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FOREWORD

The 2022 Research Progress Report of the Western Society of Weed Science (WSWS) is a compilation of research investigations contributed by weed scientists in the western United States of America. The objective of the Research Progress Report is to provide an avenue for presentation and exchange of on-going research to the weed science community. The information in this report is preliminary; therefore, it is not for the development of endorsements or recommendations.

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

Traci Rauch
Research Progress Report Editor
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TABLE OF CONTENTS

Project 1: WEEDS OF RANGE AND NATURAL AREAS Page

Project 2: WEEDS OF HORTICULTURAL CROPS

Project 3: WEEDS OF AGRONOMIC CROPS

Winter annual grass and broadleaf weed 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 grass-dominated Latah County parkland to examine broadleaf weed control after winter annual grass control in Moscow, ID. Plots 10 by 30 ft were arranged in a randomized complete block design with four replications of twelve treatments plus an untreated check. All herbicides were applied using a CO_2 pressurized backpack sprayer calibrated to deliver 15 gpa at 25 psi and 3 mph (Table 1). The winter annual grass species present were ventenata (*Ventenata dubia*), Japanese brome (*Bromus japonicus*), and medusahead (*Taeniatherum caput-medusae*) and were targeted with a fall application. The broadleaf weed species present were field bindweed (*Convolvulus arvensis)*, common teasel (*Dipsacus fullonum)*, prickly lettuce (*Lactuca serriola*), St. John's wort (*Hypericum perforatum*), western salsify (*Tragopogon dubius)*, and rush skeletonweed (*Chondrilla juncea*) and were targeted with a spring application. Perennial grasses (primarily smooth brome, *Bromus inermis*) were dormant at the time of the fall application and vegetative at the time of the spring application. The spring treatments were applied only to the plots that received the first four fall treatments. Plant cover and weed control were visually evaluated on July 9, 2021 (9 MAT-fall; 2 MAT-spring) using reduction in foliar cover contrasted to the untreated check as the dependent variable.

Table 1. Application data.

Application date	September 24, 2020	May 21, 2021
Winter annual grass growth stage	Pre-emergent	Boot
Broadleaf weed stage	Varied by species	Vegetative
Air temperature (F)	55	53
Relative humidity (%)	56	49
Wind (mph, direction)	4, NE	1, NW
Cloud cover (%)	50	100
Soil temperature at 2 inches (F)	56	48

At the July 9, 2021 evaluation, there was no difference between treatments in winter annual grass control (p=0.12) or broadleaf weed control (p=0.96; Table 2). Winter annual grasses (sum of all species) were controlled 62% to 100% on average. Broadleaf weeds (sum of all species) were controlled 61% to 90% on average. Epinasty of broadleaf weeds, especially western salsify and common teasel, was observed in all spring-treated plots treated. Of all broadleaf weed species, field bindweed was most likely to avoid injury from the spring herbicide application.

Table 2. Winter annual grass and broadleaf weed control following fall and spring herbicide applications.[1]

Treatment[2]	Application timing	Rate	Winter annual grass control 9 MAT[3]	Broadleaf weed control 9 and 2 MAT[3]
		lb ai/A	---------------------%---------------------	
Indaziflam	Sept. 2020	0.065		
Aminopyralid[4]	May 2021	0.092	62 a	90 a
Indaziflam	Sept. 2020	0.065		
Aminopyralid/florpyrauxifen-benzyl[4]	May 2021	0.104/0.010	94 a	73 a
Indaziflam + rimsulfuron	Sept. 2020	0.065 + 0.047		
Aminopyralid[4]	May 2021	0.092	100 a	73 a
Indaziflam + rimsulfuron	Sept. 2020	0.065 + 0.047		
Aminopyralid/florpyrauxifen-benzyl[4]	May 2021	0.104/0.010	100 a	72 a
Indaziflam + aminopyralid[4]	Sept. 2020	0.065 + 0.092	95 a	86 a
Indaziflam + aminopyralid/florpyrauxifen-benzyl[4]	Sept. 2020	0.065 + 0.104/0.010	99 a	72 a
Indaziflam	Sept. 2020	0.065	93 a	61 a

[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 9, 2021.

[4] Herbicide rate reported in lb ae/A.

Spring application of indaziflam and imazapic for downy brome 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 Idaho Department of Fish and Game land to examine downy brome control in Lewiston, 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 20 gpa at 30 psi and 3 mph (Table 1). Perennial grasses (primarily smooth brome, *Bromus inermis*) were dormant at the March and April 2021 applications, and vegetative at the May 2021 application. Plant cover and weed control were visually evaluated on August 31, 2021 (3, 4, and 5 MAT) using reduction in foliar cover contrasted to the untreated check as the dependent variable.

Table 1. Application data.

Application date	March 26, 2021	April 20, 2021	May 12, 2021
Downy brome growth stage	6 leaves	6 leaves	Early flower
Downy brome root length (inches)	1.5	2	2.5
Air temperature (F)	60	58	70
Relative humidity (%)	35	29	29
Wind (mph, direction)	4, SW	3, SW	2, SW
Cloud cover (%)	30	0	80
Soil temperature at 2 inches (F)	46	60	62

At the August 31, 2021 evaluation, there was no difference among treatments in downy brome control (p=0.90) and control was poor for all treatments (Table 2). Downy brome cover averaged 8 to 75% in untreated plots and 1 to 88% in treated plots (data not shown). Smooth brome cover averaged 0 to 17% in untreated plots and 0 to 40% in treated plots. No injury to desirable species was observed. From March to August, the region received less than one inch of precipitation and had maximum temperatures of 90 F or greater for 59 days. The excessive drought may have negatively impacted herbicide efficacy.

Table 2. Winter annual grass and broadleaf weed control following fall and spring herbicide applications.[1]

Treatment[2]	Application timing	Rate	Downy brome control[3]
		lb ai/A	----------------% (SD)----------------
Imazapic	March 2021	0.109	30 (41) a
Indaziflam	March 2021	0.065	25 (43) a
Imazapic + indaziflam	March 2021	0.078 + 0.065	19 (33) a
Imazapic + indaziflam	March 2021	0.109 + 0.065	52 (45) a
Imazapic	April 2021	0.109	57 (6) a
Indaziflam	April 2021	0.065	34 (35) a
Imazapic + indaziflam	April 2021	0.078 + 0.065	39 (49) a
Imazapic + indaziflam	April 2021	0.109 + 0.065	32 (31) a
Imazapic	May 2021	0.109	4 (8) a
Indaziflam	May 2021	0.065	34 (8) a
Imazapic + indaziflam	May 2021	0.078 + 0.065	18 (32) a
Imazapic + indaziflam	May 2021	0.109 + 0.065	12 (39) a

[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 August 31, 2021.

Winter annual grass control with aerial and ground application of indaziflam and imazapic. Georgia R. Harrison, Lisa C. Jones, and Timothy S. Prather. (Department of Plant Sciences, University of Idaho, Moscow, ID 83844-2333). A study was established on sagebrush steppe rangeland at Rinker Rock Creek Ranch near Hailey, ID to observe how helicopter, fixed wing airplane, and ground application volumes affect indaziflam efficacy for control of invasive winter annual grasses. Indaziflam and imazapic were applied on September 16 and 19, 2019 (Table 1).

Table 1. Application and soil data.

Application type	Fixed wing airplane, helicopter	Ground - UTV
Application date	September 16, 2019	September 19, 2019
Winter annual grass growth stage	Pre-emergence	
Air temperature (F)	68	50
Relative humidity (%)	34	73
Wind (mph, direction)	2, E	1, SE
Cloud cover (%)	80	100
Soil temperature at 2 inches (F)	--	51
Soil pH	6.5	
Soil texture	Sandy loam	

Fixed wing airplane and helicopter treatments were of 2.5, 5, 10, and 20 gpa and UTV ground applications were of 10 and 20 gpa of indaziflam alone and indaziflam and imazapic. Carrier volume rate was converted into herbicide droplet cover categories. Indaziflam and imazapic were applied at 0.065 lb ai/A and 0.078 lb ai/A, respectively. All treatments were applied with a non-ionic surfactant at 0.25% v/v. Water sensitive papers were placed within each herbicide treatment's spray swath to measure herbicide droplet coverage at time of application. Treatments were then classified into low, medium, high, or very high coverage of herbicide based on natural breaks in the data. Each herbicide application type was then classified into treatment groups based on chemical(s) and herbicide droplet coverage category (Table 2).

Table 2. Herbicide droplet coverage categories.

	Herbicide droplet percent cover		Plots
Category	Minimum value	Maximum value	n
None	Untreated plots		12
Low (L)	2.2	5.5	38
Medium (M)	7.3	10.3	12
High (H)	12.2	16.0	18
Very High (VH)	19.8	21.0	12

Permanent assessment plots of 9 sq m were arranged within treatment areas in locations that were representative of the surrounding plant community assemblages. Pre-treatment plant cover was recorded on October 3, 2019 and post-treatment plant cover was recorded on June 10, 2020 and May 26, 2021. Within each plot, plant foliar cover was recorded using cover classes; data was analyzed using the midpoint of cover classes averaged among treatment groups. Percent control was summarized by summing midpoint cover of both downy brome (*Bromus tectorum*) and Japanese brome (*Bromus japonicus*). Vegetation cover by species within plots will be monitored in summer 2023 to assess long-term treatment efficacy and native plant response.

All treatments controlled winter annual grasses 48 to 100% 9 MAT and 93 to 100% 20 MAT compared to the untreated check (Table 3). Nine MAT, good control was achieved at all four droplet coverage categories, but was more consistently good in the high and very high droplet coverage categories (data on control variability not shown). Annual grass cover was greatly reduced in all treated plots 20 MAT (maximum annual grass cover: 2%) (Table 3). Twenty MAT, excellent control was achieved at all four droplet coverage categories and variability was small. Treatments of indaziflam only and indaziflam and imazapic exhibited high control 20 MAT, even though 9 MAT control was better with indaziflam + imazapic compared to indaziflam alone.

Table 3. Control of winter annual grasses from herbicides applied at various herbicide coverage categories.

		Winter annual grass foliar cover[3]			Average control[4]	
Treatment[1]	Droplet cover category[2]	Pre-treatment[5]	9 MAT[6]	20 MAT[7]	9 MAT[6]	20 MAT[7]
		---%-------------------------------------				
Untreated check	None	67	41	24	--	--
Indaziflam	L	55	22	1	48 c	96 a
Indaziflam + imazapic	L	52	3	0	93 a	99 a
Indaziflam	M	55	9	0	79 ab	100 a
Indaziflam + imazapic	M	64	4	0	90 ab	100 a
Indaziflam	H	38	9	1	79 ab	97 a
Indaziflam + imazapic	H	61	1	0	99 a	100 a
Indaziflam	VH	45	14	2	66 bc	93 a
Indaziflam + imazapic	VH	55	3	2	92 a	93 a

[1] For all treatments, indaziflam and imazapic were applied at 0.065 lb ai/A and 0.078 lb ai/A, respectively, with 0.25% v/v non-ionic surfactant.

[2] L=low, M=medium, H=high, VH=very high. See Table 2 for values.

[3] Cover represents combined cover of downy brome and Japanese brome within each plot.

[4] Within columns, means followed by the same letter are not statistically significantly different.

[5] Evaluations made October 3, 2019.

[6] Evaluations made June 10, 2020.

[7] Evaluations made May 26, 2021.

Testing aminopyralid/florpyrauxifen-benzyl rates and formulations for bur chervil 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 in a field to examine bur chervil (*Anthriscus caucalis*) control in Lewiston, ID. Plots 10 by 30 ft were arranged in a randomized complete block design with four replications of eight treatments plus an untreated check. All herbicides were applied using a CO_2 pressurized backpack sprayer calibrated to deliver 15 gpa at 29 psi and 3 mph (Table 1). Plant cover and bur chervil control were visually evaluated on June 5, 2020 (1 MAT) and May 4, 2021 (12 MAT) using reduction in foliar cover contrasted to the untreated check as the dependent variable.

Table 1. Application data.

Application date	May 5, 2020
Bur chervil growth stage	Early flower
Air temperature (F)	66
Relative humidity (%)	50
Wind (mph, direction)	3, NNW
Cloud cover (%)	25
Soil temperature at 2 inches (F)	55

At the June 5, 2020 evaluation, there was no difference between treatments in bur chervil control and no treatment had excellent control (p=0.11; Table 2). Nominally, the highest rates of both formulations of aminopyralid/florpyrauxifen-benzyl had better control than all other treatments, but there were large variations in levels of control across plots. Bur chervil in all treated plots was epinastic but the plants still had produced seeds at the time of this evaluation.

At the May 4, 2021 evaluation, there was no difference between treatments in bur chervil control and no treatment had good control (p=0.29; Table 2). Bur chervil in treated and untreated plots was flowering at this time.

Table 2. Bur chervil control after application with different rates and formulations of aminopyralid/florpyrauxifen-benzyl.[1]

			Bur chervil control	
Treatment[2]	Formulation	Rate	1 MAT[3]	12 MAT[4]
		lb ae/A	-------------------% (SD)------------------	
Aminopyralid/florpyrauxifen-benzyl	Liquid	0.063/0.006	45 (52) a	9 (11) a
Aminopyralid/florpyrauxifen-benzyl	Liquid	0.083/0.008	48 (45) a	52 (11) a
Aminopyralid/florpyrauxifen-benzyl	Liquid	0.104/0.010	86 (16) a	31 (43) a
Aminopyralid/florpyrauxifen-benzyl	Dry	0.089/0.008	76 (24) a	19 (19) a
Aminopyralid/florpyrauxifen-benzyl	Dry	0.126/0.011	68 (47) a	18 (23) a
Aminopyralid/florpyrauxifen-benzyl	Dry	0.253/0.021	89 (15) a	13 (16) a
Aminopyralid	Liquid	0.092	40 (7) a	16 (18) a
Aminopyralid/2,4-D	Liquid	0.077/0.624	28 (22) a	18 (32) a

[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, 2020.

[4] Evaluations made May 4, 2021.

Efficacy of postemergence herbicides for the control of stinknet (*Oncosiphon pilulifer)* in the spring. Kai Umeda (University of Arizona Cooperative Extension, Maricopa County, Phoenix, AZ 85040). A small plot field experiment was conducted in a non-landscaped bare ground retention basin in Scottsdale, AZ. Treatment plots measured 5 ft by 10 ft and treatments were replicated three times in a randomized complete block design. Sprays were applied using a backpack CO_2 sprayer equipped with a hand-held boom with three TurboTeeJet flat fan 11002 nozzles spaced 20 inches apart. Sprays were applied with 40 gpa water pressurized to 35 psi. At the time of application on 24 March 2021, the air temperature was 64ºF, soil temperature was 60ºF, and small weeds were under 6-inch height and were initiating flowering. A lack of rainfall after January following emergence of the weeds kept them relatively short and less robust with flowering being initiated at a small size. Weed control was evaluated at intervals following application.

Initial postemergence weed control activity was observed at 2 to 5 days after treatment (DAT) with diquat, glufosinate, triclopyr, and combination premix product with 2,4-D, dicamba, MCPP, and carfentrazone. Glufosinate gave acceptable control 87% at 13 DAT. In another week at 21 DAT, glyphosate, metsulfuron, and the combination product demonstrated better than 80% control. At 35 DAT, glyphosate, glufosinate, imazapic, metsulfuron, and the 2,4-D combination product provided very acceptable control of stinknet. Diquat and triclopyr treated weeds exhibited regrowth and was less effective in providing complete control. Sulfentrazone was not effective against the stinknet.

Table. Evaluation of postemergence herbicides for stinknet control, Scottsdale, AZ, 2021

Treatment	Rate (lb a.i./A)	ONPI Control 26 Mar	 29 Mar	 02 Apr	 06 Apr	 14 Apr	 28 Apr
		%					
untreated check		0 b	0 c	0 c	0 c	0 c	0 c
glyphosate	1.25		0 c	30 b	75 a	83 ab	95 a
glufosinate	1.0		33 b	77 a	87 a	96 a	96 a
diquat	0.5	30 a	67 a	63 a	70 ab	72 ab	78 a
imazapic	0.08		0 c	0 c	70 ab	78 ab	87 a
metsulfuron	0.038		0 c	13 bc	70 ab	88 a	96 a
2,4-D + dicamba + MCPP + carfentrazone	1.0 + 0.09 + 0.3 + 0.03	32 a	70 a	70 a	73 a	80 ab	88 a
sulfentrazone	0.375		0 c	0 c	33 bc	0 c	0 c
triclopyr	1.0	30 a	70 a	60 a	67 ab	58 b	58 b

Treatments applied on 24 March 2021

Means followed by the same letter within a column are not significantly different by Tukey-Kramer at *p*=0.05.

New ventenata control concept 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 Latah County parkland to examine ventenata control in Moscow, ID. Plots 10 by 30 ft were arranged in a randomized complete block design with four replications of twelve treatments plus an untreated check. All herbicides were applied using a CO_2 pressurized backpack sprayer calibrated to deliver 15 gpa at 20 psi and 3 mph (Table 1). Perennial grasses (primarily smooth brome, *Bromus inermis*) were dormant at the time of application. Plant cover and ventenata control were visually evaluated on July 7, 2021 (8 MAT) using reduction in foliar cover contrasted to the untreated check as the dependent variable.

Table 1. Application data.

Application date	November 3, 2020
Ventenata growth stage	1 leaf
Air temperature (F)	64
Relative humidity (%)	34
Wind (mph, direction)	4, SE
Cloud cover (%)	90
Soil temperature at 2 inches (F)	50

At the July 7, 2021 evaluation, most treatments resulted in excellent (89-100%) control of ventenata (p=0.08; Table 2). Control from the aminopyralid/florpyrauxifen-benzyl + imazapic and halauxifen-methyl/pyroxsulam treatments was moderate at 60% and 73%, respectively.

Table 2. Ventenata control following post-emergent applications of a variety of winter annual grass herbicides.[1]

Treatment[2]	Rate	Ventenata control 8 MAT[3]
	lb ai/A	----------------%----------------
Rimsulfuron	0.006	99 a
Florpyrauxifen-benzyl + rimsulfuron	0.008 + 0.006	98 a
Aminopyralid/florpyrauxifen-benzyl[4] + rimsulfuron	0.083/0.008 + 0.006	89 a
Pyroxsulam	0.063	100 a
Florpyrauxifen-benzyl + pyroxsulam	0.008 + 0.063	100 a
Aminopyralid/florpyrauxifen-benzyl[4] + pyroxsulam	0.083/0.008 + 0.063	100 a
Halauxifen-methyl/pyroxsulam[4]	0.001/0.002	73 ab
Imazapic	0.094	93 a
Aminopyralid/florpyrauxifen-benzyl[4] + imazapic	0.083/0.008 + 0.094	60 b
Indaziflam	0.065	100 a
Aminopyralid/florpyrauxifen-benzyl[4] + indaziflam	0.083/0.008 + 0.065	100 a
Indaziflam + rimsulfuron	0.065 + 0.006	100 a
LSD ($\alpha = 0.05$)		27

[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 7, 2021.
[4] Herbicide rate reported in lb ae/A.

Ventenata control with spring-applied aminopyralid and imazapic 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 Idaho Department of Fish and Game land to examine ventenata control in Lewiston, ID. Plots 10 by 30 ft were arranged in a randomized complete block design with four replications of eleven 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 (primarily fescue, *Festuca* sp., and smooth brome, *Bromus inermis*) were dormant at the time of application. Plant cover and ventenata control were visually evaluated on August 18, 2021 (3 MAT), using reduction in foliar cover contrasted to the untreated check as the dependent variable.

Table 1. Application data.

Application date	May 19, 2021
Ventenata growth stage	vegetative
Air temperature (F)	47
Relative humidity (%)	54
Wind (mph)	0
Cloud cover (%)	100
Soil temperature at 2 inches (F)	50

At the August 18, 2021 evaluation, only the high rate of aminopyralid + imazapic resulted in good control of ventenata (Table 2). However, because of highly variable control across all treatments, there was no significant difference between treatments (p=0.5). From May to August, the region received less than one inch of precipitation and had maximum temperatures of 90 F or greater for 59 days, resulting in below average growth of ventenata. The excessive drought may have negatively impacted herbicide efficacy.

Table 2. Ventenata control following applications of aminopyralid and imazapic at different rates.[1]

Treatment[2]	Rate[3]	Ventenata control (SD) 3 MAT[4]
	lb ai/A	--------------------------%--------------------------
Aminopyralid + imazapic	0.078 + 0.078	24 (44) a
Aminopyralid + imazapic	0.078 + 0.125	44 (51) a
Aminopyralid + imazapic	0.109 + 0.078	21 (43) a
Aminopyralid + imazapic	0.109 + 0.125	92 (16) a
Aminopyralid + rimsulfuron	0.078 + 0.063	39 (48) a
Aminopyralid + rimsulfuron	0.109 + 0.063	49 (48) a
Imazapic	0.078	46 (54) a
Imazapic	0.125	72 (41) a
Rimsulfuron	0.063	25 (50) a
Aminopyralid	0.078	31 (47) a
Aminopyralid	0.109	45 (52) a

[1] Within columns, means followed by the same letter are not statistically significantly different.

[2] All treatments were applied with a methylated seed oil adjuvant at 1% ai w/w.

[3] Aminopyralid rate reported in lb ae/A.

[4] Evaluations made August 18, 2021.

Efficacy of oxeye daisy control with aminopyralid/florpyrauxifen-benzyl 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 a grassland to examine oxeye daisy control in Coeur d'Alene, ID. Efficacy with the use of a non-ionic surfactant compared to a methylated seed oil adjuvant was also tested. Plots 10 by 20 ft were arranged in a randomized complete block design with four 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 39 psi and 3 mph (Table 1). The dominant grasses were smooth brome (*Bromus inermis*), meadow foxtail (*Alopecurus pratensis*), and Canada bluegrass (*Poa compressa*). Plant cover and weed control were visually evaluated on August 11, 2020 (3 MAT) and July 19, 2021 (14 MAT) using reduction in foliar cover contrasted to the untreated check as the dependent variable.

Table 1. Application data.

Application date	June 3, 2020
Oxeye daisy growth stage	bolt
Air temperature (F)	73
Relative humidity (%)	34
Wind (mph, direction)	4, SSE
Cloud cover (%)	10
Soil temperature at 2 inches (F)	60

At the August 11, 2020 evaluation, there was no difference in oxeye daisy control between treatments (p=0.2) and most treatments had large variances in control. Excellent (95%) control was achieved in plots treated with aminopyralid/florpyrauxifen-benzyl (high rate) + 2,4-D + MSO with Leci-Tech and aminopyralid/2,4-D + NIS (Table 2). Control from the remaining treatments except aminopyralid/florpyrauxifen-benzyl (low rate) + NIS and aminopyralid + NIS was moderate, ranging from 66% to 89%. There was no difference in efficacy of the same herbicide applied with a NIS or MSO adjuvant (p>0.1; data not shown).

At the July 19, 2021 evaluation, oxeye daisy control differed between treatments (p=0.01). Control values declined compared to 2020 and most treatments continued to have large variances. Good control was achieved in plots treated with aminopyralid/florpyrauxifen-benzyl (high rate) + 2,4-D + MSO with Leci-Tech, aminopyralid/2,4-D + NIS, and aminopyralid/florpyrauxifen-benzyl (medium rate) + MSO with Leci-Tech (Table 2). There was no difference in efficacy of paired treatments that used the same herbicide applied with a NIS or MSO adjuvant (p>0.1; data not shown). The mean control of oxeye daisy at 14 MAT was 42% with NIS and 69% with MSO.

Table 2. Oxeye daisy control with aminopyralid/florpyrauxifen-benzyl at different rates.[1]

		Oxeye daisy control			
Treatment	Rate	3 MAT[2]		14 MAT[3]	
	lb ae/A	-------------% (SD)-------------			
Aminopyralid/florpyrauxifen-benzyl + NIS	0.063/0.006 + 0.25% v/v	59 (30)	a	37 (32)	bc
Aminopyralid/florpyrauxifen-benzyl + MSO	0.063/0.006 + 1% v/v	76 (24)	a	53 (43)	abc
Aminopyralid/florpyrauxifen-benzyl + NIS	0.083/0.008 + 0.25% v/v	89 (3)	a	53 (24)	abc
Aminopyralid/florpyrauxifen-benzyl + MSO	0.083/0.008 + 1% v/v	87 (16)	a	83 (7)	a
Aminopyralid/florpyrauxifen-benzyl + NIS	0.104/0.010 + 0.25% v/v	69 (16)	a	15 (15)	c
Aminopyralid/florpyrauxifen-benzyl + MSO	0.104/0.010 + 1% v/v	66 (44)	a	54 (47)	abc
Aminopyralid/florpyrauxifen-benzyl + 2,4-D + NIS	0.104/0.010 + 0.475 + 0.25% v/v	85 (11)	a	61 (3)	ab
Aminopyralid/florpyrauxifen-benzyl + 2,4-D + MSO	0.104/0.010 + 0.475 + 1% v/v	97 (6)	a	87 (20)	a
Aminopyralid/2,4-D + NIS	0.077/0.624 + 0.25% v/v	95 (5)	a	90 (11)	a
Aminopyralid + NIS	0.078 + 0.25% v/v	59 (30)	a	37 (31)	bc
LSD (α = 0.05)		NS		40	

[1] Within columns, means followed by the same letter are not statistically significantly different.

[2] Evaluations made August 11, 2020.

[3] Evaluations made July 19, 2021.

Tolerance of asparagus to indaziflam. Ed Peachey, Horticulture Dept., Oregon State University, Corvallis OR, 97330.

A trial site was set up in a field of established asparagus approximately two miles north of the town of Albany, Oregon. Field site was a Chapman loam soil with a CEC of 18.59 meq/100 g soil, 6.7 pH, and 4.57% organic matter. Experimental plots were 30 feet long with two asparagus bed rows on 36 inch centers. Treatments were replicated three times. Indaziflam treatments were applied at 20 GPA with a CO_2 backpack sprayer on 4-Mar-2021. Treatments were applied to bare soil, approximately 30 days before the emergence of first spears. Phytotoxicity and growth reduction ratings were taken at 30, 45, and 60 days after treatment. Harvesting of asparagus spears began on April 12 and continued at two to three day intervals until May 7. Harvest protocol consisted of cutting, counting and weighing of all asparagus spears of greater than 8 inches in length, and greater than 0.25 inch diameter, from within the 25 foot treated area of each plot. A buffer area of 2.5 feet on each end of plots was excluded from the harvested area. Weed control ratings were not made, as there were few weeds present and any existing weeds were removed by hoeing.

No phytotoxicity or growth reduction was recorded when rated at 30, 45, and 60 days after treatment. Analysis of the data collected from harvest of shoots indicated no significant differences between treated plots and the untreated check, and that treatment effects were consistent over time (using repeated measures analysis). This premilinary data is from the first year of this experiment; the trial will be repeated in 2022 and 2023 at the same location.

Table. Effect of indaziflam on asparagus yield, Albany, OR, 2021.

Treatment	Herbicide rate	Total # of spears harvested	Average spear weight	Sum weight of spears	
	lb ai/a (oz/a)	*no./plot*	*oz/spear*	*lb/plot*	*lbs/acre*
1 Untreated		245	0.8	12.5	994
2 Indaziflam	0.065 (5)	243	0.9	13.6	1077
3 Indaziflam	0.130 (10)	200	1.0	11.6	929
LSD (0.05)		ns	ns	ns	ns
SE		54	0.3	1.1	187

Brassica, swiss chard and beet crop tolerance to pronamide herbicide. Ed Peachey and Andy Nagy, Horticulture Dept., Oregon State University, Corvallis OR, 97330.

A trial was set at the Oregon State University Vegetable Research Farm on a Chehalis silty clay loam soil with a CEC range of 16.34 to 16.79 meq/100 g soil, pH range 6.6 to 6.9, and organic matter content 2.46 to 2.96%. Cabbage (*Brassica oleraceae*), Chinese cabbage (*B. rapus*), rutabaga (*B. napus*), Swiss chard (*Beta vulgaris subsp. Vulgaris)*, and red beets (*Beta vulgaris*) were planted on the 5-May-2021 at 3 to 4 seeds per foot at 0.75-inch depth. Fertilizer (16-16-16) was banded next to the row (2x2 inch) at 150 lb/acre at planting. Plots were 6.5 by 17 feet with three rows per plot on a 26 in spacing. Treatments were arranged in a randomized block design with 3 replications. Pronamide was applied post plant surface (PPS) one day after planting and followed on 7-May with 0.5-inch irrigation. Pronamide was applied POST to brassica seedlings with 4 to 6 leaves on 1-June followed by irrigation of 0.5 inches, late on the evening of the same day. Maintenance insecticides of carbaryl and permethrin were applied to control 12-spot cucumber beetle and flea beetles. Plots were cultivated on 4-June to reduce weed competition with the crops. No other herbicides were applied to the plots. Soil temp (2 inch) and air temperatures were recorded at 30-minute intervals. Soil and air temp averaged 68 F and 59 F respectively from 5-May through 14-June. Plots were evaluated for phytotoxicity and growth reduction.

Phytotoxicity and stunting ratings were not consistent across crops and treatments, indicating that some crops were more tolerant than others across this range of PPS and POST treatments. Injury ratings trended slightly higher for cabbage and lower for Chinese cabbage. Table 1 provides effect of pronamide timing and rate on weed control. Very little injury was noted on Chinese cabbage at the 1 lb ai/a rate even when applied PPS (Table 2). Post plant surface (PPS) applications caused the most injury, as expected. Data suggests that of all the Brassica crops in this study, Chinese cabbage was most tolerant to pronamide applied PPS. POST applications of pronamide caused much less damage than the PPS applications, near zero for some crops at the lowest rate of 1 lb ai/a. The 4x rate of 4 lb ai/a reduced Brassica crop growth by more than 23%. Beets appeared to be more sensitive than Swiss chard, but again, Chinese cabbage proved to be very tolerant. Weed control was good to excellent with the PPS application, demonstrating that pronamide may have a fit in both early spring and fall-planted crops. Pronamide dissipation is expected to increase when applied to warm soils. This year was a good test, because very little rain fell in May, and soil temperatures were normal to above average, yet weed control persisted. Irrigation was applied shortly after the pronamide applications and likely improved efficacy and contributed to the length of weed control.

Table 1. Effect of pronamide timing and rate on weed control averaged over all crops. PPS applied 5-May; POST applied 1-Jun.

ID	Pronamide rate	Timing	27-May (3 weeks after PPS)				14-Jun (2 weeks after POST)			
			Pigweed	Common lambsquarters	Hairy nightshade	Composite rating	Pigweed	Common lambsquarters	Hairy nightshade	Composite rating
	lbs ai. /acre		%							
1	1.0	PPS	75	72	88	77	32	30	63	47
2	2.0	PPS	97	88	96	92	77	90	98	83
3	4.0	PPS	97	97	99	95	75	72	83	73
4	1.0	POST	-	-	-	-	0	0	0	0
5	2.0	POST	-	-	-	-	50	38	50	47
6	4.0	POST	-	-	-	-	37	30	50	45
FPLSD			15	13	5	4	56	58	56	49

Table 2. Crop tolerance to pronamide herbicide, Corvallis, OR, 2021. Pronamide treatments applied PPS on 6-May and POST on 1-Jun (n=3).

Crop	ID	Rate	Timing	Stand	Phytotoxicity			Stunting		
				28-May	28-May	4-Jun	14/30-Jun	28-May	4-Jun	14/30-Jun
		lb ai /a		*No./3 ft of row*	------*0-10 (10=max)* -----------			---------------- *%* ---------------		
Ch cabbage	1	1	PPS	15	0.0	0.0	0.3	13	3	0
	2	2	PPS	16	1.7	0.3	0.7	47	33	30
	3	4	PPS	14	3.7	0.7	1.3	63	60	60
	4	1	POST	-	-	0	0.7	-	0	10
	5	2	POST	-	-	0	0.7	-	0	17
	6	4	POST	-	-	0	1.7	-	0	30
	7	-	-	12	0	0	0	0	0	0
FPLSD (0.05)				*ns*	*1.2*	*ns*	*ns*	*19*	*13*	*21*
Cabbage	1	1	PPS	11	1.0	1.0	3.0	40	40	37
	2	2	PPS	12	1.3	3.3	3.3	47	80	67
	3	4	PPS	10	2.0	5.3	5.0	73	60	97
	4	1	POST	-	-	0	1.0	-	0	13
	5	2	POST	-	-	0	1.3	-	0	13
	6	4	POST	-	-	0	4.7	-	0	47
	7	-		13	0	0	0	0	0	0
FPLSD (0.05)				*ns*	*1.2*	*1.3*	*1.5*	*24*	*46*	*25*
Rutabaga	1	1	PPS	16	1.7	1.3	0.7	53	43	27
	2	2	PPS	14	3.3	1.0	1.0	50	63	57
	3	4	PPS	9	6.0	1.5	1.0	80	90	85
	4	1	POST	-	-	0	0.7	-	0	3
	5	2	POST	-	-	0	1.0	-	0	10
	6	4	POST	-	-	0	1.7	-	0	23
	7	-		15	0	0	0	0	0	0
FPLSD (0.05)				*ns*	*ns*	*2.8*	*1.0*	*32*	*18*	*17*
Red beets	1	1	PPS	15	3.3	0	0.3	43	43	37
	2	2	PPS	9	2.7	0.7	1.5	77	85	83
	3	4	PPS	6	6.0	0	1.5	83	77	90
	4	1	POST	-	-	0	0.7	-	0	7
	5	2	POST	-	-	0	0.7	-	0	3
	6	4	POST	-	-	0	2.7	-	0	37
	7	-		17	0	0	0	0	0	0
FPLSD (0.05)				*8*	*3.0*	*ns*	*0.9*	*20*	*27*	*26*
Sw chard	1	1	PPS	13	2.0	0	1.0	40	45	33
	2	2	PPS	9	4.7	0	1.0	80	82	80
	3	4	PPS	7	7.3	0	0.0	92	95	95
	4	1	POST	-	-	0	0.7	-	0	3
	5	2	POST	-	-	0	0.3	-	0	0
	6	4	POST	-	-	0	2.0	-	0	0
	7	-		15	0	0	0	0	0	0
FPLSD (0.05)				*ns*	*3.3*	*ns*	*1.0*	*25*	*22*	*22*

Puncturevine control with preemergence herbicides in pumpkins grown with subsurface drip and sprinkler irrigation.

Cody Zesiger, Dan Drost, Cary Martin, Cody J. Beckley, and Corey V. Ransom. (Utah State University Cooperative Extension, Logan, UT 84322) Two small plot trials were established in pumpkins grown at the Kaysville Research Farm located in Davis County, UT. The site was chosen because of a dense and widespread puncturevine infestation. Four treatments and an untreated check were evaluated in two trials, i.e., pumpkins grown on plastic mulch using subsurface drip irrigation and pumpkins grown on bare ground using sprinkler irrigation. Plots measuring 20 by 6 ft were arranged in four replications using randomized complete block design. Treatments were applied to the drip plots between the rows of plastic and then mechanically incorporated into the soil surface. In the Sprinkler plots, treatments were applied post-plant preemergence over the row centers and incorporated with irrigation. All treatments were applied using a CO_2-pressurized backpack sprayer calibrated to deliver 18 gpa at 40 psi (Table 1). Precipitation data retrieved from an onsite weather station totaled 0.4 inches during the study period. Puncturevine biomass was measured on August 17, 2021 by harvesting the entire drip plots. Biomass in the sprinkler plots was sampled on July 16, 2021 and August 17, 2021 by clipping two 2.78 ft^2 quadrats in each plot.

Table 1. Application and soil data.

Application date	June 18, 2021
Puncturevine growth stage	preemergence
Air temperature (F)	86
Relative humidity (%)	17
Wind (mph, direction)	1.5, NW
Cloud cover (%)	60
Soil temperature at 2 inches (F)	91
Soil humidity (by feel)	powder dry
Soil texture	silt loam

At 28 days after treatment, all herbicides controlled puncturevine in sprinkler plots 51 to 79% in comparison with the untreated check (Table 2). Differences in biomass between treatments were not statistically significant (p=0.07). Mean Dry Matter (DM) ranged from 193 to 1,399 lb A^{-1} across treatments. Dry soil conditions and poor germination of puncturevine between rows of plastic mulch made it difficult to evaluate biomass in the plots 28 days after treatment. Therefore, biomass from drip plots was not evaluated until 60 days after treatment.

Two months following treatment, all treatments in the sprinkler plots did not provide statistically significant (p=0.31) control with means of 17 to 50% contrasted with the untreated check (Table 2). Mean DM ranged from 1,253 to 2,009 lb A^{-1} across treatments. However, in the drip trial, all herbicides controlled puncturevine 53 to 82% compared to the untreated check (Table 2). Differences between treatments were not statistically significant (p=0.36). Mean DM ranged from 424 to 3,705 lb A^{-1} across treatments.

Table 2. Puncturevine control in pumpkins following applications of several preemergence herbicides.

Treatment	Rate		Sprinkler 16 July	Sprinkler 17 August	Drip 17 August
	(oz a.i./A)	(fl oz a.i./A)	%	%	%
Untreated check			0 b	0 a	0 b
Trifluralin		10.3	52 a	24 a	53 a
S-metolachlor		17.6	51 a	50 a	69 a
Ethalfluralin		8.50	74 a	17 a	82 a
Halosulfuron	0.375		79 a	41 a	81 a
LSD (α = 0.05)			48	52	46

Means followed by the same letter within a column are not significantly different (p=0.05).

Effect of growth regulator herbicide, timing, and tankmix partner on control of field horsetail. Ed Peachey, Horticulture Dept., Oregon State University, Corvallis OR, 97330.

Relatively few herbicides used in annual agriculture production systems have significant activity on field horsetail. Local farmers have claimed successful control of horsetail using combinations of 2,4-D, dicamba and triclopyr in their fields. To clarify which herbicides and application timings provide the most consistent efficacy, a trial was established in a former blueberry field that had been overrun with field horsetail. Experimental plots were 25 feet long by 15 feet wide. The size of the infested area limited each treatment to two replications. Treatments were applied with a CO_2 backpack sprayer and 10 ft boom calibrated to deliver 20 GPA, on 2-Oct-2019 and 11-May-2020. Fall treatment applications were made on 2-Oct-2019, and spring applications made on 11-May, 2020. Horsetail control was evaluated on 27-May and 9-Oct, 2020. NIS at 0.25% v/v was added to all treatments (see table for rates).

When applied in the fall, the three-way mix of dicamba, 2,4-D, and triclopyr and the two way mix of triclopyr and MCPA provided the best control on 27-May (8 months after treatment), 73 and 68% control, respectively. Control ratings improved for nearly all fall treatments when evaluated one year after application (Oct-2020). The exception was triclopyr + MCPA. Control ratings following the spring application ranged from 75 to 98% five months after treatment. 2,4-D alone and dicamba+2,4-D were least effective at controlling horsetail (75 and 60% respectively. Sequential fall+spring applications did not significantly improve horsetail control, and may have reduced control when dicamba or triclopyr were tankmixed with 2,4-D, as for treatments 2 and 5. Triclopyr alone consistently provided the best control of horsetail, and there was little advantage to sequential applications. Horsetail control with triclopyr appeared to be poor in May, but by October the fall application of triclopyr was numerically greater than all other treatments.

Table. Control of horsetail with fall, fall plus spring, and spring applications at 8 and 12 months after initial treatment.

	Herbicides[a] and rates (lb ae/a)	Horsetail control					
		Evaluation on 27-May-2020			Evaluation on 9-Oct-2020		
		Fall app (Oct-2019)	Spring app (May-2020)	Fall + Spring (Oct + May)	Fall app (Oct-2019)	Spring app (May-2020)	Fall + Spring (Oct + May)
		% control					
1	dicamba 0.75	50	98	95	75	98	90
2	dicamba 0.75 2,4-D 1.7	55	95	99	75	60	38
3	dicamba 0.75 2,4-D 1.7 triclopyr 0.19	73	100	98	75	90	75
4	2,4-D 1.7	40	98	94	88	75	88
5	triclopyr 0.19 2,4-D 1.7	20	98	100	83	95	13
6	triclopyr 0.19	15	68	87	95	88	95
7	triclopyr 0.19 MCPA 1.9	68	98	100	25	98	63
	FPLSD (0.15)	41	16	11	45	14	32

[a] 2,4-D choline salt, Embed Extra; dicamba, Clarity; MCPA, Rhomene; triclopyr, Vastlan

Grass weed control and tolerance in Kentucky bluegrass with indaziflam. Traci A. Rauch and Joan M. Campbell. (Dept of Plant Sciences, University of Idaho, Moscow, ID 83844-2333) Studies were conducted in Kentucky bluegrass to evaluate Italian ryegrass, rattail fescue, and wild oat control and tolerance with indaziflam. 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). All studies were over sprayed with clopyralid/fluroxypyr at 0.188 ai/A for broadleaf weed control and fluxapyroxad/pyraclostrobin at 0.13 lb ai/A for rust. Weed control and crop injury were evaluated visually during the growing season. In the tolerance study, Kentucky bluegrass was swathed on June 28 and harvested with a small plot combine on July 9, 2021.

Table 1. Application and soil data.

Location	Reubens, ID			Gifford, ID		
K. bluegrass variety and age	Jackpot – 2nd year			Action – 3rd year		
Application timing	early fall	late fall	spring	early fall	late fall	spring
Application date	10/5/2020	10/20/2020	4/17/2021	10/15/2020	11/2/2020	4/17/2021
Growth stage						
Kentucky bluegrass	No green-up	40% green-up (2 inch)	3 tiller	No green-up	5% green-up (1 inch)	5 tiller
Rattail fescue	pre	spike	1 leaf	--	--	--
Wild oat	pre	pre	spike	--	--	--
Italian ryegrass	--	--	--	pre	spike	2 tiller
Air temperature (F)	71	48	67	58	64	70
Relative humidity (%)	29	68	23	52	41	22
Wind (mph, direction)	1, E	2, W	2, E	3, W	3, E	1, W
Cloud cover (%)	10	50	0	30	0	0
Next moisture occurred	10/12/2020	10/24/2020	5/20/2021	10/18/2020	11/6/2020	5/20/2021
Soil moisture	dry	adequate	adequate	adequate	adequate	dry
Soil temperature at 2 inch (F)	60	44	45	50	45	57
pH		4.1			4.8	
OM (%)		3.4			5.0	
CEC (meq/100g)		17.2			21.7	
Texture		silt loam			silt loam	

Location	Gifford, ID (tolerance study)		
K. bluegrass variety and age	Action – 7th year		
Application timing	early fall	late fall	spring
Application date	10/15/2020	11/2/2020	4/17/2021
Growth stage			
Kentucky bluegrass	No green-up	30% green-up (2 inch)	5 tiller
Air temperature (F)	49	66	69
Relative humidity (%)	72	53	25
Wind (mph, direction)	1, W	3, E	1, N
Cloud cover (%)	25	0	0
Next moisture occurred	10/18/2020	11/6/2020	5/20/2021
Soil moisture	adequate	adequate	dry
Soil temperature at 2 inch (F)	50	53	55
pH		4.8	
OM (%)		4.2	
CEC (meq/100g)		18.3	
Texture		silt loam	

At Reubens on June 11, rattail fescue control was evaluated in two replications due to a low population. All fall treatments averaged 99% (Table 2). At both evaluation dates, wild oat control was better with fall applied indaziflam compared to spring treatments. Fall treatments range from 76 to 97 and 78 to 93% on June 11 and 24, respectively. Wild oat control with spring treatments was 33% or less. At Gifford on May 13, all fall treatments controlled Italian ryegrass 99% (Table 3). On June 11, the early fall treatment timing at the highest rate controlled Italian ryegrass 97%

but did not differ from any fall timing at any rate. All treatments injured Kentucky bluegrass 0 to 4 and 0 to 1% on May 13 and June 11 evaluation dates, respectively (Table 4). Italian ryegrass control was 51% or less with spring treatments. Seed yield tended to be highest in the untreated check but ranged from 536 to 646 lb/A and did not differ among treatments. Seed germination is still to be determined.

The Nezperce site was not included due to a non-uniform stand of downy brome and ventenata.

Table 2. Rattail fescue and wild oat control with indaziflam in Kentucky bluegrass near Reubens, ID in 2021.

Treatment	Rate	Application timing	Rattail fescue[1]	Wild oat control	
				June 11	June 24
	lb ai/A		%	%	%
Indaziflam	0.026	early fall	99	88	78
Indaziflam	0.039	early fall	99	76	88
Indaziflam	0.052	early fall	99	97	87
Indaziflam	0.026	late fall	99	85	80
Indaziflam	0.039	late fall	99	93	91
Indaziflam	0.052	late fall	99	96	93
Indaziflam	0.026	spring	25	30	3
Indaziflam	0.039	spring	55	33	20
Indaziflam	0.052	spring	15	30	30
LSD (0.05)			--	36	23

[1] Average of two replications. Evaluated on June 11, 2021.

Table 3. Italian ryegrass control with indaziflam in Kentucky bluegrass near Gifford, ID in 2021.

Treatment	Rate	Application timing	Italian ryegrass control	
			May 13	June 11
	lb ai/A		%	%
Indaziflam	0.026	early fall	99	85
Indaziflam	0.039	early fall	99	87
Indaziflam	0.052	early fall	99	97
Indaziflam	0.026	late fall	99	88
Indaziflam	0.039	late fall	99	64
Indaziflam	0.052	late fall	99	75
Indaziflam	0.026	spring	0	10
Indaziflam	0.039	spring	0	25
Indaziflam	0.052	spring	0	51
LSD (0.05)			1	33

Table 4. Kentucky bluegrass response to indaziflam near Gifford, ID in 2021.

Treatment	Rate	Application timing	Kentucky bluegrass injury		K. bluegrass seed yield
			May 13	June 11	
	lb ai/A		%	%	1b/A
Indaziflam	0.026	early fall	3	1	556
Indaziflam	0.039	early fall	3	1	537
Indaziflam	0.052	early fall	1	0	594
Indaziflam	0.026	late fall	3	1	646
Indaziflam	0.039	late fall	0	0	570
Indaziflam	0.052	late fall	4	1	536
Indaziflam	0.026	spring	1	0	618
Indaziflam	0.039	spring	1	0	570
Indaziflam	0.052	spring	3	0	602
Untreated check	--	--	--	--	666
LSD (0.05)			NS	NS	NS

Chickpea response to dimethenamid with and without irrigation. Traci A. Rauch and Joan M. Campbell. (Crop and Weed Science Division, University of Idaho, Moscow, ID 83844-2339) A study was established on the University of Idaho Parker Farm at Moscow, Idaho to evaluate winter wheat response to dimethenamid with and without supplemental sprinkler irrigation. The experimental design was a split block with four replications. Main plots were irrigation rate (30 by 32 ft) and subplots were dimethenamid treatments (8 by 30 ft). 'Sierra' chickpea was planted on April 29, 2021. Immediately after seeding, the treatments were applied. Herbicide treatments were applied using a handheld boom CO_2 pressurized backpack sprayer calibrated to deliver 10 gpa at 32 psi and 3 mph (Table 1). On May 3, 2021, the sprinkler irrigation was applied at 0 and 0.5 inch. The study was oversprayed on May 5, 2021 with metribuzin at 0.328 and saflufenacil at 0.064 lb ai/A, May 14 (replications 1 and 2) with paraquat at 0.25 lb ai/A and June 3 (replications 1 and 2) with pyridate at 0.94 lb ai/A to control broadleaf weeds. Crop injury was evaluated during the growing season. Seed was harvested with a small plot combine on August 30, 2021.

Table 1. Application and soil data.

Seeding date	4/29/21
Application date	4/29/21
Application timing	0 DAP
Air temperature (F)	84
Relative humidity (%)	26
Wind (mph, direction)	1, WSW
Cloud cover (%)	80
Soil moisture	adequate
Soil temperature at 2 inch (F)	75
Next moisture occurred	5/3/21 – irrigated
pH	4.9
OM (%)	3.5
CEC (meq/100g)	16.9
Texture	silt loam

No visible chickpea injury was evident at 8, 13, 21, 34, and 54 DAT (data not shown). Irrigation and herbicide treatments did not affect chickpea seed yield (Table 2 and 3). Chickpea seed yield tended to be greater with irrigation due to less than 2.2 inches of rainfed precipitation from planting until harvest.

Table 2. Chickpea response averaged over herbicide treatment near Moscow, Idaho in 2021.

Irrigation rate	Yield[1]
	lb/A
0 inch	1349a
0.5 inch	1535a

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

Table 3. Chickpea seed yield averaged over irrigation rate near Moscow, Idaho in 2021.

Treatment	Rate	Yield[1]
	lb ai/A	lb/A
Dimethenamid	0.84	1389a
Dimethenamid	1.69	1434a
Dimethenamid + flumioxazin	0.84 + 0.032	1427a
Untreated check	--	1519a

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

<u>Tolpyralate/nicosulfuron at two timings compared to standards in corn.</u> Randall S. Currie and Patrick W. Geier. (Kansas State University Southwest Research-Extension Center, 4500 E. Mary Street, Garden City, KS 67846) An experiment was conducted to compare tolpyralate/nicosulfuron applied at two application timings to competitive standards for efficacy in corn. All herbicides were applied using a tractor-mounted, compressed CO_2 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 35 feet and arranged in a randomized complete block design with four replications. Soil was a Beeler silt loam with 2.4% organic matter and pH of 7.5. Visual weed control estimates were determined on June 18 and July 2, 2021. These dates were 6 and 20 days after the late postemergence treatments (DA-B), respectively. Corn chlorosis was evaluated on June 6 and June 18, 2021, which was 2 days after the early postemergence treatments (2 DA-A), and 6 DA-B, respectively. Yields were determined on October 6, 2021 by mechanically harvesting the center two rows of each plot and adjusting grain weights to 15.5% moisture.

Table 1. Application, environmental, and weed data for tolpyralate/nicosulfuron study.

Application timing	Early postemergence	Late postemergence
Application date	June 4, 2021	June 12, 2021
Air temperature (F)	77	75
Relative humidity	60	64
Soil temperature (F)	68	76
Wind speed (mph)	2 to 5	2 to 6
Wind direction	South	East
Soil moisture	Good	Good
Corn		
Height (inches)	5 to 7	9 to 12
Leaves (no.)	2 to 3	4 to 6
Kochia		
Height (inches)	1 to 3	3 to 5
Density (plants/ft^2)	0.5	0.5
Russian thistle		
Height (inches)	2 to 4	4 to 6
Density (plants/ft^2)	1	0.5
Palmer amaranth		
Height (inches)	1 to 4	4 to 10
Density (plants/ft^2)	3	2
Common lambsquarters		
Height (inches)	1 to 2	2 to 6
Density (plants/ft^2)	0.5	0.5
Green foxtail		
Height (inches)	1 to 2	2 to 6
Density (plants/ft^2)	0.5	0.5
Volunteer oats		
Height (inches)	2 to 4	4 to 8
Density (plants/ft^2)	1	1

Tolpyralate/nicosulfuron plus atrazine applied early postemergence (EPOST) controlled all weed species similar to tembotrione/thiencarbazone, dimethenamid/topramezone, or metolachlor/mesotrione, each with atrazine, applied EPOST (Tables 2 and 3). Late- postemergence (LPOST) applications of these herbicides without atrazine were less effective on all species except common lambsquarters (97 to 100% control), and when metolachlor/mesotrione was applied to green foxtail (33 to 35% control) late in the season. Less corn chlorosis was observed with tolpyralate/nicosulfuron applied EPOST than with dimethenamid/topramezone or metolachlor/mesotrione at 2 DA-A

(Table 3). However, injury did not persist. All herbicides increased grain yields 59 to 165 bu/A relative to the untreated control except mesotrione/metolachlor LPOST. Yields were greatest when any of the herbicides evaluated was applied EPOST and when dicamba/diflufenzopyr plus glyphosate was applied LPOST. Delaying herbicide treatment to LPOST resulted in yields 61 to 124 bu/A less than with the same treatments applied EPOST.

Table 2. Broadleaf weed control in the tolpyralate/nicosulfuron study.

			Kochia		Palmer amaranth		Common lambsquarters		Russian thistle	
Treatment[1]	Rate	Timing[2]	6 DA-B[3]	20 DA-B[3]	6 DA-B	20 DA-B	6 DA-B	20 DA-B	6 DA-B	20 DA-B
	lb/a		——— % Visual -———		——— % Visual -———		——— % Visual -———		——— % Visual -———	
Tolpyralate/ Nicosulfuron	0.05	EPOST	99	100	95	89	100	100	100	100
Atrazine	1.0	EPOST								
HSOC	1%	EPOST								
Tolpyralate/ Nicosulfuron	0.05	LPOST	45	58	45	60	48	97	40	60
HSOC	1%	LPOST								
Tembotrione/ Thiencarbazone	0.081	EPOST	100	100	96	86	100	100	100	100
Atrazine	1.0	EPOST								
COC	1%	EPOST								
AMS	1%	EPOST								
Tembotrione/ Thiencarbazone	0.081	LPOST	48	53	50	53	55	100	53	55
COC	1%	LPOST								
AMS	1%	LPOST								
Dimethenamid/ Topramezone	0.84	EPOST	100	100	94	88	100	100	100	100
Atrazine	1.0	EPOST								
COC	1%	EPOST								
AMS	1%	EPOST								
Dimethenamid/ Topramezone	0.84	LPOST	48	53	55	53	48	98	48	55
COC	1%	LPOST								
AMS	1%	LPOST								

Metolachlor/ Mesotrione	1.84	EPOST	100	100	94	88	100	100	100	100
Atrazine	1.0	EPOST								
COC	1%	EPOST								
AMS	1%	EPOST								
Metolachlor/ Mesotrione	1.84	LPOST	45	48	35	23	48	100	40	43
COC	1%	LPOST								
AMS	1%	LPOST								
Dicamba/ Diflufenzopyr	0.175	LPOST	89	94	96	96	100	100	100	100
Glyphosate	0.77	LPOST								
NIS	0.25%	LPOST								
AMS	1%	LPOST								
LSD (0.05)			7	9	6	9	9	NS	6	8

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[1] HSOC is high surfactant oil concentrate, COC is crop oil concentrate, AMS is ammonium sulfate, and NIS is nonionic surfactant.

[2] EPOST is early postemergence, LPOST is late postemergence.

[3] DA-B is days after the late postemergence treatments.

Table 3. Grass weed control and crop response in the tolpyralate/nicosulfuron study.

			Volunteer oats		Green foxtail		Corn chlorosis		Corn
Treatment[1]	Rate	Timing[2]	6 DA-B[3]	20 DA-B	6 DA-B	20 DA-B	2 DA-A[4]	6 DA-B	yield
	lb/a		——— % Visual -———		——— % Visual -———		——— % Visual -———		bu/A
Nontreated	---	---	---	---	---	---	0	0	15.4
Tolpyralate/ Nicosulfuron	0.05	EPOST	99	100	99	99	5	0	175.3
Atrazine	1.0	EPOST							
HSOC	1%	EPOST							
Tolpyralate/ Nicosulfuron	0.05	LPOST	33	73	30	70	---	0	114.2
HSOC	1%	LPOST							
Tembotrione/ Thiencarbazone	0.081	EPOST	96	100	100	96	1	0	180.6
Atrazine	1.0	EPOST							
COC	1%	EPOST							
AMS	1%	EPOST							
Tembotrione/ Thiencarbazone	0.081	LPOST	40	68	35	68	---	0	74.9
COC	1%	LPOST							
AMS	1%	LPOST							
Dimethenamid/ Topramezone	0.84	EPOST	96	100	100	100	11	0	173.6
Atrazine	1.0	EPOST							
COC	1%	EPOST							
AMS	1%	EPOST							
Dimethenamid/ Topramezone	0.84	LPOST	60	63	45	65	---	0	75.6
COC	1%	LPOST							
AMS	1%	LPOST							
Metolachlor/ Mesotrione	1.84	EPOST	96	100	73	35	18	0	154.3
Atrazine	1.0	EPOST							

COC	1%	EPOST							
AMS	1%	EPOST							
Metolachlor/ Mesotrione	1.84	LPOST	40	35	23	33	---	0	30.1
COC	1%	LPOST							
AMS	1%	LPOST							
Dicamba/ Diflufenzopyr	0.175	LPOST	96	100	95	100	---	0	180.4
Glyphosate	0.77	LPOST							
NIS	0.25%	LPOST							
AMS	1%	LPOST							
LSD (0.05)			6	7	8	11	3	NS	26.6

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[1] HSOC is high surfactant oil concentrate, COC is crop oil concentrate, AMS is ammonium sulfate, and NIS is nonionic surfactant.

[2] EPOST is early postemergence, LPOST is late postemergence.

[3] DA-B is days after the late postemergence treatments.

[4] DA-A is days after the early postemergence treatments.

Single and split herbicide applications for efficacy in corn. Randall S. Currie and Patrick W. Geier. (Kansas State University Southwest Research-Extension Center, 4500 E. Mary Street, Garden City, KS 67846) An experiment was conducted to compare residual herbicides applied in single or split applications for efficacy in corn. All herbicides were applied using a tractor-mounted, compressed CO_2 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 35 feet and arranged in a randomized complete block design with four replications. Soil was a Beeler silt loam with 2.4% organic matter and pH of 7.5. Visual weed control estimates were determined on May 28 and July 19, 2021. These dates were 28 days after the preemergence treatments (28 DA-A), and 46 days after the postemergence treatments (46 DA-B), respectively. Corn chlorosis was evaluated on June 6 and June 18, 2021, which was 3 and 15 days after the postemergence treatments (DA-B). Yields were determined on October 5, 2021 by mechanically harvesting the center two rows of each plot and adjusting grain weights to 15.5% moisture.

Table 1. Application, environmental, and weed data for the single and split application study.

Application timing	Preemergence	Postemergence
Application date	April 30, 2021	June 3, 2021
Air temperature (F)	63	86
Relative humidity	37	32
Soil temperature (F)	52	70
Wind speed (mph)	2 to 5	0 to 2
Wind direction	West	South
Soil moisture	Good	Good
Corn		
Height (inches)	---	6 to 9
Leaves (no.)	0	3 to 4
Kochia		
Height (inches)	---	1 to 2
Density (plants/ft^2)	0	0.5
Russian thistle		
Height (inches)	---	1 to 3
Density (plants/ft^2)	0	1
Palmer amaranth		
Height (inches)	---	1 to 3
Density (plants/ft^2)	0	1
Common sunflower		
Height (inches)	---	3 to 5
Density (plants/ft^2)	0	0.5
Volunteer oats		
Height (inches)	---	4 to 8
Density (plants/ft^2)	0	15

Sunflower control was 90% or more regardless of herbicide or application timing, and did not differ (data not shown). Kochia, Russian thistle, and volunteer oats control was similar among all preemergence (PRE) herbicide treatments at 26 DA-A (Table 2). By 46 DA-B, control of each of these weed species was complete with all PRE followed by postemergence (POST) herbicides. Similarly, Palmer amaranth control with all sequential treatments was 95 to 98% at 46 DA-B. Although minor corn chlorosis was evident with most POST herbicides at 3 DA-B, visual injury did not persist (Table 3). All herbicides increased grain yields 71 to 104 bu/A compared to the untreated control. Atrazine/mesotrione/metolachlor PRE was followed by atrazine/bicycloppyrone/mesotrione/metolachlor plus glyphosate resulted in the highest yields, and was better than any herbicide treatment applied PRE alone.

Table 2. Weed control with single and split herbicide applications in corn.

			Kochia		Russian thistle		Palmer amaranth		Volunteer oats	
Treatment[1]	Rate	Timing[2]	28 DA-A[3]	46 DA-B[3]	28 DA-A	46 DA-B	28 DA-A	46 DA-B	28 DA-A	46 DA-B
	lb ai/a		% Visual		% Visual		% Visual		% Visual	
Atrazine/ Mesotrione/ Metolachlor	2.48	PRE	100	85	96	80	100	75	75	78
Atrazine/ Bicyclopyrone/ Mesotrione/ Metolachlor	2.58	PRE	100	100	100	90	100	85	83	93
Atrazine	0.5	PRE								
Atrazine/ Mesotrione/ Metolachlor	1.24	PRE	100	100	98	100	98	96	73	100
Atrazine/ Bicyclopyrone/ Mesotrione/ Metolachlor	1.29	POST								
Glyphosate	0.95	POST								
AMS	1%	POST								
Metolachlor/ Atrazine	2.25	PRE	100	100	90	100	93	98	80	100
Metolachlor/ Glyphosate/ Mesotrione	1.94	POST								
Atrazine	0.5	POST								
Glyphosate	0.95	POST								
NIS	0.25%	POST								
AMS	1%	POST								
Metolachlor/ Atrazine	1.65	PRE	99	100	90	100	85	95	78	100
Metolachlor/ Atrazine	2.25	POST								
Glyphosate	0.95	POST								
AMS	1%	POST								
Atrazine/ Bicyclopyrone/	1.29	PRE	98	100	98	100	98	96	75	100

Mesotrione/ Metolachlor										
Atrazine/ Bicyclopyrone/ Mesotrione/ Metolachlor	1.29	POST								
Glyphosate	0.95	POST								
AMS	1%	POST								
Acetochlor/ Clopyralid/ Mesotrione	1.03	PRE	96	100	93	100	95	98	85	100
Acetochlor/ Clopyralid/ Mesotrione	1.03	POST								
Glyphosate	0.95	POST								
AMS	1%	POST								
LSD (0.05)			NS	6	NS	5	7	7	NS	4

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

[2] PRE is preemergence, POST is postemergence.

[3] 28 DA-A is 28 days after the preemergence applications, 46 DA-B is 46 days after the postemergence treatments.

Table 3. Crop response to the single and split herbicide applications in corn.

			Chlorosis		
Treatment[1]	Rate	Timing[2]	3 DA-B[3]	15 DA-B[3]	Yield
	lb ai/a		% Visual		bu/A
Nontreated control			0	0	6.8
Atrazine/ Mesotrione/ Metolachlor	2.48	PRE	0	0	78.1
Atrazine/ Bicyclopyrone/ Mesotrione/ Metolachlor	2.58	PRE	0	0	91.1
Atrazine	0.5	PRE			
Atrazine/ Mesotrione/ Metolachlor	1.24	PRE	4	0	111.6
Atrazine/ Bicyclopyrone/ Mesotrione/ Metolachlor	1.29	POST			
Glyphosate	0.95	POST			
AMS	1%	POST			
Metolachlor/ Atrazine	2.25	PRE	4	0	98.6
Metolachlor/ Glyphosate/ Mesotrione	1.94	POST			
Atrazine	0.5	POST			
Glyphosate	0.95	POST			
NIS	0.25%	POST			
AMS	1%	POST			
Metolachlor/ Atrazine	1.65	PRE	8	0	102.3
Metolachlor/ Atrazine	2.25	POST			
Glyphosate	0.95	POST			
AMS	1%	POST			
Atrazine/ Bicyclopyrone/ Mesotrione/ Metolachlor	1.29	PRE	5	0	96.2
Atrazine/ Bicyclopyrone/ Mesotrione/ Metolachlor	1.29	POST			
Glyphosate	0.95	POST			
AMS	1%	POST			
Acetochlor/ Clopyralid/ Mesotrione	1.03	PRE	1	0	96.8
Acetochlor/ Clopyralid/ Mesotrione	1.03	POST			
Glyphosate	0.95	POST			
AMS	1%	POST			
LSD (0.05)			3	NS	20.4

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

[2] PRE is preemergence, POST is postemergence.

[3] DA-B is days after the postemergence treatments.

Quizalofop alone and with fenoxaprop and chlorimuron for efficacy in fallow. Randall S. Currie and Patrick W. Geier. (Kansas State University Southwest Research-Extension Center, 4500 E. Mary Street, Garden City, KS 67846) An experiment was conducted to compare quizalofop alone and in tank mixtures for grass control in fallow. All herbicides were applied postemergence using a tractor-mounted, compressed CO_2 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 35 feet and arranged in a randomized complete block design with four replications. Soil was a Ulysses silt loam with 1.8% organic matter and pH of 8.1. Visual weed control estimates were determined on June 11, June 25, and July 9, 2021. These dates were 14, 28, and 42 days after herbicide treatment (DAT).

Table 1. Application, environmental, and weed data for the quizalofop, fenoxaprop, and chlorimuron fallow study.

Application date	May 28, 2021
Air temperature (F)	55
Relative humidity	66
Soil temperature (F)	60
Wind speed (mph)	1 to 4
Wind direction	East
Soil moisture	Good
Volunteer corn	
Height (inches)	1 to 3
Density (plants/ft^2)	2
Volunteer barley	
Height (inches)	2 to 5
Density (plants/ft^2)	20

Volunteer corn and volunteer barley were the only grass weeds emerged at the time of herbicide application and the only weeds evaluated. Increasing the rate of quizalofop from 0.041 to 0.055 lb/a did not improve volunteer corn or barley at any rating date (Table 2). The addition of fenoxaprop or fenoxaprop plus chlorimuron at the higher rates improved volunteer corn control compared to quizalofop alone at 14 DAT. By 42 DAT, only the treatment of quizalofop plus chlorimuron provided less than 90% corn control. All herbicides provided 90% or more volunteer barley control. The addition of fenoxaprop, at any rate, increased barley control compared to quizalofop at 0.055 lb/a alone at 14 DAT. The addition of fenoxaprop at 0.028 and 0.042 lb/a also increased barley control at 28 and 42 DAT.

Table 2. Grass weed control with quizalofop alone and in mixtures in fallow.

		Volunteer corn			Volunteer barley		
Treatment[1]	Rate	14 DAT[2]	28 DAT	42 DAT	14 DAT	28 DAT	42 DAT
	lb ai/A	% Visual			% Visual		
Quizalofop COC	0.041 1.0%	86	98	98	95	95	94
Quizalofop Fenoxaprop COC	0.041 0.021 1.0%	92	98	96	98	99	98
Quizalofop Fenoxaprop COC	0.041 0.026 1.0%	93	99	98	100	98	96
Quizalofop Fenoxaprop COC	0.041 0.032 1.0%	94	98	99	100	99	98
Quizalofop COC	0.055 1.0%	91	96	91	91	95	90
Quizalofop Fenoxaprop COC	0.055 0.028 1.0%	97	98	95	100	100	99
Quizalofop Fenoxaprop COC	0.055 0.034 1.0%	97	100	100	100	98	96
Quizalofop Fenoxaprop COC	0.055 0.042 1.0%	98	98	98	100	100	99
Quizalofop Chlorimuron COC	0.055 0.008 1.0%	83	88	85	98	100	100
Quizalofop Fenoxaprop Chlorimuron COC	0.055 0.028 0.008 1.0%	88	92	90	100	100	100
Quizalofop Fenoxaprop Chlorimuron COC	0.055 0.034 0.008 1.0%	95	95	94	100	100	100
Quizalofop Fenoxaprop Chlorimuron COC	0.055 0.042 0.008 1.0%	93	93	90	100	99	98
LSD (0.05)		6	6	7	5	4	6

[1] COC is crop oil concentrate.

[2] DAT is days after treatment.

Pyraflufen tank mixtures for efficacy in fallow. Randall S. Currie and Patrick W. Geier. (Kansas State University Southwest Research-Extension Center, 4500 E. Mary Street, Garden City, KS 67846) An experiment was conducted to compare pyraflufen tank mixtures for weed control in fallow. All herbicides were applied postemergence using a tractor-mounted, compressed CO_2 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 35 feet and arranged in a randomized complete block design with four replications. Soil was a Ulysses silt loam with 1.8% organic matter and pH of 8.1. Visual weed control estimates were determined on May 13, May 20, and May 27, 2021. These dates were 7, 14, and 21 days after herbicide treatment (DAT).

Table 1. Application, environmental, and weed data for the pyraflufen tank mixture study.

Application date	May 6, 2021
Air temperature (F)	72
Relative humidity	43
Soil temperature (F)	72
Wind speed (mph)	2 to 6
Wind direction	Northeast
Soil moisture	Good
Kochia	
Height (inches)	1 to 3
Density (plants/ft^2)	100
Downy brome	
Height (inches)	10 to 25
Density (plants/ft^2)	15

Kochia control at 7 and 14 DAT was greatest (80 to 85%) when saflufenacil was included in the herbicide mixture (Table 2). However, by 21 DAT, only those treatments containing dicamba controlled kochia more than 75%. Kochia control with all herbicide treatments peaked at the 21 DAT mark, and began to decline later in the season (data not shown). Pyraflufen plus saflufenacil, glyphosate and 2,4-D controlled downy brome best at 7 DAT (65%). At 14 DAT, downy brome control was greater than 95% with all treatments except glyphosate with 2,4-D or dicamba. Downy brome control was complete regardless of herbicide treatment by 21 DAT.

Table 2. Weed control with pyraflufen tank mixtures in fallow.

		Kochia			Downy brome		
Treatment[1]	Rate[2]	7 DAT[3]	14 DAT	21 DAT	7 DAT	14 DAT	21 DAT
	lb/A	% Visual			% Visual		
Pyraflufen	0.0033	63	50	45	48	96	100
Glyphosate	0.84						
COC	1.0%						
AMS	3.0						
Glyphosate	0.84	20	43	58	43	91	100
2,4-D amine	0.25						
AMS	3.0						
Pyraflufen	0.0033	63	58	50	58	97	100
Glyphosate	0.84						
2,4-D amine	0.25						
COC	1.0%						
AMS	3.0						
Pyraflufen	0.0033	80	84	70	60	99	100
Saflufenacil	0.045						
Glyphosate	0.84						
COC	1.0%						
AMS	3.0						
Saflufenacil	0.045	81	80	60	63	98	100
Glyphosate	0.84						
COC	1.0%						
AMS	3.0						
Pyraflufen	0.0033	84	85	73	65	97	100
Saflufenacil	0.045						
2,4-D amine	0.25						
Glyphosate	0.84						
COC	1.0%						
AMS	3.0						
Dicamba	0.25	30	55	79	43	93	100
Glyphosate	0.84						
AMS	3.0						
Pyraflufen	0.0033	68	68	80	55	97	100
Dicamba	0.25						
Glyphosate	0.84						
COC	1.0%						
AMS	3.0						
Pyraflufen	0.0033	81	85	78	55	97	100
Dicamba	0.25						
Saflufenacil	0.045						
Glyphosate	0.84						
COC	1.0%						
AMS	3.0						
LSD (0.05)		6	8	7	5	3	NS

[1] COC is crop oil concentrate, AMS is ammonium sulfate.

[2] Pyraflufen and saflufenacil rates are in pounds active ingredient; glyphosate, 2,4-D, and dicamba rates are in pounds acid equivalent.

[3] DAT is days after herbicide treatment.

<u>Industrial weed control with indaziflam, aminocyclopyrachlor and imazapyr application timings.</u> Randall S. Currie and Patrick W. Geier. (Kansas State University Southwest Research-Extension Center, 4500 E. Mary Street, Garden City, KS 67846) An experiment was conducted to evaluate nonselective herbicides at three application timings for noncropland weed control. All herbicides were applied using a tractor-mounted, compressed CO_2 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 35 feet and arranged in a randomized complete block design with four replications. Soil was a Ulysses silt loam with 1.8% organic matter and pH of 8.1. Visual weed control estimates were determined on May 12, August 13, and October 11, 2021. These dates were approximately 2, 5, and 7 months after the early spring applications (MA-C)

Table 1. Application, environmental, and weed data for the industrial weed control study.

Application Timing	Early Fall	Late fall	Early Spring
Application date	October 8, 2020	December 9, 2020	March 11, 2021
Air temperature (F)	79	71	55
Relative humidity	28	14	30
Soil temperature (F)	64	38	53
Wind speed (mph)	1 to 4	0 to 3	4 to 8
Wind direction	South	North-northwest	East-northeast
Soil moisture	Dry	Dry	Dry
Kochia			
Height (inches)	---	---	0.5
Density (plants/ft^2)	0	0	1
Woollyleaf bursage			
Height (inches)	3 to 6	2 to 4	---
Density (plants/ft^2)	1	1	0

Glyphosate provided no residual kochia or woollyleaf bursage control regardless of application time (Table 2). All other herbicides controlled kochia 100% at 2 MA-C. Kochia control at 5 MA-C remained high when indaziflam/aminocyclopyrachlor/imazapyr was applied early fall or late fall, and with bromacil/diuron at any application timing. These same treatments controlled kochia 84% or more at 7 MA-C. Woollyleaf bursage control was complete with any combination of indaziflam, aminocyclopyrachlor, and/or imazapyr regardless of application timing or rating date. Conversely, no treatment of bromacil/diuron provided more than 60% woollyleaf bursage control.

Table 2. Efficacy in the industrial weed control study.

			Kochia			Woollyleaf bursage		
Treatment	Rate	Timing	2 MA-C[1]	5 MA-C	7 MA-C	2 MA-C	5 MA-C	7 MA-C
	lb ai/A							
Glyphosate	2.5	Early Fall	0	0	0	0	0	0
NIS	0.25%	Early Fall						
Indaziflam/ Aminocyclopyrachlor/ Imazapyr	0.81	Early Fall	100	90	84	100	100	100
Glyphosate	2.5	Early Fall						
Nonionic surfactant	0.25%	Early Fall						
Indaziflam/ Aminocyclopyrachlor/ Imazapyr	1.07	Early Fall	100	90	88	100	100	100
Glyphosate	2.5	Early Fall						
Nonionic surfactant	0.25%	Early Fall						
Bromacil/ Diuron	6.4	Early Fall	100	100	100	53	60	57
Glyphosate	2.5	Early Fall						
Nonionic surfactant	0.25%	Early Fall						
Indaziflam	0.065	Early Fall	100	84	79	100	100	100
Aminocyclopyrachlor	0.188	Early Fall						
Glyphosate	2.5	Early Fall						
Nonionic surfactant	0.25%	Early Fall						
Glyphosate	2.5	Late Fall	0	0	0	0	0	0
Nonionic surfactant	0.25%	Late Fall						
Indaziflam/ Aminocyclopyrachlor/ Imazapyr	0.81	Late Fall	100	85	81	100	100	100
Glyphosate	2.5	Late Fall						
Nonionic surfactant	0.25%	Late Fall						
Indaziflam/ Aminocyclopyrachlor/ Imazapyr	1.07	Late Fall	100	91	90	100	100	100
Glyphosate	2.5	Late Fall						
Nonionic surfactant	0.25%	Late Fall						
Bromacil/ Diuron	6.4	Late Fall	100	100	100	50	60	60

Glyphosate	2.5	Late Fall						
Nonionic surfactant	0.25%	Late Fall						
Indaziflam	0.065	Late Fall	100	68	63	100	100	100
Aminocyclopyrachlor	0.188	Late Fall						
Glyphosate	2.5	Late Fall						
Nonionic surfactant	0.25%	Late Fall						
Glyphosate	2.5	Early Spring	0	0	0	0	0	0
Nonionic surfactant	0.25%	Early Spring						
Indaziflam/Aminocyclopyrachlor/Imazapyr	0.81	Early Spring	98	68	63	100	100	100
Glyphosate	2.5	Early Spring						
Nonionic surfactant	0.25%	Early Spring						
Indaziflam/Aminocyclopyrachlor/Imazapyr	1.07	Early Spring	100	78	70	100	100	100
Glyphosate	2.5	Early Spring						
Nonionic surfactant	0.25%	Early Spring						
Bromacil/Diuron	6.4	Early Spring	100	100	100	53	58	55
Glyphosate	2.5	Early Spring						
Nonionic surfactant	0.25%	Early Spring						
Indaziflam	0.065	Early Spring	100	63	55	100	100	100
Aminocyclopyrachlor	0.188	Early Spring						
Glyphosate	2.5	Early Spring						
Nonionic surfactant	0.25%	Early Spring						
LSD (0.05)			2	12	14	6	4	3

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[1] MA-C is months after the early spring applications.

Long-term control of smooth scouringrush with glyphosate and chlorsulfuron/metsulfuron in wheat/fallow cropping systems. Mark Thorne, Marija Savic, and Drew Lyon (Dept. of Crop & Soil Sciences, Washington State Univ., Pullman, WA 99164) Smooth scouringrush (*Equisetum laevigatum*) control in wheat/fallow rotations in eastern Washington has been difficult because of limited effective herbicide options. In different studies, we have shown that applications of chlorsulfuron/metsulfuron in fallow can have activity on smooth scouringrush at least a year after application; however, tank mixing glyphosate with chlorsulfuron/metsulfuron in fallow-year applications may increase control of smooth scouringrush into the following crop year and beyond. Glyphosate has been effective when applied at a high rate and with an organosilicone surfactant. In contrast, chlorsulfuron/metsulfuron is effective for at least two years after application, but when applied alone, does not control some other weeds that might be present in the fallow. This study examines the effect of chlorsulfuron/metsulfuron and glyphosate applied alone or in combination at different rates of glyphosate one year after application in fallow.

Table 1. Application and soil data.

Location	Dayton, WA	Steptoe, WA
Application date	July 6, 2020	July 6, 2020
Smooth scouringrush growth stage	stems with strobili	stems with strobili
Crop phase	no-till fallow	no-till fallow
Air temperature (°F)	75	79
Relative humidity (%)	35	36
Wind (mph, direction)	2-4, SW	1, SW
Cloud cover (%)	0	0
Soil temperature at 2 inches (°F)	67	90
Soil texture	Walla Walla silt loam	Covello silt loam
Soil organic matter 0-6 inches (%)	2.1	2.9
Soil pH	5.4	5.8

Study trials were initiated in 2020 near Dayton, WA and Steptoe, WA (Table 1). The Dayton site is on a 30-40% northwest facing slope while the Steptoe site is on low-lying flat that is sometimes inundated with water during winter or early spring. All plots measured 10 by 30 ft and were arranged in a randomized complete block design with four replications per treatment. All treatments were applied with a hand-held spray boom with six TeeJet® XR11002 nozzles on 20-inch spacing and pressurized with a CO_2 backpack at 3 mph. Spray output was 15 gpa at 25 psi. All treatments included an organosilicone surfactant. Initial smooth scouringrush density in 2020 averaged 326 and 279 stems/yd^2 at the Dayton and Steptoe sites, respectively (Table 2). In October 2020 the Dayton and Reardan sites were seeded to winter wheat.

In July 2021, winter wheat at Dayton and Steptoe was ripening when smooth scouringrush stems were counted in two 1.2-yd^2 quadrats per plot, one year after treatment. At Dayton, the nontreated check plots averaged 122 stems/yd^2 in the 2021 winter wheat, 37% of the initial density, which illustrates that winter wheat is somewhat competitive with smooth scouringrush. This difference was even more dramatic at Steptoe (Table 2). At both locations, the weakest treatment was 1.13 lb ae/A of glyphosate alone. All treatments with chlorsulfuron/metsulfuron resulted in zero stems in the winter wheat. At Dayton, the 2.25 and 3.38 lb ae/A rates of glyphosate alone resulted in 30 and 23 stems/yd^2 but at Steptoe, all treatments except the 1.13 lb ae/A glyphosate had zero stems/yd^2. The treatments applied in 2020 at Dayton were much slower to show symptoms compared with the Steptoe site and this difference was likely related to soil temperature and moisture differences at the time of application. The Steptoe site had warmer soil temperature at application and was located on a low-lying flat with the potential for adequate soil water. In contrast, the Dayton site was on the upper part of a steep north-facing slope and had cooler temperatures at application. It is difficult to determine if glyphosate aided chlorsulfuron/metsulfuron since all applications with chlorsulfuron/metsulfuron resulted in zero stems, however, stem counts will be taken again in 2022 to see if other treatment differences begin to show over time.

Table 2. Smooth scouringrush density in winter wheat one year after applications of glyphosate and chlorsulfuron/metsulfuron in fallow at Dayton and Steptoe, WA.

		Smooth scouringrush stem density – July 2021**	
Treatments	Rates*	Dayton	Steptoe
	lb ae/A	stems/yd^2	
nontreated check	none	122 a	29 a
glyphosate	1.13	67 b	1 b
chlorsulfuron/metsulfuron	0.02/0.004	0 d	0 c
glyphosate + chlorsulfuron/metsulfuron	1.13 + 0.02/0.004	0 d	0 c
glyphosate	2.25	30 c	0 c
glyphosate + chlorsulfuron/metsulfuron	2.25 + 0.02/0.004	0 d	0 c
glyphosate	3.38	23 c	0 c
glyphosate + chlorsulfuron/metsulfuron	3.38 + 0.02/0.004	0 d	0 c
Initial stem density - 2020		326	279

*All herbicide treatments included an organosilicone surfactant at 0.5% v/v. Rate of chlorsulfuron/metsulfuron is in lb ai/A.

**Means are based on four replicates per treatment. Means within a column for each location followed by the same letter are not significantly different (α=0.05).

Precision and broadcast sprayer applications of picloram in fall and spring for rush skeletonweed control in fallow. Mark Thorne, Marija Savic, and Drew Lyon (Dept. of Crop & Soil Sciences, Washington State Univ., Pullman, WA 99164) Precision sprayer (WEED-IT, Hoge Wesselink 8, 7221 CJ Steenderen, The Netherlands) and standard broadcast applications of picloram in fall and spring were compared for control of rush skeletonweed (*Chondrilla juncea*) in a winter wheat/no-till fallow system. Precision sprayers can be effective at spot spraying weeds in fallow, thus reducing chemical inputs compared to a complete coverage broadcast spray application. Picloram is an effective herbicide for controlling rush skeletonweed and is labeled for fallow applications at 0.25 lb ae/A. However, picloram applied at high rates in fallow can result in subsequent crop injury.

The fall- and spring-applied trials were initiated in October 2020 and May 2021, respectively, near LaCrosse, WA in winter wheat stubble (Table 1). The field site was in no-till fallow following the 2020 winter wheat. Picloram was applied at 0.125, 0.25, and 0.5 lb/A with the broadcast applicator and the precision sprayer, if set to spray in the continuous mode. The broadcast application spray volume was 15 gpa at 3 mph. The spray volume of the precision sprayer in continuous mode was 29.4 gpa at 5 mph; however, the total output per plot in spot-spray mode depended on the density of rush skeletonweed; therefore, the volume sprayed in each plot was measured to determine the area sprayed per plot to calculate the amount of picloram applied. All plots measured 10 by 35 ft, but the precision sprayer only covered a width of 6.7 ft through the center of each plot. Initial baseline density of rush skeletonweed plants were counted in a 6.7-ft strip through each plot at the time of application. Treatment efficacy was evaluated in July 2021 by counting rush skeletonweed plants in each plot prior to summer no-till fallow burn-down herbicide applications.

Table 1. Application and soil data.

Location	LaCrosse, WA	
Application date	October 15, 2020	May 19, 2021
Rush skeletonweed growth stage	post-flowering stems and rosettes	rosettes and bolting stems
Crop phase	no-till fallow	no-till fallow
Air temperature (°F)	47	56
Relative humidity (%)	50	33
Wind (mph, direction)	0-2, SW	3, SW
Cloud cover (%)	100	100
Soil temperature at 2 inches (°F)	51	60
Soil texture	Walla Walla silt loam	
Soil organic matter 0-6 inches (%)	2.1	
Soil pH	5.9	

Dry fall conditions in 2020 and cold winter and early spring temperatures in 2021 reduced emergence of rush skeletonweed rosettes compared with previous years. The number of plants available for herbicide application by the precision sprayer were few in both fall and spring trials, but especially in spring. Consequently, at any given herbicide rate, the broadcast applications outperformed the precision sprayer applications in the fall-applied trial, but not in the spring-applied trial (Table 2). In the spring-applied trial, plant density did not differ between herbicide rates applied with a precision sprayer, but rate did affect plant density in broadcast treatments. Emergence of rosettes in spring 2021 was delayed until late April and May due to cold, dry soil conditions. Furthermore, many rosettes quickly initiated bolting within a couple weeks of emergence. This is problematic for spring-applied herbicides because very little long-term control has been observed from applications once bolting begins in spring or early summer. Consequently, very few differences in application method were found with the spring applications by the summer 2021 count. Furthermore, all spring treatments had an average increase of 0.6 to 1.1 plants/yd^2 from May to July except for the 0.5/A broadcast rate, which only increased by 0.1 plants/yd^2 (data not shown). However, the spring 0.25 and 0.5 lb/A broadcast rates and the 0.5 lb/A precision sprayer rate resulted in fewer rush skeletonweed plants compared with the nontreated check by the summer 2021 count (Table 2).

The precision sprayer applications were consistently lower in amount of product applied compared with the broadcast applications (Table 3). The fall precision sprayer applications ranged between 21 and 27% of the full picloram broadcast rate per acre. The spring precision sprayer applications ranged between 5 and 12% of the full broadcast rates; however, the reduced coverage rates also reflect the low rush skeletonweed emergence at the time of application. None of the precision sprayer applications exceeded the labeled 0.25 lb/A rate. Since picloram has soil activity, more control may occur from the broadcast applications into the next crop phase. It is evident that the precision sprayer may be better suited to years with a higher percentage of potential weed emergence prior to application as only emerged plants will be treated compared to complete area coverage with a broadcast applicator. Winter wheat was seeded in October 2021 and will be harvested for yield in 2022.

Table 2. Rush skeletonweed density in no-till summer fallow following fall- and spring applications of picloram with precision sprayer and broadcast applications.

		Rush skeletonweed density measured in July 2021*	
Application method	Rate	Fall 2020 applied	Spring 2021 applied
	lb ae/A	---------------------plants/yd^2	---------------------**
nontreated check	0	2.2 a	1.3 a
precision sprayer	0.125	0.9 b	0.9 ab
broadcast	0.125	0.3 cd	0.9 ab
precision sprayer	0.25	0.3 c	0.9 ab
broadcast	0.25	0.1 de	0.6 bc
precision sprayer	0.5	0.4 c	0.6 bc
broadcast	0.5	0.0 e	0.3 c

*Fall applications were made October 2020; spring applications were made May 2021.

**Means are based on four replicates per treatment. Means within a column for each location followed by the same letter are not significantly different (α=0.05).

Table 3. Amount of picloram applied with a precision sprayer compared with a standard broadcast application.

Amount of picloram applied		
Broadcast	Precision sprayer	Percent of the broadcast rate applied by the precision sprayer
lb ae/A	lb ae/A	%
	Fall 2020 applied	
0.125	0.03	26
0.25	0.05	21
0.5	0.14	27
	Spring 2021 applied	
0.125	0.01	11
0.25	0.03	12
0.5	0.03	5

Imazamox rates for efficacy in imidazolinone-tolerant grain sorghum. Randall S. Currie and Patrick W. Geier (Kansas State University Southwest Research-Extension Center, Garden City, KS 67846) An experiment compared imazamox rates and timings for efficacy and crop response in imidazolinone-tolerant grain sorghum. All herbicides were applied using a tractor-mounted, compressed CO_2 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 35 feet and arranged in a randomized complete block design with four replications. Soil was a Beeler silt loam with 2.4% organic matter and pH of 7.5. Visual weed control estimates were determined on July 14 and August 23, 2021. These dates were 2 and 42 days after the late postemergence treatments (DA-B), respectively. Yields were determined on November 23, 2021 by mechanically harvesting the center two rows of each plot and adjusting grain weights to 14.0% moisture.

Table 1. Application, environmental, and weed data for the imazamox sorghum trial in Kansas.

Application timing	Preemergence	Postemergence
Application date	June 16, 2021	July 12, 2021
Air temperature (F)	87	78
Relative humidity	43	42
Soil temperature (F)	77	72
Wind speed (mph)	4 to 11	3 to 7
Wind direction	South	South
Soil moisture	Good	Good
Grain sorghum		
Height (inches)	---	12 to 15
Leaves (no.)	0	5 to 7
Palmer amaranth		
Height (inches)	---	2 to 6
Density (plants/ft^2)	0	1
Volunteer corn		
Height (inches)	---	10 to 15
Density (plants/ft^2)	0	0.3
Johnsongrass		
Height (inches)	---	3 to 7
Density (plants/ft^2)	0	0.5

Imazamox at 0.07 lb/A applied preemergence (PRE) controlled volunteer corn 63 to 88% regardless of tank mix partner early in the season (Table 2). By 42 DA-B, volunteer corn control exceeded 90% with imazamox PRE alone, or with metolachlor and mesotrione PRE, followed by atrazine postemergence (POST), and with metolachlor plus mesotrione or saflufenacil PRE followed by imazamox at 0.047 lb/A POST. Late-season johnsongrass control was best (95 to 99%) when imazamox was applied POST. However, tank mixing bromoxynil/pyrasulfotole with imazamox POST provided only 85% johnsongrass control. Imazamox applied POST controlled Palmer amaranth 86 to 96% at 42 DA-B, and was similar to imazamox plus mesotrione PRE followed by atrazine POST. Grain yields from herbicide-treated sorghum were 29 to 66 bu/A greater than the untreated controls. Yields were best when metolachlor plus mesotrione PRE was followed by imazamox POST or metolachlor plus saflufenacil PRE was followed by imazamox plus atrazine POST.

Imazamox is not labeled for johnsongrass or shattercane control in imidazolinone-resistant sorghum due to stewardship reasons. ImiFlex (imazamox brand sold by UPL) is the only imidazolinone herbicide registered for use in imidazolinone-resistant sorghum (Igrowth sorghum).

Table 2. Weed control at Garden City in the imazamox sorghum study.

			Volunteer corn		Johnsongrass		Palmer amaranth		Sorghum
Treatment[1]	Rate	Timing[2]	2 DA-B[3]	42 DA-B	2 DA-B	42 DA-B	2 DA-B	42 DA-B	yield
	lb/A		——— % Visual ———		——— % Visual ———		——— % Visual ———		bu/A
Untreated	---	---	---	---	---	---	---	---	29.9
Imazamox	0.07	PRE	70	88	73	73	75	78	83.3
Atrazine	1.0	PRE							
2,4-D amine	0.24	POST							
Imazamox	0.07	PRE	75	83	90	83	94	91	90.4
Mesotrione	0.19	PRE							
Atrazine	1.0	POST							
COC	1%	POST							
Imazamox	0.07	PRE	83	85	75	75	80	73	74.2
Saflufenacil	0.022	PRE							
Atrazine	1.0	POST							
COC	1%	POST							
Imazamox	0.07	PRE	78	88	84	73	85	81	77.6
Metolachlor	1.25	PRE							
Atrazine	1.0	POST							
COC	1%	POST							
Imazamox	0.07	PRE	63	98	80	83	78	65	59.3
Atrazine	1.0	POST							
COC	1%	POST							
UAN	2.5%	POST							
Imazamox	0.07	PRE	88	91	90	83	94	85	93.3
Metolachlor	1.25	PRE							
Mesotrione	0.19	PRE							
Atrazine	1.0	POST							
COC	1%	POST							
Metolachlor	1.25	PRE	0	99	88	99	95	91	95.8
Mesotrione	0.19	PRE							
Imazamox	0.047	POST							
COC	1%	POST							

UAN	2.5%	POST							
Metolachlor	1.25	PRE	0	99	80	95	81	86	95.1
Saflufenacil	0.022	PRE							
Imazamox	0.047	POST							
Atrazine	1.0	POST							
COC	1%	POST							
UAN	2.5%	POST							
Metolachlor	1.25	PRE	0	100	78	98	91	96	93.7
Mesotrione	0.19	PRE							
Imazamox	0.047	POST							
Atrazine	1.0	POST							
COC	1%	POST							
UAN	2.5%	POST							
Metolachlor	1.25	PRE	0	0	70	0	83	75	60.9
Atrazine	1.0	PRE							
Bromoxynil/ Pyrasulfotole	0.225	POST							
AMS	1.0	POST							
Metolachlor	1.25	PRE	0	86	70	85	85	93	82.5
Atrazine	1.0	PRE							
Imazamox	0.047	POST							
Bromoxynil/ Pyrasulfotole	0.225	POST							
LSD (0.05)			8	10	15	12	12	10	20.7

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[1] COC is crop oil concentrate, UAN is 28% urea-ammonium nitrate, AMS is ammonium sulfate.

[2] PRE is preemergence, POST is postemergence.

[3] DA-B is days after the postemergence treatments.

<u>Quizalofop for efficacy in ACCase-tolerant grain sorghum.</u> Randall S. Currie[1] and Patrick W. Geier (Kansas State University Southwest Research-Extension Center, Garden City, KS 67846) An experiment was conducted to compare quizalofop with various tank mix partners for weed control in acetyl CoA carboxylase (ACCase)-tolerant grain sorghum. All herbicides were applied using a tractor-mounted, compressed CO_2 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 35 feet and arranged in a randomized complete block design with four replications. Soil was a Beeler silt loam with 2.4% organic matter and pH of 7.5. Visual weed control estimates were determined on July 27 and August 24, 2021. These dates were 14 and 42 days after the postemergence treatments (DA-B), respectively. Sorghum injury response was visually estimated on July 27, August 10, and August 24, 2021 (14, 28, and 42 DA-B). Yields were determined on November 23, 2021 by mechanically harvesting the center two rows of each plot and adjusting grain weights to 14.0% moisture.

Table 1. Application, environmental, and weed data for the ACCase-tolerant sorghum trial in Kansas.

Application timing	Preemergence	Postemergence
Application date	June 17, 2021	July 13, 2021
Air temperature (F)	73	75
Relative humidity	47	61
Soil temperature (F)	76	73
Wind speed (mph)	2 to 5	1 to 4
Wind direction	South	South
Soil moisture	Good	Good
Grain sorghum		
Height (inches)	---	12 to 18
Leaves (no.)	0	8 to 9
Palmer amaranth		
Height (inches)	---	6 to 10
Density (plants/ft^2)	0	0.3
Johnsongrass		
Height (inches)	---	6 to 15
Density (plants/ft^2)	0	0.5

Quizalofop applied at 0.065 lb/A applied postemergence controlled johnsongrass 94% or more regardless of tank mix partner or rating date (Table 2). Conversely, Palmer amaranth control was generally lower with quizalofop tank mix compared to bromoxynil/pyrasulfotole plus atrazine, bromoxynil/fluroxypyr, or atrazine alone postemergence. Minor sorghum necrosis and sprawling occurred with quizalofop plus 2,4-D amine or dicamba, and with 2,4-D ester/bromoxynil/fluroxypyr at 14 DA-B (Table 3). Visual sorghum injury declined to 5% or less by 42 DA-B. Grain yields increased 34 to 64 bu/A with all postemergence treatments except atrazine alone. The highest yields occurred when quizalofop alone or quizalofop plus dicamba were applied postemergence.

Table 2. Weed control in the quizalofop sorghum study.

			Johnsongrass		Palmer amaranth	
Treatment[1]	Rate	Timing[2]	14 DA-B[3]	42 DA-B	14 DA-B	42 DA-B
	lb/a		% Visual		% Visual	
Atrazine/ Metolachlor	1.38	PRE	99	100	0	0
Quizalofop	0.065	POST				
COC	1%	POST				
Atrazine/ Metolachlor	1.38	PRE	99	98	68	73
Quizalofop	0.065	POST				
Bromoxynil/ Pyrasulfotole	0.26	POST				
COC	1%	POST				
Atrazine/ Metolachlor	1.38	PRE	98	94	68	74
Quizalofop	0.065	POST				
2,4-D amine	0.475	POST				
COC	1%	POST				
Atrazine/ Metolachlor	1.38	PRE	99	100	60	87
Quizalofop	0.065	POST				
Dicamba	0.238	POST				
COC	1%	POST				
Atrazine/ Metolachlor	1.38	PRE	99	98	75	78
Quizalofop	0.065	POST				
Bromoxynil	0.25	POST				
COC	1%	POST				
Atrazine/ Metolachlor	1.38	PRE	0	0	85	95
Bromoxynil/ Pyrasulfotole	0.26	POST				
Atrazine	0.5	POST				
NIS	0.25%	POST				
Atrazine/ Metolachlor	1.38	PRE	0	0	95	93
2,4-D ester/ Bromoxynil/ Fluroxypyr	0.75	POST				
Atrazine/ Metolachlor	1.38	PRE	0	0	71	72
Atrazine	0.5	POST				
COC	1%	POST				
Metolachlor/ Mesotrione	1.84	PRE	0	29	98	100

Atrazine	0.5	POST				
COC	1%	POST				
LSD (0.05)			4	10	17	13

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[1] COC is crop oil concentrate, NIS is nonionic surfactant.

[2] PRE is preemergence, POST is postemergence.

[3] DA-B is days after the postemergence treatments.

Table 3. Crop response to quizalofop in the ACCase-tolerant sorghum study.

			Necrosis		Sprawl		Sorghum
Treatment[1]	Rate	Timing[2]	14 DA-B[3]	28 DA-B	14 DA-B	28 DA-B	yield
	lb/a		——— % Visual ———		——— % Visual ———		bu/A
Atrazine/Metolachlor	1.38	PRE	0	0	0	0	44.9
Atrazine/Metolachlor	1.38	PRE	0	0	0	0	107.9
Quizalofop	0.065	POST					
COC	1%	POST					
Atrazine/Metolachlor	1.38	PRE	0	1	3	0	93.0
Quizalofop	0.065	POST					
Bromoxynil/Pyrasulfotole	0.26	POST					
COC	1%	POST					
Atrazine/Metolachlor	1.38	PRE	13	0	11	0	94.5
Quizalofop	0.065	POST					
2,4-D amine	0.475	POST					
COC	1%	POST					
Atrazine/Metolachlor	1.38	PRE	6	0	6	0	109.0
Quizalofop	0.065	POST					
Dicamba	0.238	POST					
COC	1%	POST					
Atrazine/Metolachlor	1.38	PRE	0	0	0	0	91.6
Quizalofop	0.065	POST					
Bromoxynil	0.25	POST					
COC	1%	POST					
Atrazine/Metolachlor	1.38	PRE	0	3	0	0	93.7
Bromoxynil/Pyrasulfotole	0.26	POST					
Atrazine	0.5	POST					
NIS	0.25%	POST					
Atrazine/Metolachlor	1.38	PRE	15	1	10	5	78.6
2,4-D ester/Bromoxynil/Fluroxypyr	0.75	POST					
Atrazine/Metolachlor	1.38	PRE	0	0	0	0	65.4
Atrazine	0.5	POST					
COC	1%	POST					

Metolachlor/ Mesotrione	1.84	PRE	0	0	0	0	91.2
Atrazine	0.5	POST					
COC	1%	POST					
LSD (0.05)			2	3	5	2	25.1

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[1] COC is crop oil concentrate, NIS is nonionic surfactant.

[2] PRE is preemergence, POST is postemergence.

[3] DA-B is days after the postemergence treatments.

Wild oat and common lambsquarters control in spring wheat. Traci A. Rauch and Joan M. Campbell. (Dept of Plant Sciences, University of Idaho, Moscow, ID 83844-2333) A study was established in spring wheat to evaluate crop response, wild oat and common lambsquarters control with thiencarbazone/fluroxypyr alone or in combinations with broadleaf herbicides near Moscow, ID. The study was arranged in a randomized complete block design with four replications and included an untreated check. All herbicide treatments were applied using a CO_2 pressurized backpack sprayer calibrated to deliver 10 gpa at 32 psi and 3 mph (Table 1). Wheat response and weed control were evaluated visually during the growing season.

Table 1. Application and soil data.

Winter wheat variety - planting date	Ryan - 4/22/21
Application date	5/26/21
Growth stage	
Spring wheat	2 tiller
Wild oat (AVEFA)	1 tiller
Common lambsquarters (CHEAL)	4 leaf
Air temperature (F)	66
Relative humidity (%)	53
Wind (mph), direction	1, W
Cloud cover (%)	20
Soil moisture	dry
Soil temperature at 2 inch (F)	65
pH	4.5
OM (%)	4.1
CEC (meq/100g)	18.2
Texture	silt loam

No treatment injured spring wheat (data not shown). At 36 and 48 DAT, common lambsquarters control was 81% or greater with all treatments, except thiencarbazone alone or plus bromoxynil/pyrasulfotole/fluroxypyr and thiencarbazone/fluroxypyr alone or combined with halauxifen/florasulam (Table 2). At 36 DAT, wild oat control ranged from 59 to 90% and did not differ among treatments. At 48 DAT, wild oat control was best with thiencarbazone/fluroxypyr plus bromoxynil/MCPA (94%) but did not differ from fluroxypyr/pyroxsulam plus 2,4-D, thiencarbazone plus bromoxynil/pyrasulfotole/fluroxypyr, thiencarbazone/fluroxypyr alone or plus 2,4-D or thifensulfuron/tribenuron plus MCPA ester (88 to 92%).

Table 2. Wild oat and common lambsquarters control in spring wheat with thiencarbazone/fluroxypyr combinations near Moscow, ID in 2021.

		CHEAL control[3]		AVEFA control[3]	
Treatment[1]	Rate[2]	36 DAT	48 DAT	36 DAT	48 DAT
	lb ai/A	%	%	%	%
Thiencarbazone	0.0044	33	44	68	80
Thiencarbazone/fluroxypyr	0.155	43	62	88	88
Thiencarbazone +	0.0044				
bromoxynil/pyrasulfotole/fluroxypyr	0.279	66	71	81	92
Thiencarbazone/fluroxypyr +	0.155				
bromoxynil/pyrasulfotole	0.206	88	89	71	93
Thiencarbazone/fluroxypyr +	0.155				
bromoxynil/MCPA	0.5	89	89	85	94
Thiencarbazone/fluroxypyr +	0.155				
2,4-D ester	0.25	86	88	90	92
Thiencarbazone/fluroxypyr +	0.155				
halauxifen/florasulam	0.0096	58	70	70	85
Thiencarbazone/fluroxypyr +	0.155				
thifensulfuron/ tribenuron +	0.0094				
MCPA ester	0.25	81	84	85	92
Clopyralid/fluroxypyr/pyroxsulam +	0.201				
2,4-D ester	0.25	97	96	71	74
Pyroxsulam/florasulam +	0.132				
2,4-D ester	0.25	92	92	84	92
Flucarbazone +	0.0137				
bromoxynil/pyrasulfotole/fluroxypyr	0.279	91	92	59	71
LSD (0.05)		19	13	NS	10
Density (plants/ft^2)		7		12	

[1] A non-ionic surfactant (R-11) was applied at 0.25% v/v with halauxifen/florasulam and fluroxypyr/pyroxsulam and ammonium sulfate (Bronc) was applied at 1.5 lb ai/A with clopyralid/fluroxypyr/pyroxsulam.

[2] Rate for bromoxynil/MCPA and MCPA ester based on lb ae/A.

[3] CHEAL = common lambsquarters and AVEFA = wild oat.

<u>Downy brome control in winter wheat with mesosulfuron/thiencarbazone combinations</u>. Traci A. Rauch and Joan M. Campbell. (Dept of Plant Sciences, University of Idaho, Moscow, ID 83844-2333) A study was established in winter wheat to evaluate downy brome control with mesosulfuron/thiencarbazone 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 calibrated to deliver 10 gpa at 32 psi and 3 mph (Table 1). Downy brome control was evaluated visually during the growing season. The study was harvested at crop maturity with a small plot combine on July 26, 2021.

Table 1. Application and soil data.

Variety and seeding date	Castle CL+ – 10/9/2020
Application date	4/18/20
Growth stage winter wheat	2 tiller
Growth stage downy brome	1 tiller
Air temperature (F)	55
Relative humidity (%)	45
Wind (mph, direction)	3, ENE
Cloud cover (%)	0
Soil moisture	dry
Next rain occurred	5/20/21
Soil temperature at 2 inch (F)	44
pH	5.1
OM (%)	2.9
CEC (meq/100g)	15.3
Texture	silt loam

All treatments injured winter wheat 5% on April 26, 2021 (Table 2). No crop injury was visible by May 3 (data not shown). Downy brome control was best with mesosulfuron/thiencarbazone plus pyrasulfotole/bromoxynil and bromoxynil/MCPA (80%) but did not differ from mesosulfuron/thiencarbazone combined with florasulam/fluroxypyr or clopyralid/fluroxypyr (76 and 71%). Grain yield tended to be lowest for the untreated check but did not differ from any treatments. Grain test weight did not differ among treatments including the untreated check.

Table 2. Winter wheat response and downy brome control with mesosulfuron/thiencarbazone combinations near Moscow, ID in 2021.

Treatment[1]	Rate	Downy brome control[2]	Winter wheat Injury[3]	Winter wheat Yield	Winter wheat Test weight
	lb ai/A	%	%	lb/A	lb/bu
Mesosulfuron/thiencarbazone	0.0178	58	5	3290	60.3
Mesosulfuron/thiencarbazone + pyrasulfotole/bromoxynil	0.0178 0.217	59	5	3279	60.2
Mesosulfuron/thiencarbazone + pyrasulfotole/bromoxynil + bromoxynil/MCPA	0.0178 0.217 0.5	80	5	3620	60.5
Mesosulfuron/thiencarbazone + pyrasulfotole/bromoxynil + florasulam/fluroxypyr	0.0178 0.217 0.092	76	5	3431	60.6
Mesosulfuron/thiencarbazone + pyrasulfotole/bromoxynil + clopyralid/fluroxypyr	0.0178 0.217 0.188	71	5	3411	60.9
Untreated check	--	--	--	3099	60.9
LSD (0.05)		14	0	NS	NS
Density (plants/ft^2)		25			

[1] All treatments, except mesosulfuron/thiencarbazone alone, were applied with a non-ionic surfactant (NIS) at 0.25% v/v and urea ammonium nitrate (UAN) at 5% v/v. Mesosulfuron/thiencarbazone alone was applied with 0.5% NIS and 5% UAN.

[2] Evaluation date May 26, 2021.

[3] Evaluation date April 26, 2021.

Italian ryegrass control with pyroxasulfone combinations in winter wheat. Traci A. Rauch and Joan M. Campbell. (Dept of Plant Sciences, University of Idaho, Moscow, ID 83844-2333) A study was established near Potlatch, ID to evaluate winter wheat response and Italian ryegrass (LOLMU) control with pyroxasulfone combinations in winter wheat. The plots were arranged in a randomized complete block design with four replications and included an untreated check. All herbicide treatments were applied using a CO_2 pressurized backpack sprayer calibrated to deliver 10 gpa at 32 psi and 3 mph (Table 1).

The study area was oversprayed with glyphosate at 1.13 lb ae/A on September 30, 2020 for preplant burndown application. On May 10, 2021, the study was oversprayed with pyrasulfotole/bromoxynil at 0.9 lb ai/A, fluroxypyr/florasulam at 0.09 lb ai/A and thifensulfuron/tribenuron at 0.031 lb ai/A for broadleaf weed control and propiconazole at 0.028 lb ai/A for stripe rust control. Wheat injury and Italian ryegrass control were evaluated visually during the growing season.

Table 1. Application and soil data.

Wheat variety – seeding date	PNW Trooper II (Jasper/WB 1783 blend) – 10/9/20	
Application date	10/14/20	4/29/21
Application timing	postplant pre	post
Wheat	germinating	3 tiller
Italian ryegrass	pre	1 to 2 leaf
Air temperature (F)	54	78
Relative humidity (%)	52	26
Wind (mph, direction)	3, W	3, W
Cloud cover (%)	30	70
Soil moisture	adequate	dry
Next rain occurred	10/18/20	5/20/21
Soil temperature at 2 inch (F)	55	60
pH	4.5	
OM (%)	4.6	
CEC (meq/100g)	17.1	
Texture	silt loam	

No winter wheat injury was visible at any evaluation date (data not shown). Italian ryegrass density was light and could only be evaluated in two replications (Table 2). Most treatments controlled Italian ryegrass 90% or better except flufenacet/metribuzin applied postplant preemergence followed by pyroxasulfone postemergence and pyroxasulfone at 0.11 lb ai/A postplant combined with metribuzin at 0.09 lb ai/A (87 and 75%). Grain yield and test weight did not differ among treatments including the untreated check and ranged from 3734 to 3972 lb/A and 53.4 to 55.9 lb/bu, respectively. Grain yield tended to be highest in the untreated check.

Table 2. Italian ryegrass control with pyroxasulfone combinations near Moscow, ID in 2021.

Treatment	Rate	Application timing[1]	Italian ryegrass control[2]	Winter wheat Yield	Winter wheat Test weight
	lb ai/A		%	lb/A	lb/bu
Pyroxasulfone	0.11	postplant pre	90	4171	55.7
Pyroxasulfone	0.13	postplant pre	99	3815	54.8
Pyroxasulfone + pyroxasulfone	0.07 0.06	postplant pre 3 tiller	95	4108	55.9
Pyroxasulfone + pyroxasulfone	0.10 0.03	postplant pre 3 tiller	99	3748	53.8
Pyroxasulfone + pyroxasulfone pendimethalin	0.10 0.03 1.43	postplant pre 3 tiller 3 tiller	97	4086	54.8
Flufenacet/metribuzin + pyroxasulfone	0.34 0.11	postplant pre 3 tiller	87	3734	53.4
Pyroxasulfone + flufenacet/metribuzin	0.11 0.34	postplant pre 3 tiller	99	4026	55.7
Pyroxasulfone + metribuzin	0.11 0.07	postplant pre postplant pre	99	4074	54.8
Pyroxasulfone + metribuzin	0.11 0.09	postplant pre postplant pre	75	3972	54.0
Untreated check	--	--	--	4263	55.7
LSD (0.05)			--	NS	NS
Density (plants/ft^2)			0.5	--	--

[1] Based on wheat growth stage. Postplant pre is after planting wheat but before emergence.

[2] Average of two replications evaluated on July 7, 2021

AUTHOR INDEX

KEYWORD INDEX