3 inch.

[3]LOLMU = Italian ryegrass. Evaluation date June 19, 2018.

Italian ryegrass control with pyroxasulfone in winter wheat. Traci A. Rauch and Joan M. Campbell. (Weed Science, University of Idaho, Moscow, ID 83844-2333) Two studies were established near Viola, ID to evaluate winter wheat response and Italian ryegrass (LOLMU) control with pyroxasulfone/carfentrazone at different timings and preemergence pyroxasulfone herbicides combined with postemergence mesosulfuron or pyroxsulam. The plots were arranged in a randomized complete block design with four replications and included an untreated check. All herbicide treatments were applied using a CO_2 pressurized backpack sprayer calibrated to deliver 10 gpa at 32 psi and 3 mph (Table 1). The studies were oversprayed with thifensulfuron/tribenuron at 0.031 lb ai/A, pyrasulfotole/bromoxynil at 0.21 lb ai/A, and fluroxypyr at 0.13 lb ai/A for broadleaf weed control and azoxystrobin/propiconazole at 0.24 lb ai/A for stripe rust control on May 14. Winter wheat injury and Italian ryegrass control were evaluated visually during the growing season. Grain was harvested with a small plot combine on August 6, 2018.

Table 1. Application and soil data.

	Pyroxasulfone/carfentrazone study		
Wheat variety – seeding date		Ovation – 10/2/17	
Application date	9/28/17	10/4/17	4/20/18
Growth stage			
Winter wheat	preplant	preemergence	4 tiller
Italian ryegrass (LOLMU)	preemergence	preemergence	2 tiller
Air temperature (F)	66	50	59
Relative humidity (%)	38	55	57
Wind (mph, direction)	2, N	0	1, W
Cloud cover (%)	0	0	0
Soil moisture	dry	dry	wet
Soil temperature at 2 inch (F)	66	48	55
Next rain occurred	10/12/17	10/12/17	5/9/18
Soil pH		4.8	
OM (%)		3.6	
CEC (meq/100g)		11.1	
Texture		silt loam	

	Preemergence and postemergence combination study	
Wheat variety – seeding date	Ovation – 10/2/17	
Application date	10/4/17	4/20/18
Growth stage		
Winter wheat	preemergence	4 tiller
Italian ryegrass (LOLMU)	preemergence	2 tiller
Air temperature (F)	54	59
Relative humidity (%)	49	57
Wind (mph, direction)	1, W	2, W
Cloud cover (%)	0	0
Soil moisture	dry	wet
Soil temperature at 2 inch (F)	49	55
Next rain occurred	10/12/17	5/9/18
Soil pH	4.8	
OM (%)	3.6	
CEC (meq/100g)	11.1	
Texture	silt loam	

In the pyroxasulfone/carfentrazone study, all treatments injured winter wheat less than 9% (Table 2). All pyroxasulfone/carfentrazone treatments that totaled 0.14 lb ai/A tended to control Italian ryegrass best (88 to 99%) but did not differ from other treatments. Grain seed yield was lowest for pyroxasulfone/carfentrazone applied preplant alone at the two lowest rates. Grain test weight was similar for all treatments. The untreated check plots were sprayed with glyphosate in July and therefore not harvested.

In the preemergence and postemergence combination study, all mesosulfuron and pyroxsulam treatments injured winter wheat 2 to 6% on May 1 (Table 3). By June 11, all flumioxazin treatments injured wheat 14 to 22%. All preemergence treatments except flufenacet/metribuzin controlled Italian ryegrass 88 to 92%. Also, preemergence and postemergence combinations with flufenacet/metribuzin, pyroxasulfone/fluthiacet and pyroxasulfone/flumioxazin controlled Italian ryegrass 87 to 98%. Mesosulfuron and pyroxsulam alone did not control Italian ryegrass most likely due to resistant biotypes.

Table 2. Winter wheat response and Italian ryegrass control with pyroxasulfone/carfentrazone at different application timings near Viola, ID in 2018.

Treatment[1]	Rate	Application timing[2]	Wheat			LOLMU control[3]
			Injury	Yield	Test weight	
	lb ai/A		%	lb/A	lb/bu	%
Pyroxasulfone/carfentrazone	0.078	preplant	2	6824	60.4	67
Pyroxasulfone/carfentrazone	0.113	preplant	2	7432	61.6	80
Pyroxasulfone/carfentrazone	0.140	preplant	2	8234	62.4	94
Pyroxasulfone/carfentrazone +	0.078	preplant				
pyroxasulfone/carfentrazone +	0.063	4 tiller				
pyroxsulam	0.016	4 tiller	8	7779	62.5	88
Pyroxasulfone/carfentrazone +	0.109	preplant				
pyroxasulfone/carfentrazone +	0.031	4 tiller				
pyroxsulam	0.016	4 tiller	2	8253	62.5	98
Pyroxasulfone/carfentrazone +	0.14	postplant pre				
metribuzin	0.09	4 tiller	6	8174	62.2	99
Pyroxasulfone/carfentrazone +	0.14	postplant pre				
metribuzin	0.14	4 tiller	9	8394	62.6	98
Untreated check		--	--	--	--	--
LSD (0.05)			NS	834	NS	NS
Density (plants/ft^2)						30

[1]Ammonium sulfate at 5% v/v and a 90% nonionic surfactant at 0.5% v/v were applied with mesosulfuron and pyroxsulam.
[2]Application timing was based on winter wheat growth stage.
[3]Evaluation date was June 11, 2018.

Table 3. Winter wheat response and Italian ryegrass control with pyroxasulfone combinations near Viola, ID in 2018.

Treatment[1]	Rate	Application timing[2]	Wheat injury 5/1/18	Wheat injury 6/11/18	LOLMU control[3]
	lb ai/A		%	%	%
Flufenacet/metribuzin	0.34	preemergence	0	1	66
Pyroxasulfone	0.08	preemergence	0	4	90
Pyroxasulfone/fluthiacet	0.091	preemergence	0	3	88
Pyroxasulfone/flumioxazin	0.143	preemergence	0	19	92
Mesosulfuron	0.013	4 tiller	6	0	8
Pyroxsulam	0.016	4 tiller	5	0	15
Flufenacet/metribuzin +	0.34	preemergence			
mesosulfuron	0.013	4 tiller	5	10	93
Flufenacet/metribuzin +	0.34	preemergence			
pyroxsulam	0.016	4 tiller	4	9	88
Pyroxasulfone +	0.08	preemergence			
mesosulfuron	0.013	4 tiller	5	4	81
Pyroxasulfone +	0.34	preemergence			
pyroxsulam	0.016	4 tiller	5	8	83
Pyroxasulfone/fluthiacet +	0.091	preemergence			
mesosulfuron	0.013	4 tiller	5	10	98
Pyroxasulfone/fluthiacet +	0.091	preemergence			
pyroxsulam	0.016	4 tiller	2	6	87
Pyroxasulfone/flumioxazin +	0.143	preemergence			
mesosulfuron	0.013	4 tiller	5	14	98
Pyroxasulfone/flumioxazin +	0.143	preemergence			
pyroxsulam	0.016	4 tiller	3	22	94
LSD (0.05)			2	8	14
Density (plants/ft^2)					30

[1]Ammonium sulfate at 5% v/v and a 90% nonionic surfactant at 0.5% v/v were applied with mesosulfuron and pyroxsulam.
[2]Application timing was based on winter wheat growth stage.
[3]Evaluation date was June 11, 2018.

Evaluation of application timings with pyroxasulfone for the control of Italian ryegrass in winter wheat. Henry Wetzel and Drew Lyon. (Dept. of Crop & Soil Sciences, Washington State Univ., Pullman, WA 99164-6420) A field study was conducted at the Cook Agronomy Farm near Pullman, WA to determine the application timing of pyroxasulfone that would provide optimum control of Italian ryegrass (LOLMU) in winter wheat. We evaluated four herbicide application timings in relation to wheat growth stage: preemergence (10/12/17), delayed preemergence (10/16/17), spike leaf emerged (10/30/17), and early tillering (3/29/18). The trial area followed chickpeas. On October 11, 2017, 'Trooper (blend of Puma, SY107 and Ovation)' winter wheat was seeded at 120 lb seed per acre at a depth of 2.0 inches with a Horsch direct-seed air drill on a 12-inch row spacing. Plots were 10 ft by 33 ft and arranged in a randomized complete block design with four replications. All herbicide treatments were applied with a CO_2-powered backpack sprayer set to deliver 10 gpa at 48 psi at 2.3 mph (Table 1). Visual ratings of LOLMU control were initially assessed on May 11th when LOLMU seedheads were visible above the crop canopy and then again on July 6th when the contrast of LOLUM seedheads against the wheat were at their best. Wheat seed was harvested with a small plot combine on August 2nd.

Table 1. Application and soil data.

Location	Cook Agronomy Farm Pullman, Washington			
Application date	October 12, 2017	October 16, 2017	October 30, 2017	March 29, 2018
Application type	preemergence	delayed preemergence	postemergence	postemergence
Wheat growth stage	beginning of imbibition	radicles emerged	first leaf unfolded	2-tiller
Wheat height	--	--	2 inch	6 inch
Italian ryegrass growth stage	--	--	--	2-tiller
Italian ryegrass height	--	--	--	2 inch
Air temperature (F)	46	62	51	44
Relative humidity (%)	67	33	25	64
Wind (mph, direction)	calm	8, east	5, east	6, west
Cloud cover (%)	100	0	20	100
Soil temperature at 6 inch (F)	46	49	45	37
pH	5.2			
OM (%)	3.7			
Texture	silt loam			

Precipitation was above average during the fall and winter months, which was favorable for LOLMU germination and growth. The crop was in and out of snow cover from December to March, but overall winter conditions were moderate and most likely minimal winterkill occurred in LOLMU. The results suggest that the best control of LOLMU is achieved when the maximum annual use rate (0.13 lb ai/A) of pyroxasulfone is applied, but 0.081 to 0.106 lb ai/A of the seasonal maximum use rate needs to be applied around the time of planting, or shortly thereafter, with the remainder applied from spike leaf emergence to early tillering. Although waiting until early tillering to make the second application was effective in this study, this was not the case in a similar study conducted the previous year. A single application at early tillering, which is typically late winter/early spring in Pullman was too late for LOLMU control because the majority of the plants emerge in the fall. Pyroxasulfone + pyroxsulam (0.13 + 0.016 lb ai/A), applied at spike leaf, was the only treatment where the addition of pyroxsulam showed a slight improvement in LOLMU control over pyroxasulfone applied alone. Although not confirmed, the LOLMU biotype at this site has likely developed resistance to pyroxsulam.

Table 2. LOLMU control in 'Trooper' winter wheat with herbicides near Pullman, Washington in 2018.

Treatment	Rate	Application Date	LOLMU control 5/11	LOLMU control 7/6	Yield 8/2
	lb ai/A		----------------0 to 100%---------------		bu/A
Nontreated check	--	--	--	--	28
Pyroxasulfone	0.106	10/12/17	74	86	96
Pyroxasulfone	0.106	10/16/17	61	75	87
Pyroxasulfone + metribuzin	0.106 + 0.068	10/16/17	59	75	78
Pyroxasulfone	0.13	10/30/17	76	81	93
Pyroxasulfone + pyroxsulam[1]	0.13 + 0.016	10/30/17	84	88	88
Pyroxasulfone	0.13	3/29/18	70	40	62
Pyroxasulfone + pyroxsulam[1]	0.13 + 0.016	3/29/18	44	35	61
Pyroxasulfone fb pyroxasulfone	0.081 fb 0.049	10/12/17 fb 10/30/17	84	91	90
Pyroxasulfone fb pyroxasulfone + pyroxsulam[1]	0.081 fb 0.049 + 0.016	10/12/17 fb 10/30/17	82	93	91
Pyroxasulfone fb pyroxasulfone	0.081 fb 0.049	10/12/17 fb 3/29/18	88	94	87
Pyroxasulfone fb pyroxasulfone + pyroxsulam[1]	0.081 fb 0.049 + 0.016	10/12/17 fb 3/29/18	91	91	84
LSD (0.05)			13	11	18

[1]Treatment was applied with urea ammonium nitrate at 2 qt/a and a 90% nonionic surfactant (R-11) at 0.5% v/v.

<u>Rush skeletonweed control in winter wheat fallow</u>. Mark E. Thorne, Jacob W. Fischer, and Drew J. Lyon. (Dept. of Crop & Soil Sciences, Washington State Univ., Pullman, WA 99164-6420) Rush skeletonweed (*Chondrilla juncea* L.) established on thousands of acres of rangeland in eastern Washington during the mid-1900s, and then spread into adjacent farmland after the land was enrolled in the Conservation Reserve Program (CRP). When CRP contracts expired, the land was returned to winter wheat production, but the rush skeletonweed persisted. Soil moisture is depleted by rush skeletonweed in the fallow phase of the winter wheat/fallow rotation, which results in poor winter wheat establishment in the fall and reduced yields at harvest.

An herbicide trial was initiated near LaCrosse, WA in October 2017 to evaluate fall-, spring-, and summer-applied herbicides for control of rush skeletonweed in the fallow phase of a winter wheat/fallow rotation. The study area produced spring wheat in 2017 and the stubble remained standing through the fall and winter. The initial rush skeletonweed density averaged 0.5 plants/ft^2. By October 2017, most plants had bolted during the summer and the flowering stems were still present; however, some plants consisted of only rosettes. The 2017 spring wheat crop followed winter wheat in 2016, therefore, soil moisture was depleted and signs of drought, including dull leaf color and few leaves were visible on the rush skeletonweed plants at the fall application. During the 2018 fallow period, the plot area was cross cultivated, fertilized, and rod-weeded in late spring, and then rod-weeded in August prior to winter wheat seeding on September 1.

Plots measured 10 by 30 ft and were arranged in a randomized complete block design with four replications per treatment. Herbicides were applied with a hand-held spray boom with six nozzles on 20-inch spacing and pressurized with a CO_2 backpack. Spray output was calibrated to 15 gpa at 25 psi and traveling 3 mph. Fall treatments were applied October 9, 2017, 7 days after the first frost. Spring treatments were applied on April 9, 2018 to coincide with normal spring fallow aid-to-tillage herbicide applications. Summer treatments were applied June 26, 2018 when rush skeletonweed plants were bolting (Table 1). Herbicide efficacy was assessed by counting all rush skeletonweed plants in a 6.6 by 28 ft strip through the middle of each 10 by 30 ft plot at several times throughout the year.

Table 1. Application and soil data.

Location		LaCrosse, WA	
Application date	October 9, 2017	April 9, 2018	June 26, 2018
Growth stage	bolted stems and rosettes	rosettes, only	rosettes and bolted stems
Air temperature	65	61	75
Relative humidity (%)	27	29	24
Wind (mph, direction)	2-4, E	0-4, SSW	2-4, WSW
Cloud cover (%)	10	10	10
Soil temperature at 3 inches (F)	60	62	80
Soil texture		sandy loam	
Soil pH		6.3	

Rush skeletonweed density at the time of the fall applications averaged 84 plants/plot and ranged from 66 to 97 plants/plot. By the following spring, all fall-applied treatments had substantially reduced rush skeletonweed density. At the April 25, 2018 census, rush skeletonweed were not yet present in plots treated with clopyralid, aminopyralid, clopyralid/2,4-D, or picloram (Table 2). Plots treated with clopyralid/2,4-D + chlorsulfuron/metsulfuron averaged 0.3 plants/plot and glyphosate + 2,4-D treated plots averaged 2.5 plants/plot, but these densities were not different from zero.

Spring applications on April 9, 2018 included an 0.84 lb ae/A application of glyphosate to all fall-applied treatments and the glyphosate check plots. This application was to control volunteer crop and winter annual weeds that had emerged through the winter. Spring-applied treatments of clopyralid and aminopyralid were tank mixed with glyphosate at the 0.84 lb ae/A rate to combine the normal spring aid-to-tillage application with treatments for rush skeletonweed control during the fallow phase. Fallow tillage operations followed the spring herbicide applications during May and early June. The May/June tillage would have eliminated all above-ground plant material. Regrowth occurred in all plots, except those treated with picloram, by the June 21 census; however, there were no differences between the fall-applied treatments except for fall-applied glyphosate + 2,4-D, which averaged 13 plants/plot and was not different from the glyphosate check, which average 23 plants/plot (Table 2). The greatest amount of regrowth occurred with spring-applied clopyralid + glyphosate, spring-applied aminopyralid + glyphosate, fall- and spring-applied glyphosate, and the glyphosate check.

On June 26, 2,4-D was applied to plots previously treated with clopyralid, aminopyralid, and glyphosate (Table 2). This was intended as a rescue treatment for re-establishing rush skeletonweed beginning to bolt. At the mid-summer census on August 2, it was evident that the 2,4-D treatment only slightly checked an increasing density in the aminopyralid fall-treated plots, but it did not benefit fall-applied clopyralid plots, which were already relatively low in density (Table 2). At the August 2 census, fall-applied picloram was the most effective treatment averaging only 5 plants/plot.

A final census occurred on November 8, after the winter wheat had been seeded and had emerged. Fall treatments that were not different from the glyphosate check included aminopyralid, clopyralid/2,4-D + chlorsulfuron/metsulfuron, and fall-applied glyphosate + 2,4-D (Table 2). In previous research, aminopyralid applied at 0.019 lb ae/A controlled rush skeletonweed in the winter wheat crop; however, in the current trial it had lost control by mid-summer. Aminopyralid is not yet labeled for use in winter wheat or fallow, but the rate used in this trial may be too low for effective fallow control. In addition, the June application of 2,4-D had not reduced rush skeletonweed density in the clopyralid or aminopyralid treatments where it was included as a rescue treatment (Table 2). Furthermore, spring-applied clopyralid + glyphosate or aminopyralid + glyphosate were not different from the glyphosate check. The lack of rush skeletonweed control with these two treatments is not fully understood. It is not clear if there is potential antagonism between glyphosate and the two synthetic auxins, or if the lack of control is simply a timing issue.

The best year-long control was with either picloram or clopyralid/2,4-D. At the November census, plots with these treatments averaged 11 and 16 plants/plot, respectively (Table 2). A concern with picloram is reduced yield in the following crop; however, no visible crop injury was observed at this census (data not shown). Yield will be evaluated at crop harvest in 2019. Control with clopyralid/2,4-D was more effective than clopyralid/2,4-D + chlorsulfuron/metsulfuron, and more effective than the fall-applied clopyralid + summer-applied 2,4-D (Table 2). The clopyralid/2,4-D treatment applied 0.l9 lb ae/A clopyralid + 1.0 lb ae/A 2,4-D while the clopyralid treatment applied 0.25 lb ae/A. This would suggest there may be benefit or synergism from the combination of clopyralid and 2,4-D, both being synthetic auxin herbicides.

Glyphosate has been the standard fallow herbicide treatment in this region. In this trial, the aid-to-tillage application of 0.84 lb ae/A glyphosate in April controlled winter annual weeds and volunteer growth in the fall-treated plots and the glyphosate check plots. However, from grower communication it was reported that the aid-to-tillage rate does not reduce rush skeletonweed pressure in the fallow. By the August 2 census, density of rush skeletonweed in the glyphosate check plots was 50% greater than either the fall or spring glyphosate treatments of 2.25 lb ae/A (Table 2). By the November 8 census, the spring-applied 2.25 lb ae/A glyphosate plots still averaged 50% less rush skeletonweed plants than the glyphosate check. Density in the fall-applied glyphosate plots had increased and was not different from the glyphosate check, and averaged 1.6 times greater density than the spring-applied glyphosate treatment. This would suggest that if glyphosate is the primary herbicide used for rush skeletonweed control, a spring high-rate application would give better control through the fallow phase than the fall application.

From previous research, we have reported good control of rush skeletonweed with clopyralid at 0.19 lb ae/A applied either in the fall or spring in the winter wheat crop. However, control during the crop phase does not guarantee control through the following fallow year. This trial finds good but not complete control with either picloram or clopyralid/2,4-D, each applied at the maximum labeled rate for fallow. Long-term control will require use of effective herbicides in both the fallow and crop phases.

Table 2. Rush skeletonweed density in winter wheat fallow in relation to fall, spring, and summer-applied herbicides.[1]

Trt	Herbicide[2]	Rate[3]	Time[4]	Spring 3/29/18	Early Summer 6/21/18	Mid-Summer 8/2/18	Fall 11/8/18
		(lb ae/A)		------- plants per plot (6.6 by 28 ft)[5] -------			
1	Clopyralid	0.25	F	0 b	3 d	14 cd	28 cd
	glyphosate	0.84	Sp				
2	Aminopyralid	0.019	F	0 b	9 d	48 a	59 ab
	glyphosate	0.84	Sp				
3	Clopyralid	0.25	F	0 b	5 d	14 cd	30 c
	glyphosate	0.84	Sp				
	2,4-D	1.85	Su				
4	Aminopyralid	0.019	F	0 b	7 d	30 b	46 abc
	glyphosate	0.84	Sp				
	2,4-D	1.85	Su				
5	Clopyralid/2,4-D	0.19/1.0	F	0 b	5 d	13 d	16 de
	glyphosate	0.84	Sp				
6	Clopyralid/2,4-D + chlorsulfuron/metsulfuron	0.095/0.5 + 0.016/0.003	F	0.3 b	6 d	23 bc	41 bc
	glyphosate	0.84	Sp				
7	Picloram	0.25	F	0 b	0 d	5 e	11 e
	glyphosate	0.84	Sp				
8	Glyphosate + 2,4-D	2.25 + 1.85	F	2.5 b	13 c	25 b	44 bc
	glyphosate	0.84	Sp				
	2,4-D	1.85	Su				
9	Clopyralid + glyphosate	0.25 + 0.84	Sp	76 a	39 a	64 a	76 a
10	Aminopyralid + glyphosate	0.019 + 0.84	Sp	81 a	21 bc	49 a	69 ab
11	Glyphosate	2.25	Sp	75 a	13 bc	21 bcd	28 cd
	2,4-D	1.85	Su				
12	Glyphosate check	0.84	Sp	75 a	23 b	54 a	57 ab

[1] Initial spring tillage and fertilization occurred in May/June 2018; Field was rod-weeded August 22, 2018; Field was seeded September 1, 2018.
[2] Aminopyralid and clopyralid/2,4-D + chlorsulfuron/metsulfuron treatments included non-ionic surfactant at 0.25% v/v; all glyphosate treatments included ammonium sulfate at 18 lb/gal. Glyphosate check plots were sprayed with an aid-to-tillage rate of glyphosate for control of winter annual weeds and volunteer crop.
[3] Rate of chlorsulfuron/metsulfuron is in lb ai/A; all other herbicides were lb ae/A.
[4] Time of application F = October 9, 2017, Sp = April 9, 2018, Su = June 26, 2018.
[5] Numbers in each column followed by the same letter are not statistically different (α=0.05)

Winter wheat tolerance to bicyclopyrone/bromoxynil combined with various fungicides. Traci A. Rauch and Joan M. Campbell. (Weed Science, University of Idaho, Moscow, ID 83844-2333) Fungicides combined with herbicides can sometimes cause crop injury. A study was established to evaluate 'Brundage96' winter wheat tolerance with bicyclopyrone/bromoxynil herbicide combined with various fungicides at the University of Idaho Plant Science Farm near Moscow, ID. The plots were arranged in a randomized complete block design with four replications and included an untreated check. All herbicide treatments were applied using a CO_2 pressurized backpack sprayer calibrated to deliver 10 gpa at 32 psi and 3 mph (Table 1). Crop injury was evaluated visually during the growing season. Grain was harvested with a small plot combine on August 8, 2018.

Table 1. Application and soil data.

Winter wheat seeding date	10/5/17
Application date	5/4/18
Growth stage	
Winter wheat	4 tiller
Air temperature (F)	73
Relative humidity (%)	46
Wind (mph)	3, W
Cloud cover (%)	0
Next rain occurred	5/9/18
Soil	
Moisture	dry
Temperature at 2 inch (F)	61
pH	4.7
OM (%)	5.8
CEC (meq/100g)	15.0
Texture	silt loam

At 4, 11, 21, 32, and 44 DAT, no treatment visibly injured winter wheat (data not shown). Grain yield and test weight did not differ among treatments including the untreated check. (Table 2)

Table 2. Winter wheat response with bicyclopyrone/bromoxynil combined with various fungicides in 2018.

Treatment[1]	Rate	Yield	Test weight
	lb ai/A	lb/A	lb/bu
Bicyclopyrone/bromoxynil	0.193	4634	62.0
Bicyclopyrone/bromoxynil +	0.193		
propiconazole	0.113	4300	62.4
Bicyclopyrone/bromoxynil +	0.193		
propiconazole +	0.113		
fluxapyroxad/pyraclostrobin	0.13	4306	62.2
Bicyclopyrone/bromoxynil +	0.193		
azoxystrobin/propiconazole	0.18	4567	62.4
Bicyclopyrone/bromoxynil +	0.193		
fluxapyroxad/pyraclostrobin/propiconazole	0.162	4553	62.2
Bicyclopyrone/bromoxynil +	0.193		
picoxystrobin	0.065	4833	62.2
Bicyclopyrone/bromoxynil +	0.193		
azoxystrobin/benzovindiflupyr/propiconazole	0.162	4706	61.7
Bicyclopyrone/bromoxynil +	0.193		
azoxystrobin/benzovindiflupyr/propiconazole	0.235	4594	62.2
Untreated check	--	4788	62.0
LSD (0.05)		NS	NS

[1]Sodium bicarbonate (CoAct) was used as a buffer and applied at 0.58 lb ai/A. NIS (R-11) is non-ionic surfactant and was applied at 0.25% v/v.

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