2017 RESEARCH PROGRESS REPORT

ISSN-0090-8142

Coeur d’Alene Resort

COEUR D’ALENE, IDAHO

March 13-16, 2017

FOREWORD

The 2017 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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Project 6: BASIC SCIENCES

Reed canarygrass control in wetlands. Rodney G. Lym. (Department of Plant Sciences, North Dakota State University, Fargo, ND 58108-6050). Reed canarygrass (*Phalaris arundinacea* L.) is considered a major invasive weed threat to wetlands as the plant out competes most native species. Reed canarygrass is a perennial that can grow up to 6 ft tall, has 0.25 to 0.4 inch wide leaves, and spreads by rhizomes. The plant was introduced into the US as a forage crop in the 1800s and is still planted because of high biomass production and greater tolerance to cold temperatures than many other cool-season grass species. Glyphosate has provided short-term top-growth reed canarygrass control, but the plant rapidly reestablishes from rhizomes a few months after treatment. The purpose of this study was to evaluate a variety of herbicides for efficacy on reed canarygrass to increase long-term control of the plant.

Two studies were established on the Albert Ekre Grassland Preserve near Walcott, ND on June 2 or September 25, 2015. All treatments were applied using a hand-held boom sprayer delivering 17 gpa at 35 psi. Experimental plots were 10 by 30 feet and with two replications in a randomized complete block design. In June, 18 herbicides were applied to reed canarygrass which was 6 to 16 inches tall. Plants were mowed in August to facilitate the fall study. Herbicides that showed the highest efficacy from the spring study were applied to reed canarygrass that had regrown to 2 to 3 inches tall. Reed canarygrass control was evaluated visually using percent stand reduction compared to the untreated control.

Clethodim and glyphosate were the only herbicides to provide greater than 90% reed canarygrass control 1 month after treatment (MAT) in June (Table 1). Reed canarygrass control averaged 94% 2 MAT with clethodim, but only 70% with glyphosate. Control gradually increased over time with imazapic, metsulfuron, sulfometuron, and tebuthiuron and averaged 97, 73, 74, and 68% 2 MAT, respectively. Only 3 herbicides provided satsifactory control the following spring; imazapic, sulfometuron, and tebuthiuron provided 85, 94, and 73% control 11 MAT. No treatment provided satisfactory control by September 2016, 15 MAT. Based on the 2 MAT evaluation data, glyphosate, imazapic, sulfometuron, and metsulfuron were chosen to be further evaluated in the fall study.

All fall-applied herbicides except metsulfuron provided 88% or greater reed canarygrass when evaluated in May 2016, 8 MAT (Table 2). However, control declined rapidly during the growing season. Reed canarygrass control 11 MAT with sulfometuron applied at 6 oz/A averaged 90% and 75% with glyphosate at 24 oz/A. Metsulfuron and imazapic did not provide satisfactory reed canarygrass control 11 MAT.

Imazapic, sulfometuron, and tebuthiuron provided season long reed canarygrass control when applied in June. Clethodim and glyphosate provide rapid, but short-term control. Sulfometuron also provided long-term reed canarygrass control as a fall applied treatment. Clethodim was the only herbicide evaluated that provided at least temporary reed canarygrass control and could be used if desirable forbs are present or to be seeded. Sulfometuron is a wide-spectrum herbicide that would inhibit establishment of native species but could be used if bare ground could be tolerated for a few months. Glyphosate provided better long-term reed canarygrass control when applied in the fall compared to spring.

Table 1. Evaluation of various herbicides for reed canarygrass control with treatments applied on June 2, 2015 at the Ekre ranch near Walcott, ND.

		Evaluation/months after treatment			
		2015		2016	
Treatment	Rate	1	2	11	15
	—— oz/A ——	—— % control ——			
Aminocyclopyrachlor + chlorsulfuron + NIS[a]	2.4 + 0.95 0.25%	28	33	10	0
Atrazine + MSO[b]	24 + 1 qt	45	25	0	0
Chlorsulfuron + MSO	1.5 + 1 qt	6	14	0	0
Clethodim + MSO	16 + 1 qt	93	94	38	0
Fenoxaprop	1.75 + 1.5 pt	10	3	0	0
Flucarbazone + MSO	0.88 + 1 qt	53	12	0	0
Glyphosate + AMS	24 + 24	97	70	0	0
Imazamox + MSO	0.75 + 1 qt	39	19	6	0
Imazapic + MSO	2 + 1 qt	38	97	85	13
Imazaquin + MSO	2.1 + 1 qt	3	0	0	0
Metsulfuron + MSO	0.9 + 1 qt	47	73	15	0
Nicosulfuron + MSO	0.75 + 1.5 pt	23	31	8	0
Primsulfuron + NIS	0.57 + 0.25%	18	4	0	0
Quinclorac + MSO	16 + 1 qt	13	38	0	0
Quizalofop + MSO	1.32 + 1 qt	20	19	0	0
Sethoxydim + MSO	7.5 + 1 qt	28	10	0	0
Sulfometuron + MSO	2.5 + 1.5 pt	58	74	94	30
Tebuthiuron + NIS	19 + 0.25%	50	68	73	10
LSD (0.05)		37	39	27	12

[a]Activator 90 by Loveland Products, 3005 Rocky Mountain Ave., Loveland, CO 80538.
[b]WCS Crop Oil by West Central Inc., 2700 Trott Avenue SW, PO Box 897, Willmar, MN 56201.

Table 2. Evaluation of various herbicides for reed canarygrass control applied on September 25, 2015 at the Ekre ranch near Walcott, ND.

Treatment	Rate	Evaluation/months after treatment 8	12
	——— oz/A ———	——— % control ———	
Glyphosate + MSO[a]	4 + 1 qt	88	0
Glyphosate + MSO	8 + 1 qt	96	5
Glyphosate + MSO	16 + 1 qt	99	0
Glyphosate + MSO	24 + 1 qt	99	75
Imazapic + MSO	2 + 1 qt	95	13
Imazapic + MSO	3 + 1 qt	99	45
Metsulfuron + MSO	2 + 1 qt	69	13
Sulfometuron + MSO	6 + 1 qt	100	90
LSD (0.05)		18	38

[a]WCS Crop Oil by West Central Inc., 2700 Trott Avenue SW, PO Box 897, Willmar, MN 56201.

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

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

In general, quinclorac tended to provide slightly better leafy spurge control at the Walcott location than at the SNG and also as a spring compared to fall applied treatment (Tables 1 and 2). For instance, leafy spurge control in the fall of 2014 [3 months after treatment (MAT)] averaged across all quinclorac application rates was 88 and 97% at the SNG and Walcott locations, respectively. Quinclorac applied in September 2014 provided excellent leafy spurge control at both locations when evaluated in June 2015 (96% average) but control dropped rapidly thereafter. Leafy spurge control at the SNG averaged over all quinclorac application rates was 82% and 62% when applied in June or September 12 MAT. The decrease in control was even more dramatic at the Walcott location as leafy spurge control averaged 95% and 71% when spring and fall applied 12 MAT. Control continued to decline in 2016 and treatments applied in June 2014 averaged 78 and 59% at the Walcott and SNG locations, respectively.

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

The increased leafy spurge control at Walcott compared to the SNG may be due to the presence of the biological control agent *Aphthona* spp. flea beetles which were present but in very low numbers with no visible reduction in non herbicide treated areas. Research conducted at North Dakota State University has shown that herbicides applied on leafy spurge with *Aphthona* spp. present provided better long-term control than either method used alone.

In summary, quinclorac applied in June tended to provide slightly better long-term control than September applications at the Walcott but not SNG location. Thus, the optimum timing for quinclorac use to control leafy spurge could not be determined and is likely not critical. However, regardless of application timing, quinclorac applied at 9 oz/A was the most cost-effective application rate.

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

		Evaluation date					
		2014		2015		2016	
Treatment	Rate	25 Aug	8 Sept	5 June	26 Aug	26 May	13 Sept
	—— oz/A ——	% control					
June application							
Quinclorac[a] + MSO[b]	6 + 1 qt	81	78	86	68	51	46
Quinclorac + MSO	9 + 1 qt	89	86	81	55	40	36
Quinclorac + MSO	12 + 1 qt	95	84	79	87	85	77
2,4-D	16	40	35	30	10	18	13
September application							
Quinclorac + MSO	6 + 1 qt			87	49	31	29
Quinclorac + MSO	9 + 1 qt			98	68	61	58
Quinclorac + MSO	12 + 1 qt			98	71	63	56
2,4-D	16			24	8	8	14
LSD (0.05)		36	11	12	27	37	38

[a]Commercial formulation - Facet L by BASF Corporation, 26 Davis Drive, Research Triangle Park, NC 27709.

[b]Upland MSO by West Central Inc., 2700 Trott Ave. SW, P.O. Box 897, Willmar, MN 56201.

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

		Evaluation date				
		2014	2015		2016	
Treatment	Rate	4 Sept	4 June	26 Aug	24 May	8 Sept
	— oz/A —	% control				
June application						
Quinclorac[a] + MSO[b]	6 + 1 qt	96	92	78	59	46
Quinclorac + MSO	9 + 1 qt	96	94	91	87	71
Quinclorac + MSO	12 + 1 qt	99	95	93	89	76
Aminocyclopyrachlor + chlorsulfuron[c]	1.4 + 0.6	97	97	98	91	75
September application						
Quinclorac + MSO	6 + 1 qt		97	56	39	31
Quinclorac + MSO	9 + 1 qt		99	68	43	21
Quinclorac + MSO	12 + 1 qt		99	89	55	25
Aminocyclopyrachlor + chlorsulfuron	1.4 + 0.6		99	93	77	33
LSD (0.05)		NS	4	22	24	33

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

Leafy spurge control with quinclorac applied alone or with aminopyralid. Rodney G. Lym. (Department of Plant Sciences, North Dakota State University, Fargo, ND 58108-6050). Previous research at North Dakota State University has found that both quinclorac and aminopyralid applied with 2,4-D will control leafy spurge. Quinclorac and aminopyralid can be used in areas with shallow groundwater or near trees and other desirable vegetation unlike commonly used leafy spurge control herbicides such as picloram, aminocyclopyrachlor, and dicamba. The purpose of this research was to evaluate mixtures of quinclorac with aminopyralid for control of leafy spurge as either a spring or fall applied treatment.

The quinclorac plus aminopyralid study was established at two sites. The first site was on abandoned farmland near Fargo, ND, while the second was on the Sheyenne National Grassland (SNG) near Anslem, ND. Treatments were applied on June 10 or 12, 2015 at Fargo or the SNG, respectively, to leafy spurge in the flowering growth stage or on September 25, 2015 at both locations to leafy spurge in the fall regrowth stage with 1 to 3 inch new stem growth. All treatments were applied using a hand-held boom sprayer delivering 17 gpa at 35 psi. Experimental plots were 10 by 25 feet and replicated four times in a randomized complete block design. Leafy spurge control was evaluated visually using percent stand reduction compared to the untreated control.

Long-term leafy spurge control was better at the SNG than Fargo, so the results will be discussed by location. Leafy spurge control from treatments applied in June averaged only 67% or less 3 months after treatment (MAT) at Fargo (Table 1). Control with quinclorac at 6 oz/A applied alone was similar to when applied with aminopyralid or aminopyralid plus 2,4-D and averaged 44%. The same treatments applied in September provided an average of 98% leafy spurge control 9 MAT but control declined rapidly to an average of 50% 12 MAT. Leafy spurge control was similar when aminopyralid was applied alone or with 2,4-D regardless of application date.

Leafy spurge control with quinclorac applied at 6 oz/A plus aminopyralid or aminopyralid plus 2,4-D averaged 76% control compared to only 46% control with quinclorac applied alone 3 MAT at the SNG (Table 2). Control was also improved when quinclorac was applied with aminopyralid or aminopyralid plus 2,4-D in the fall and averaged 89% compared to 71%, respectively, 9 MAT. However, control was similar when quinclorac was applied alone or with aminopyralid by 15 and 12 MAT, for the spring and fall applied treatments, respectively. No treatment provided satisfactory control 12 MAT. Leafy spurge control with aminopyralid generally was improved when 2,4-D was included compared to aminopyralid applied alone.

In summary, leafy spurge control with quinclorac generally was not improved with the addition of aminopyralid or aminopyralid plus 2,4-D and the combination treatment would not be cost-effective. Aminopyralid plus 2,4-D provided better leafy spurge control than aminopyralid applied alone at the SNG but not the Fargo location.

Table 1. Leafy spurge control with quinclorac applied alone or with aminopyralid and 2,4-D in June or September near Fargo, ND.

Treatment	Rate	Evaluation (MAT S/F)		
		3	12/9	15/12
	——— oz/A ———	———	% control	———
Spring application (June 10, 2015)				
Quinclorac[a] + MSO[b]	6 + 1 qt	46	33	13
Quinclorac + aminopyralid + 2,4-D[c] + MSO	6 + 1.72 + 14 + 1 qt	43	27	8
Quinclorac + aminopyralid[d] + MSO	6 + 1.75 + 1 qt	46	31	14
Quinclorac + MSO	12 + 1 qt	67	52	35
Aminopyralid + 2,4-D + MSO	1.72 + 14 + 1 qt	30	14	3
Aminopyralid + HSMOC[e]	1.75 + 1 qt	8	15	9
Fall application (Sept. 25, 2015)				
Quinclorac + MSO	6 + 1 qt		96	46
Quinclorac + aminopyralid + 2,4-D + MSO	6 + 1.72 + 14 + 1 qt		98	44
Quinclorac + aminopyralid + MSO	6 + 1.75 + 1 qt		97	61
Quinclorac + MSO	12 + 1 qt		95	63
Aminopyralid + 2,4-D + MSO	1.72 + 14 + 1 qt		77	28
Aminopyralid + HSMOC	1.75 + 1 qt		88	33
LSD (0.05)		33	23	28

[a]Commercial formulation - Facet L by BASF Corporation, 26 Davis Drive, Research Triangle Park, NC 27709.
[b]Upland MSO by West Central Inc., 2700 Trott Ave SW, P.O. Box 897, Willmar, MN 56201.
[c]Commercial formulations - Forefront HL and [d]Milestone by Dow AgroSciences LLC, 9330 Zionsville Road, Indianapolis, IN 46268-1189.
[e]Destiny HC by Winfield Solutions, LLC, P.O. Box 64589, St. Paul, MN 55164-0089.

Table 2. Leafy spurge control with quinclorac applied alone or with aminopyralid and 2,4-D in June or September on the Sheyenne National Grassland near Anselm, ND.

		Evaluation (MAT S/F)		
Treatment	Rate	3	12/9	15/12
	——— oz/A ———	———	% control	———
Spring application (June 12, 2015)				
Quinclorac[a] + MSO[b]	6 + 1 qt	46	54	41
Quinclorac + aminopyralid + 2,4-D[c] + MSO	6 + 1.72 + 14 + 1 qt	79	69	70
Quinclorac + aminopyralid[d] + MSO	6 + 1.75 + 1 qt	74	74	69
Quinclorac + MSO	12 + 1 qt	86	93	79
Aminopyralid + 2,4-D + MSO	1.72 + 14 + 1 qt	55	68	60
Aminopyralid + HSMOC[e]	1.75 + 1 qt	19	31	24
Fall application (Sept. 25, 2015)				
Quinclorac + MSO	6 + 1 qt		71	58
Quinclorac + aminopyralid + 2,4-D + MSO	6 + 1.72 + 14 + 1 qt		86	43
Quinclorac + aminopyralid + MSO	6 + 1.75 + 1 qt		92	50
Quinclorac + MSO	12 + 1 qt		97	72
Aminopyralid + 2,4-D + MSO	1.72 + 14 + 1 qt		71	29
Aminopyralid + HSMOC	1.75 + 1 qt		29	26
LSD (0.05)		22	23	35

[a]Commercial formulation - Facet L by BASF Corporation, 26 Davis Drive, Research Triangle Park, NC 27709.
[b]Upland MSO by West Central Inc., 2700 Trott Ave SW, P.O. Box 897, Willmar, MN 56201.
[c]Commercial formulations - Forefront HL and [d]Milestone by Dow AgroSciences LLC, 9330 Zionsville Road, Indianapolis, IN 46268-1189.
[e]Destiny HC by Winfield Solutions, LLC, P.O. Box 64589, St. Paul, MN 55164-0089.

Leafy spurge control with quinclorac mixtures applied in June or September. Rodney G. Lym. (Department of Plant Sciences, North Dakota State University, Fargo, ND 58108-6050). Quinclorac can be used to control leafy spurge in pasture, rangeland, and wildlands and is very safe on most native and cultivated grass species. Quinclorac is generally applied at 12 oz/A but at that rate is more expensive than other commonly used herbicides such as picloram and aminocyclopyrachlor. Combinations of herbicides such as picloram plus 2,4-D are often used in place of picloram alone for leafy spurge control because the combination treatment provides better long-term control than picloram used alone at similar or higher rates. The purpose of this research was to evaluate quinclorac applied alone or with 2,4-D or dicamba plus diflufenzopyr for leafy spurge control.

A study to evaluate quinclorac applied alone or combined with dicamba plus diflufenzopyr for leafy spurge control was established at the Albert Ekre Grassland Preserve, near Walcott, ND. Treatments were applied on June 23 or September 8, 2014. Leafy spurge was in the true-flower growth stage in June and had fall regrowth and was 22 to 26 inches tall in September. All treatments in these studies were applied using a hand-held boom sprayer delivering 17 gpa at 35 psi. Experimental plots were 10 by 30 feet and replicated four times in a randomized complete block design. Leafy spurge control was evaluated visually using percent stand reduction compared to the untreated control.

Long-term leafy spurge control with quinclorac was generally better when applied in June compared to September and at 12 compared to 6 oz/A (Table 1). For instance, leafy spurge control with quinclorac at 12 oz/A applied in June was 98% 12 months after treatment (12 MAT) compared to 70% 11 MAT (Aug 2015) when applied in September. Control was similar whether quinclorac was applied alone, with 2,4-D, or with dicamba plus diflufenzopyr.

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

In summary, leafy spurge control with quinclorac was not improved with the addition of dicamba plus diflufenzopyr or 2,4-D. Leafy spurge control tended to be better when quinclorac was applied in June compared to September at the one of the two locations. Thus, the optimum application timing for quinclorac to control leafy spurge could not be determined.

Table 1. Quinclorac applied in June or September alone or with various herbicide mixtures for leafy spurge control near Walcott, ND.

		Evaluation date				
		2014	2015		2016	
Treatment[a]	Rate	4 Sept	4 June	26 Aug	24 May	4 Sept
	— oz/A —	— % control —				
Spring application (June 23, 2014)						
Quinclorac[b]	6	98	90	67	35	24
Quinclorac	12	99	98	88	34	10
Quinclorac + dicamba + diflufenzopyr	6 + 3 + 1.2	98	96	78	65	51
Quinclorac + 2,4-D	6 + 16	96	80	60	90	83
Dicamba + diflufenzopyr[c]	3 + 1.2	68	54	32	73	56
Dicamba + diflufenzopyr + 2,4-D	3 + 1.2 + 16	84	64	38	49	30
2,4-D	16	68	42	16	8	10
Fall application (Sept. 8, 2014)						
Quinclorac	6		78	42	15	5
Quinclorac	12		98	70	35	13
Quinclorac + dicamba + diflufenzopyr	6 + 3 + 1.2		99	68	29	18
Quinclorac + 2,4-D	6 + 16		52	28	40	24
Dicamba + diflufenzopyr	3 + 1.2		75	36	54	28
Dicamba + diflufenzopyr + 2,4-D	3 + 1.2 + 16		83	39	3	0
2,4-D	16		23	9	6	0
LSD (0.05)		13	33	31	32	35

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

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

		Evaluation date					
		2014		2015		2016	
Treatment[a]	Rate	5 Aug	8 Sept	5 June	26 Aug	26 May	13 Sept
	— oz/A —	% control					
Spring application (June 23, 2014)							
Quinclorac[b]	6	71	82	88	44	46	30
Quinclorac	12	94	97	90	71	20	16
Quinclorac + 2,4-D	6 +16	83	86	76	58	69	54
Quinclorac + 2,4-D	12 + 16	93	91	84	82	75	64
2,4-D	16	32	50	20	18	15	8
Fall application (Sept 8, 2014)							
Quinclorac	6			95	77	41	36
Quinclorac	12			97	88	63	44
Quinclorac + 2,4-D	6 + 16			92	63	81	66
Quinclorac + 2,4-D	12 + 16			91	75	58	48
2,4-D	16			56	42	43	31
LSD (0.05)		23	20	19	33	36	NS

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

<u>Performance of glufosinate-ammonium formulations in California perennial crops.</u> Caio A. Brunharo, John Roncoroni, Bradley D. Hanson. (University of California, Davis, CA 95616) Adequate herbicide absorption is crucial for postemergence weed control and may be limited by several factors, herbicide formulation among them. Three field experiments were carried out to evaluate the performance of several glufosinate-ammonium formulations in almond (Yolo County), grape (Napa County) and walnut (Butte County) in California. A backpack sprayer, pressurized with CO_2 and calibrated to deliver 20 gallons per acre, was used for the treatment applications. Randomized complete block designs were adopted, with 3 to 4 replications for each treatment (Table 1). Five glufosinate-ammonium formulations registered in California were tested, and their efficacy compared to saflufenacil applied alone or glyphosate + oxyfluorfen (local standards). The saflufenacil treatment was replaced with paraquat in the grape vineyard, and glyphosate + oxyfluorfen replaced with paraquat in the walnut orchard (Table 2) due to label restrictions. Evaluations were carried out at 7, 14, 21 and 28 days after treatment using a 0-100 visual scale, where 0 represents no visible injury and 100 represents complete weed control.

Table 1. Application data and weeds presents in three glufosinate formulation comparisons experiments in California.

Location	Yolo Co.	Napa Co.	Butte Co.
Crop	Almond	Grape	Walnut
Application date	8/8/2016	8/8/2016	8/5/2016
Plot size (m^2)	15	10	27
Number of replications	4	3	4
Temperature (C)	42	26	45
Relative humidity (%)	25	48	24
Wind speed (m s^{-1})	1.2	1.1	0.3
Soil temperature (C)	35	29	31
Cloud cover (%)	0	0	0
		Weed presence or absence	
bindweed, field (CONAR)	+	-	-
crabgrass, large (DIGSA)	-	-	+
goosegrass, threespike (ELETR)	-	-	+
horseweed (ERICA)	+	-	-
junglerice (ECHCO)	-	-	+
oxtongue, bristly (PICEC)	-	+	-
pigweed, prostrate (AMABL)	+	-	-
purslane, common (POROL)	+	-	+
sedges (CYPSS)	-	-	+

In the almond orchard, control of POROL did not differ among treatments or the untreated control, presumably due to high variability among plots. Visual control data from ERICA, CONAR and AMABL were not subjected to multiple comparison analysis due to the lack of normality (because of highly effective control with most treatments). However, based on the response means, ERICA and AMABL were efficiently controlled by all treatments (>85%), whereas CONAR control was more variable. In the grape vineyard, treatment (9) had the lowest control of PICEC and was statistically inferior when compared to treatments (5) and (7). POROL control at the walnut orchard site was highly variable (38-94%) but there were few statistical difference among treatments. ECHCO, CYPSS, ELETR and DIGSA showed statistically similar response to most of the herbicide treatments, and treatment (5) was the only one to exhibit low mean visual injury in all instances. Based on the results obtained in this study, different glufosinate-ammonium formulations had similar control of POROL in almonds, PICEC in grapes, and POROL, ECHCO, CYPSS, ELETR and DIGSA in walnuts.

Table 2. Weed control 28 days after treatment with different glufosinate-ammonium formulations in almond, grape and walnut trials in California.

	Treatment[1]	Rate[2]	Almond (Yolo Co.)				Grape (Napa Co.)	Walnut (Butte Co.)				
			POROL[3]	ERICA[4]	CONAR[4]	AMABL[4]	PICEC[3]	POROL	ECHCO	CYPSS[3]	ELETR[3]	DIGSA
		g ha^{-1}	%[3]									
1	Untreated control	-	0±0b	0±0	0±0	0±0	0±0c	0±0c	0±0c	0±0b	0±0b	0±0b
2	Rely 280	980	66±4a	100±0	100±0	100±0	95±3ab	43±9abc	75±6a	55±12ab	85±5a	79±7a
3	Rely 280	1150	58±9a	100±0	100±0	100±0	98±2ab	38±11bc	65±13ab	49±12ab	70±7a	73±9a
4	Rely 280	1640	71±5a	90±5	75±7	100±0	98±2ab	53±9abc	73±6ab	75±9a	70±16a	79±8a
5	Reckon 280 SL	1640	80±10a	100±0	91±2	100±0	100±0a	71±14ab	79±8a	79±7a	84±8a	83±11a
6	Lifeline	1640	98±1a	100±0	98±1	100±0	98±1ab	48±13abc	79±2a	53±16ab	55±19ab	80±4a
7	Cheetah	1640	70±9a	100±0	90±4	93±4	100±0 a	53±15abc	65±10ab	85±6a	73±8a	73±9a
8	Forfeit 280	1640	66±9a	85±8	80±8	100±0	98±2ab	45±15abc	65±3ab	60±15ab	51±18ab	73±5a
9	paraquat	1120	-	-	-	-	90±0b	60±15ab	69±3ab	63±17ab	80±7a	78±6a
10	glyphosate +oxyfluorfen	1240	70±9a	95±3	95±1	100±0	93±2ab	-	-	-	-	-
11	saflufenacil	49	65±10a	100±0	100±0	100±0	-	94±2a	38±11b	30±0ab	56±14ab	33±9b

[1]All treatments included NIS at 0.25% v/v except for saflufenacil, which included MSO at 1% v/v. Ammonium sulfate was added to all glufosinate and glyphosate treatments at 2000 g ha^{-1}; Paraquat was Gramoxone SL 2.0, glyphosate was Roundup PowerMAX, oxyfluorfen was GoalTender, and saflufenacil was Treevix; Rely 280, Recon 280 SL, Lifeline, Cheetah, and Forfeit are all 280 g ai L^{-1} glufosinate formulations.
[2]Means within a column followed by the same letter are not significantly different at the 5% level as determined by the Tukey HSD test.
[3]Data transformation was performed in order to meet ANOVA assumptions.
[4]Multiple comparisons was not carried out due to failure of meeting ANOVA assumptions with raw and transformed data.

Postemergence herbicide control of bindweed and silverleaf nightshade in bermudagrass. Kai Umeda. (University of Arizona Cooperative Extension, Maricopa County, Phoenix, AZ 85040) A small plot field experiment was conducted on common bermudagrass in a pasture-like setting in Tempe, AZ. Treated plots measured 5 ft by 10 ft and treatments were replicated three times in a randomized complete block design. Herbicides were applied using a backpack CO_2 sprayer equipped with a hand-held boom with three flat fan 8002VS nozzles spaced 20 inches apart. The sprayer was pressurized to 50 psi and herbicides were delivered in 31 gpa water. At the time of the applications on 13 July 2016, the air temperature was 97°F, partly cloudy, with a slight wind at 1.5 mph and soil temperature was 88°F. The field bindweed (*Convolvulus arvensis*) and silverleaf nightshade (*Solanum elaeagnifolium*) were mature and flowering at the time of applications. The weed control was evaluated at intervals following the single application.

On 26 August at 44 days after treatment (DAT), EH 1601, EH 1545, pre-mix halauxifen-methyl + fluroxypyr + dicamba, pre-mix carfentrazone + 2,4-D + MCPP + dicamba, pre-mix 2,4-D + triclopyr + dicamba + pyraflufen, and quinclorac controlled bindweed better than 91% (Table). EH 1601 and pre-mix 2,4-D + triclopyr + dicamba + pyraflufen controlled silverleaf nightshade better than 91%.

Table. Postemergence herbicide control of bindweed and silverleaf nightshade in bermudagrass, Tempe, AZ

Treatment	Rate	CONAR control				SOLEL control			
		18 Jul	03 Aug	10 Aug	26 Aug	18 Jul	03 Aug	10 Aug	26 Aug
	lb a.i./A	%				%			
Untreated check		0 e	0 c	0 d	0 c	0 c	0 b	0 e	0 e
NB 39020	0.214	73 b	80 b	72 bc	57 b	75 a	78 a	75 bc	7 de
NB 39051	0.276	77 ab	87 ab	82 ab	70 b	75 a	63 a	50 d	17 cde
EH 1601	0.87	80 ab	92 a	93 a	94 a	75 a	92 a	96 a	94 ab
EH 1601	1.12	83 ab	90 ab	95 a	99 a	77 a	88 a	96 a	98 a
EH 1601	1.37	85 ab	92 a	96 a	99 a	78 a	92 a	93 a	94 ab
Carfentrazone + 2,4-D + MCPP + Dicamba	0.96	88 a	95 a	93 a	96 a	78 a	92 a	93 ab	83 ab
Halauxifen-methyl + Fluroxypyr + Dicamba	0.104	18 d	92 a	63 c	93 a	75 a	63 a	63 cd	33 cde
Halauxifen-methyl + Fluroxypyr + Dicamba	0.19	15 d	85 ab	63 c	91 a	75 a	77 a	70 c	50 bcd
Halauxifen-methyl + Fluroxypyr + Dicamba	0.276	22 d	88 ab	93 a	96 a	75 a	83 a	73 c	57 abc
EH 1545	1.41	50 c	93 a	96 a	98 a	75 a	67 a	63 cd	33 cde
2,4-D + MCPA + Dicamba	1.41	50 c	93 a	99 a	99 a	75 a	78 a	63 cd	57 abc
2,4-D + Triclopyr + Dicamba + Pyraflufen	1.25	75 b	93 a	93 a	99 a	75 a	93 a	93 ab	91 ab
Quinclorac	0.75	50 c	85 ab	92 a	99 a	30 b	17 b	0 e	0 e

Herbicides applied on 13 July 2016.
Means in the columns followed by the same letter are not significantly different by Tukey’s HSD.

Efficacy and comparison of postemergence herbicides for liverseedgrass in turf. Kai Umeda (University of Arizona Cooperative Extension, Maricopa County, Phoenix, AZ 85040) Two small plot field experiments were conducted on common bermudagrass turf at the Greenwood Cemetery in Phoenix, AZ. In both experiments, the treatment plots measured 5 ft by 10 ft and treatments were replicated three times in randomized complete block design. Herbicide treatments were applied with a backpack CO_2 sprayer equipped with a hand-held boom with three flat-fan 8002VS nozzles spaced 20 inches apart. The sprays were applied in 58 gpa water along with a methylated seed oil, Hasten at 1 qt/A, and pressurized to 40 psi. The first experiment was initially sprayed on 02 June 2016 when the air temperature was 96°F, with a slight breeze at 2 mph, and the soil temperature at 72°F. The turf was mowed regularly and the liverseedgrass (*Urochloa panicoides*) was about 3-inches height and mature with seedheads forming. A sequential application was sprayed on 15 June with the temperature at 90°F, a slight breeze at 4 mph, and soil temperature at 78°F. The second experiment to evaluate tank-mix combinations was initiated on 16 June 2016. The air temperature was 93°F with a slight breeze at 3 mph and soil temperature at 70°F. A sequential application was sprayed on 12 July with the air temperature at 99°F, clear sky, and negligible wind at less than 1 mph. A third application was sprayed on 04 August with the temperature at 92°F, clear sky, and breeze at 5 mph from the east. Sencor was not included on the third application date. Weed control was evaluated at intervals after the applications.

In experiment 1 to compare several postemergence herbicides, topramezone demonstrated activity following the second application on the liverseedgrass (Table 1). Quinclorac and pre-mix quinclorac plus sulfentrazone plus 2,4-D plus dicamba and ALS-enzyme inhibiting metsulfuron and sulfosulfuron did not exhibit adequate activity against the mature liverseedgrass.

Experiment 2 evaluated the tank-mix combinations with mesotrione and topramezone. Activity on liverseedgrass was observed for all treatments following the initial application (Table 2). Within a week of the second and third applications, liverseedgrass control was approaching acceptable levels of better than 80%. Mesotrione combined with metribuzin or simazine appeared to be more active among the treatments. Nearly a month after the third application, mesotrione plus simazine and topramezone plus quinclorac exhibited the highest degree of liverseedgrass control at 68 and 73% control, respectively. Mesotrione and topramezone alone exhibited a bleaching effect on the grasses. The combination with simazine or quinclorac caused less bleaching and more burning effect on the grasses.

Table 1. Comparison of postemergence herbicides for liverseedgrass control, Phoenix, AZ

Treatment	Rate	UROPA control 15 Jun	23 Jun	30 Jun	12 Jul	04 Aug
	lb a.i./A	%				
Untreated check		0 b	0 b	0 b	0 a	0 a
Quinclorac	0.75	3 b	15 b	15 ab	23 a	20 a
Quinclorac + Sulfentrazone + 2,4-D + Dicamba	1.54	8 b	17 b	27 ab	30 a	25 a
Metsulfuron	0.038	7 b	10 b	30 ab	17 a	17 a
Sulfosulfuron	0.094	8 b	8 b	20 ab	17 a	10 a
Topramezone	0.022	63 a	68 a	68 a	55 a	32 a

Treatments applied on 02 June and 15 June 2016.
Means followed by the same letter within a column are not significantly different by Tukey's HSD.

Table 2. Evaluation of combinations of postemergence herbicides for liverseedgrass, Phoenix, AZ

Treatment	Rate	UROPA control 23 Jun	30 Jun	18 Jul	04 Aug	10 Aug	29 Aug
	lb a.i./A	%					
Untreated check		0 c	0 b	0 c	0 d	0 c	0 b
Mesotrione + Metribuzin*	0.16 + 0.188	47 b	50 a	82 a	10 cd	20 bc	8 b
Mesotrione + Simazine	0.16 + 0.25	43 b	60 a	82 a	22 b	83 a	68 a
Mesotrione + Sulfentrazone	0.16 + 0.25	53 ab	57 a	77 ab	22 b	63 ab	28 ab
Mesotrione	0.16	63 a	57 a	65 b	18 bc	72 a	10 b
Topramezone	0.022	47 b	57 a	78 ab	50 a	57 ab	43 ab
Topramezone + Quinclorac	0.022 + 0.75	47 b	77 a	72 ab	53 a	72 a	73 a

Treatments applied on 16 June, 12 July, and 04 August 2016.
*Metribuzin not applied on 04 August.
Means followed by the same letter within a column are not significantly different by Tukey's HSD.

Topramezone and quinclorac herbicide combinations for grass weed control in turf. Kai Umeda (University of Arizona Cooperative Extension, Maricopa County, Phoenix, AZ 85040) A small plot experiment was conducted in a municipal park in Scottsdale, AZ on bermudagrass cv. Tifway 419 mowed twice per week at approximately 1-inch height. Treatment plots measured 5 ft by 5 ft and herbicide treatments were replicated four times in a randomized complete block design. All treatments were applied using a backpack CO_2 sprayer equipped with a hand-held boom with three 8002VS flat fan nozzles spaced 20 inches apart. The sprays were applied in 46 gpa water pressurized to 40 psi and included methylated seed oil, Hasten, at 0.5% v/v. At the time of the initial application on 15 July 2016, the air temperature was 111°F, clear sky, and a negligible breeze at less than 1 mph. The sequential treatments were applied on 02 August with the air temperature at 88°F, 70% cloudy, and a slight breeze at less than 3 mph.

On 02 August at 18 days after treatment of initial applications (DAT-1), topramezone alone and the topramezone plus quinclorac treatments completely controlled crabgrass and controlled goosegrass about 90%. Quinclorac alone did not adequately control crabgrass nor goosegrass. Bermudagrass injury was diminishing and at an acceptable level of less than 19% for topramezone treatments at 18 DAT. Following the single application at 25 DAT, topramezone induced injury was negligible on bermudagrass. At 24 DAT of the sequential application, topramezone treatments applied once and twice controlled crabgrass and goosegrass better than 97%. Bermudagrass injury was severe at 43 to 50% with topramezone treatments at 10 DAT-2.

Table. Topramezone and quinclorac herbicide combinations for grass weed control in turf, Scottsdale, AZ

Treatment	Rate	No. of apps	DIGIS control				ELEIN control				CYNDA injury		
	lb a.e./A		02 Aug	09 Aug	12 Aug	26 Aug	02 Aug	09 Aug	12 Aug	26 Aug	02 Aug	09 Aug	12 Aug
			%				%				%		
Untreated check			0	0 b	0 b	0 c	0 c	0 b	0 b	0 b	0 b	0 c	0 b
Topramezone	0.033	2	99	99 a	99 a	99 a	90 a	95 a	97 a	99 a	19 a	50 a	50 a
Topramezone + Quinclorac	0.016 + 0.38	1	99	99 a	99 a	99 a	92 a	94 a	99 a	97 a	19 a	0 c	0 b
Topramezone + Quinclorac	0.016 + 0.38	2	99	99 a	99 a	99 a	89 a	98 a	96 a	97 a	13 a	40 b	43 a
Quinclorac	0.75	2	0	35 b	72 a	43 b	58 b	23 b	35 b	0 b	0 b	3 c	4 b

Treatments applied on 15 July 2016 followed by 02 August.

Methylated seed oil, Hasten, added to all treatments at 0.5% v/v.

Means followed by the same letter within a column are not significantly different by Tukey’s HSD.

Postemergence herbicide control of winter broadleaved weeds in turf. Kai Umeda (University of Arizona Cooperative Extension, Maricopa County, Phoenix, AZ 85040). A small plot field experiment was conducted on the San Marcos Golf Course in Chandler, AZ in an out-of-play rough area. A second small plot field experiment was conducted in the City of Phoenix Japanese Friendship Garden in a landscaped turf area with a mix of bermudagrass overseeded with perennial ryegrass and cultivars of fescues. At both locations, the treatment plots measured 5 ft by 10 ft and each treatment was replicated three times in a randomized complete block design. Herbicides were applied with a CO_2 backpack sprayer equipped with a hand-held boom with 3 flat fan 8002VS nozzles spaced 20 inches apart. The sprays were applied in 31 gpa water pressurized to 50 psi. In Chandler, the chickweed (*Stellaria media*) measured 3 to 8 inches across in diameter. Additional weeds in the plot included London rocket (*Sisymbrium irio*) that was 3 to 12 inches in height and flowering, and few shepherdspurse (*Capsella bursa-pastoris*) at 4 to 6 inches. The herbicides were applied in Chandler on 02 March 2016 when the temperature was 61°F, clear sky, calm air, and soil temperature was 56°F. In Phoenix, the chickweed was maturing and started flowering on 28 March 2016 when the air temperature was 84°F, clear sky, no wind, and moist soil was 60°F. Weed control ratings were conducted at regular intervals following the applications and statistically analyzed.

In Chandler, chickweed in all treatments plots exhibited injury as well as London rocket and shepherdspurse within 5 days after treatment (DAT) (Table 1). At 21 DAT, all herbicides gave better than 94% control of chickweed. The pre-mix halauxifen-methyl + fluroxypyr + dicamba showed a rate response with the high rate of 0.276 lb a.i./A being comparable to EH 1545, the pre-mix 2,4-D + MCPA + dicamba, and 2,4-D + triclopyr + dicamba + pyraflufen. At 14 DAT, halauxifen-methyl + fluroxypyr + dicamba at 0.276 lb a.i./A, EH 1545, 2,4-D + MCPA + dicamba, and 2,4-D + triclopyr + dicamba + pyraflufen were similar in providing nearly acceptable levels of London rocket and shepherdspurse control.

In Phoenix, halauxifen-methyl + fluroxypyr + dicamba and EH 1545 showed slightly greater injury at 8 DAT compared to 2,4-D + MCPA + dicamba (Table 2). At 21 DAT, halauxifen-methyl + fluroxypyr + dicamba and EH 1545 gave nearly complete control of chickweed while 2,4-D + MCPA + dicamba plots had only a few remaining injured weeds.

Table 1. Postemergence herbicides for control of winter broadleaved weeds in turf, Chandler, AZ

Treatment	Rate	STEME control					SSYIR control			CAPBP control		
		7-Mar	11-Mar	16-Mar	23-Mar	30-Mar	7-Mar	11-Mar	16-Mar	7-Mar	11-Mar	16-Mar
	lb a.i/A			%				%			%	
Untreated check		0 d	0 c	0 c	0 c	o b	0 d	0 c	0 c	0 d	0 c	0 c
Halauxifen-methyl + fluroxypyr + dicamba	0.104	50 c	40 b	32 b	67 b	88 a	47 c	53 b	27 bc	50 c	37 b	25 bc
Halauxifen-methyl + fluroxypyr + dicamba	0.19	70 c	57 ab	47 b	68 ab	83 a	72 b	68 ab	57 ab	67 b	53 ab	47 ab
Halauxifen-methyl + fluroxypyr + dicamba	0.276	78 a	60 ab	75 a	96 ab	99 a	78 ab	77 ab	77 a	77 ab	68 ab	65 a
EH 1545	1.41	78 a	72 a	73 a	94 ab	99 a	80 ab	82 a	82 a	78 a	78 a	77 a
2,4-D + MCPA + dicamba	1.41	80 a	73 a	75 a	99 a	99 a	82 ab	80 a	82 a	80 a	78 a	77 a
2,4-D + triclopyr + dicamba + pyraflufen	1.25	80 a	82 a	80 a	99 a	99 a	83 a	85 a	88 a	82 a	82 a	83 a

Treatments applied on 02 March 2016.
Means followed by the same letter within a column are not significantly different by Tukey’s HSD.

Table 2. Postemergence herbicides for control of chickweed in turf, Phoenix, AZ

Treatment	Rate	STEME control (%)	
		5-Apr	18-Apr
	lb a.i./A	%	
Halauxifen-methyl + fluroxypyr + dicamba	0.276	57 a	99 a
EH 1545	1.41	63 a	99 a
2,4-D + MCPA + dicamba	1.41	40 a	92 b

Treatments applied on 28 March 2016.
Means followed by the same letter within a column are not significantly different by Tukey’s HSD.

Efficacy of burndown treatments with different nonionic surfactant and herbicide rates. Caio A. Brunharo and Bradley D. Hanson. (Department of Plant Sciences, University of California, Davis, CA 95616) The objective of this study was to compare burndown treatments containing either glyphosate or glufosinate at two different rates and the addition of two different nonionic surfactants. Two experiments were carried out in 2015 and 2016 in Davis, California, during fallow intervals (Table 1), prior to tomato (UC LAWR) and fava bean (UC Plant Pathology Field) planting. A backpack sprayer, pressurized with CO_2 and calibrated to deliver 20 gallons per acre, was used for the treatment applications. Randomized complete block designs were adopted, with 4 replications for each treatment. Tap water, instead of deionized water, was used to mimic field applications by growers in the Central Valley of California, and ammonium sulfate was added to all treatments to reduce the effects of hard water on weed control. Evaluations were carried out at 7, 14, 21 and 28 days after treatment using a 0-100 visual scale, where 0 represents no visible injury and 100 represents complete weed control.

Table 1. Application data and weeds present in two burndown herbicide experiments conducted in Davis, CA.

Site	UC LAWR	UC Plant Pathology Field
Application date	10/2/2015	2/17/16
Plot size (m^2)	9	12
Number of replications	5	4
Temperature (C)	23	21
Relative humidity (%)	41	60
Wind speed ($m\ s^{-1}$)	0.8	1.3
Soil temperature (C)	19	15
Cloud cover (%)	0	60
	Weed species m^{-2}	
fiddleneck, coast (AMSIN)	-	3
groundsel, common (SENVU)	-	6
henbit (LAMAM)	-	4
milkthistle, blessed (SLYMA)	-	2
purslane, common (POROL)	3	-
redmaids (CLNCM)	-	2
shepherd's-purse (CAPBP)	-	6

POROL was controlled with all treatments containing glufosinate at UC LAWR site. Weed control efficacy was reduced with the lowest glyphosate rate (870 g ae ha^{-1}) but was statistically similar with both surfactants (Table 2). CAPBP, AMSIN, LAMAM, SENVU, SLYMA and CLNCM were efficiently controlled by all treatments, with the lowest average visual injury observed >90%.

Table 2. Weed control with different rates of glufosinate, glyphosate and nonionic surfactants 28 days after treatment at two experimental sites near Davis, CA in 2015 and 2016.

			UC LAWR	UC Plant Pathology Field					
			10/30/15	3/16/16					
	Treatment[1]	Units	POROL[2]	CAPBP	AMSIN	LAMAM	SENVU	SLYMA	CLNCM
		g ha^{-1}	%						
1	Untreated check	-	0±0b	0±0	0±0	0±0	0±0	0±0	0±0
2	glufosinate + Activator 90	1145	100±0a	100±0	100±0	100±0	100±0	100±0	97±2
3	Glufosinate + OR 009	1145	100±0a	100±0	100±0	100±0	100±0	100±0	100±0
4	glufosinate + Activator 90	1473	100±0a	100±0	100±0	100±0	100±0	100±0	100±0
5	glufosinate + OR 009	1473	100±0a	100±0	100±0	100±0	100±0	100±0	100±0
6	glyphosate + Activator 90	868	81±7ab	100±0	100±0	100±0	100±0	100±0	95±3
7	glyphosate + OR 009	868	73±4b	100±0	100±0	97±2	97±2	97±2	90±0
8	glyphosate + Activator 90	1263	96±2ab	100±0	100±0	100±0	100±0	100±0	97±2
9	glyphosate + OR 009	1263	92±5ab	100±0	100±0	100±0	100±0	100±0	100±0

[1]Ammonium sulfate was added at 1% (v/v) as Bronc Max to all treatments. Glufosinate was Rely 280 (rates in g ai ha^{-1}) and glyphosate was Roundup PowerMAX (rates in g ae ha^{-1}). Activator 90 and OR 009 are nonionic surfactants.
[2]Means within a column followed by the same letter are not significantly different at the 5% level as determined by the Tukey HSD test.

Postemergent weed control in walnuts within weeds of different maturity levels. Sarah R. Parry, Nicholas E. Clark, Eduardo Padilla, Isaac Giron, Kevin R. Day, Brad Hanson, Anil Shrestha, and Steven D. Wright. (University of California Cooperative Extension, Tulare, CA 93274-9537) The objective of this study was to evaluate 15 herbicides and tank mixes on difficult-to-control weeds typical in tree crops using postemergent herbicides. Weeds present in this trial included junglerice, Palmer amaranth, common lambsquarters, hairy fleabane, horseweed, little mallow, common purslane, puncturevine, and barnyardgrass. The study was initiated in Tulare, California in June 2015. Plots were 5 by 30 feet, and treatments were replicated four times in a randomized complete block design.

Treatments were applied on June 2, 2015. Air temperature was 75°F, wind speed ranged from five to seven mph, and relative humidity was 54%. Applications were sprayed at 15 gpa using a CO_2 pressurized quad sprayer with TJet 8002 flat fan nozzles at 30 psi. Weekly evaluations of weed control were made from 7 to 28 days after treatment (DAT) (data for 7, 14, and 28 DAT not shown). Evaluations were made for two maturity levels of Palmer amaranth and common lambsquarters.

Under the conditions of this study, all of the treatments showed great control on Palmer amaranth, lambsquarters, malva, and fleabane (Table). Palmer amaranth was controlled completely by all treatments when sprayed at a small growth stage. The greatest control of large Palmer amaranth plants was by the treatments NUP-13028, saflufenacil, and carfentrazone-ethyl. There were similar results for small common lambsquarters with complete control by all treatments, except for glyphosate. However, large common lambsquarters was only slightly controlled by most treatments except by glufosinate + flumioxazin, which gave complete control. There was good control of barnyardgrass with all treatments. The best control observed was by glufosinate (Cheetah) tank mixes, NUP-13028 + glyphosate at various rates, and glufosinate (Rely 280) alone at various rates.

Due to the scattered variation in weeds throughout the study, some results were highly variable, such as for common purslane, puncturevine, junglerice, and horseweed.

Table. Various weeds[1] control by different herbicides at 21 DAT.

		Weed control										
		---Small[2] weeds---		---Large[3] weeds---		---Various sized weeds---						
Treatment[4]	Rate	AMAPA	CHEAL	AMAPA	CHEAL	ECHEG	POROL	TRBTE	MALPA	ERIBO	ECHCO	ERICA
	lbs ai/A[5]	---%---										
Untreated control	-	0	0	0	0	0	0	0	0	0	0	0
Glufosinate[6]	1.32	80	100	50	30	100	-	100	100	100	-	-
Glyphosate[7]	1.46	90	80	50	30	-	-	-	100	10	30	-
Glufosinate[6] + glyphosate	1.01 + 1.46	100	100	50	60	70	-	-	100	70	-	-
Glufosinate[6] + flumioxazin	1.01 + 0.38	100	100	80	100	60	-	-	100	100	100	90
Glufosinate[6] + flumioxazin	1.32 + 0.38	100	100	80	50	60	-	100	100	60	-	-
Glufosinate[6] + flumioxazin + glyphosate	1.01 + 0.29 + 1.46	100	100	70	50	70	100	-	100	80	100	-
NUP-13028	55	100	100	70	50	70	100	100	100	90	-	-
NUP-13028	72	100	100	100	80	-	100	-	100	100	-	-
NUP-13028 + glyphosate	55 + 1.46	100	100	70	70	90	100	100	100	100	100	-
NUP-13028 + glyphosate	72 + 1.46	100	100	70	70	90	-	100	100	100	-	70
Glufosinate[8]	0.88	100	100	70	50	60	100	100	100	100	-	-
Glufosinate[8]	1.02	100	100	70	40	80	-	-	100	100	30	-
Glufosinate[8]	1.46	100	100	70	30	90	100	100	100	100	-	90
Saflufenacil	0.44	100	100	90	30	80	-	100	100	100	-	-
Carfentrazone-ethyl	0.03	100	100	80	40	50	-	100	100	100	-	-

[1]AMAPA = Palmer amaranth, CHEAL = common lambsquarters, ECHCG = barnyardgrass, POROL = common purslane, TRBTE = puncturevine, MALPA = little mallow, ERIBO = hairy fleabane, ECHCO = junglerice, and ERICA = horseweed.
[2]Small weeds were less than three inches in diameter and four inches in height.
[3]Large weeds were greater than three inches in diameter and four inches in height.
[4]All treatments included AMS and COC at rates of 0.05 and 1.86 lbs ai/A, respectively.
[5]All units of rate are expressed in lbs ai/A except for NUP-13028 which is expressed in fl oz product/A.
[6]Trade name of product used was Cheetah.
[7]All glyphosate in this study was glycine in the premixed form of its isopropylamine and potassium salts at a respective ratio of 1.33:1 by weight.
[8]Trade name of product used was Rely 280.

Broadleaf weed control in timothy and Kentucky bluegrass with bicyclopyrone. Traci A. Rauch and Joan M. Campbell. (Crop and Weed Science Division, University of Idaho, Moscow, ID 83844-2339) Studies were conducted to evaluate broadleaf weed control with bicyclopyrone in seedling timothy and Kentucky bluegrass at the University of Idaho Plant Science Farm. 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. Broadleaf weed control was evaluated visually.

Table 1. Application data for grass weed sites.

	Timothy			Kentucky bluegrass		
Planting date		5/3/16			5/5/16	
Application date	5/11/16	5/28/16	6/1/16	5/11/16	6/1/16	6/15/16
Growth stage						
Timothy	pre	2 leaf	1 tiller	--	--	--
Kentucky bluegrass	--	--	--	pre	pre	spike
Common lambsquarters (CHEAL)	pre	4 leaf	8 leaf	pre	cotyledon	3 leaf
Redroot pigweed (AMARE)	pre	3 leaf	6 leaf	pre	2 leaf	4 leaf
Mayweed chamomile (ANTCO)	--	--	--	pre	1 leaf	4 leaf
Black nightshade (SOLNI)	--	--	--	pre	cotyledon	4 leaf
Field pennycress (THLAR)	--	--	--	pre	5 leaf	flowering
Air temperature (F)	71	46	76	71	76	57
Relative humidity (%)	36	78	44	36	44	58
Wind (mph, direction)	2, E	2, W	0	2, E	0	2, SW
Cloud cover (%)	0	40	70	0	70	0
Next moisture occurred	5/15/16	6/9/16	6/9/16	5/15/16	6/9/16	6/18/16
Soil moisture	wet	good	dry	wet	dry	good
Soil temperature at 2 inch (F)	70	50	66	70	66	54
pH			5.9			
OM (%)			4.0			
CEC (meq/100g)			19.1			
Texture			silt loam			

No treatment injured timothy (data not shown). Saflufenacil and pyrasulfotole/bromoxynil controlled common lambsquarters 94 and 96% (Table 2). Redroot pigweed control did not differ among treatments most likely due to a non-uniform population. Pyrasulfotole/bromoxynil tended to control redroot pigweed 96%. The high rate of bicyclopyrone applied on May 11 (preemergence) tended to controlled common lambsquarters and redroot pigweed better than the low rate or May 28 (postemergence) timing.

No treatment injured Kentucky bluegrass (data not shown). All treatments controlled common lambsquarters 90% or greater (Table 3). All treatments, except the low rate of bicyclopyrone applied on May 11 (preemergence), controlled redroot pigweed 85% or better. All treatments, except saflufenacil, controlled mayweed chamomile 85% or greater. All treatments, except the low rate of bicyclopyrone at both timings and saflufenacil, controlled black nightshade 83 to 99%. The high rate of bicyclopyrone at both timings, pyrasulfotole/bromoxynil, and saflufenacil controlled field pennycress 92% and better. In general, broadleaf weed control was better with the low rate and later timing of bicyclopyrone in the Kentucky bluegrass study compare to the timothy study. This was mostly like due to an earlier growth stage at the June 1 (postemergence) application time.

Table 2. Broadleaf weed control in timothy with bicyclopyrone near Moscow, ID in 2016.

Treatment[1]	Rate	Application timing	Common lambsquarters control[2]	Redroot pigweed control[2]
	lb ai/A		%	%
Bicyclopyrone	0.04	May 11	78	79
Bicyclopyrone	0.09	May 11	84	93
Bicyclopyrone	0.04	May 28	58	63
Bicyclopyrone	0.09	May 28	61	73
Pyrasulfotole/bromoxynil	0.22	May 28	96	96
Saflufenacil	0.02	June 1	94	85
LSD (0.05)			21	NS
Density (plants/ft^2)			5	10

[1]A nonionic surfactant at 0.25% v/v/ was applied with bicyclopyrone treatments and methylated seed oil at 1% v/v was applied with saflufenacil.
[2]Evaluation date July 6, 2016.

Table 3. Broadleaf weed control in Kentucky bluegrass with bicyclopyrone near Moscow, ID in 2016.

Treatment[1]	Rate	Application timing	CHEAL control[2]	AMARE control[2]	ANTCO control[2]	SOLNI control[2]	THLAR control[2]
	lb ai/A		%	%	%	%	%
Bicyclopyrone	0.04	May 11	94	56	87	35	78
Bicyclopyrone	0.09	May 11	97	85	96	95	92
Bicyclopyrone	0.04	June 1	94	86	89	42	84
Bicyclopyrone	0.09	June 1	99	98	99	83	97
Pyrasulfotole/bromoxynil	0.22	June 1	99	99	99	99	99
Saflufenacil	0.02	June 15	99	93	83	45	90
LSD (0.05)			4	8	7	14	8
Density (plants/ft^2)			5	10	3	1	15

[1]A nonionic surfactant at 0.25% v/v/ was applied with bicyclopyrone treatments and methylated seed oil at 1% v/v was applied with saflufenacil.
[2]Evaluation date July 6, 2016. CHEAL = common lambsquarters, AMARE = redroot pigweed, ANTCO = mayweed chamomile, THLAR = field pennycress, and SOLNI= black nightshade.

Herbicide application timings in 'Frontier' chickpeas. Henry Wetzel and Drew Lyon (Dept. of Crop & Soil Sciences, Washington State Univ., Pullman, WA 99164-6420) A field study was conducted on the WSU Cook Agronomy Farm near Pullman, WA to evaluate different herbicide application timings for the control of broadleaf weeds in chickpeas. Plots were 10 ft by 33 ft arranged in a randomized complete block design with four replications. Lack of rainfall to activate herbicides after application has been problematic in recent years; therefore early pre-plant applications, which took place on April 7th and 28th, might have more opportunity to be activated by rainfall than herbicides applied post-plant, pre-emerge. On May 13th, the entire trial area was sprayed with glyphosate (1.69 lb ae/A) to kill common lambsquarters (CHEAL) and Italian ryegrass (LOLMU) that germinated following conventional ground preparation and rain that fell throughout April. On May 15th, the trial area received 0.57 in. of rainfall that most likely stimulated weed seed germination. On May 18th, 'Frontier' chickpeas were planted at a rate of 175 lb/acre at a depth of 1.5 inches using a Monosem vacuum planter with a 10-inch row spacing. The post-plant pre-emerge application took place on May 18th. The entire trial area was sprayed with clethodim, the first week of July, for the control of LOLMU. The trial area was harvested with a Kincaid 8XP plot combine on September 15th.

Table 1. Application and soil data.

Location	Cook Agronomy Farm, Pullman, Washington		
Application Date	April 7, 2016	April 28, 2016	May 18, 2016
Chickpea growth stage	n/a	n/a	Beginning of imbibition
Air temperature (F)	60	59	71
Relative humidity (%)	40	48	36
Wind (mph, direction)	4, W	4, W	4, W
Cloud cover (%)	0	100	90
Soil temperature at 6 in (F)	52	54	61
pH		4.8	
OM (%)		3	
Texture		silt loam	

Within two weeks of application, treatments applied on April 7th received a total of 0.36 inches of rain, treatments applied on April 28th received a total of 0.94 inch of rain, and treatments applied on May 18th received 0.15 inches of rain. Between May 20th and September 6th, the crop received a total of 2.21 inches of rain, with rainfall events being fairly spread out. CHEAL was the only broadleaf weed uniformly distributed within the trial area. Crop injury was not noted with any treatments in this trial. Based on visual ratings, sulfentrazone and metribuzin generally provided the best control of CHEAL, flumioxazin was intermediate and linuron provided very little control (Table 2). On the June 30th rating date, metribuzin applied on May 18th was providing less control than on the two application dates in April. CHEAL density counts were taken on July 6th. Statistical analysis suggested that application date was not significant, so treatment means are averaged over the three dates (Table 3). Metribuzin, sulfentrazone and flumioxazin significantly reduced the density of CHEAL when compared to linuron. Linuron's activity on CHEAL was between the other three herbicides and the nontreated check. Yield and 100-seed-weight were not affected by herbicide application date, thus treatment means were averaged over application date (Table 4). Sulfentrazone- and flumioxazin-treated plots yielded better than the nontreated check plots. Linuron- and metribuzin-treated plots yielded similarly to the nontreated check plots. There were no differences noted among 100-seed-weight when compared among all herbicide treatments and the nontreated check. Timely rains after the pre-plant herbicide applications would have activated these early treatments thus providing good weed control. Even though we received only 0.15 inches of rainfall within the two weeks after the at-plant herbicide application, 0.57 inches of rainfall was received three days prior to planting and may have helped to activate the post-plant pre-emerge treatments. Thus, in this study, all three herbicide application timings provided similar control of CHEAL.

Table 2. Herbicide, application date and their effects on CHEAL control in 'Frontier' chickpeas near Pullman, Washington in 2016.

Treatment	Rate	Application Date	CHEAL control 6/17	CHEAL control 6/30[1]
	lb ai/A		---------------------%---------------------	
linuron	0.625	4/7	26 d[2]	17 d[2]
linuron	0.625	4/28	55 b-d	30 cd
linuron	0.625	5/18	50 cd	22 cd
metribuzin	0.375	4/7	91 a	81 a
metribuzin	0.375	4/28	95 a	87 a
metribuzin	0.375	5/18	75 a-c	52 bc
sulfentrazone	0.25	4/7	96 a	85 a
sulfentrazone	0.25	4/28	94 a	82 a
sulfentrazone	0.25	5/18	95 a	79 ab
flumioxazin	0.064	4/7	82 ab	66 ab
flumioxazin	0.064	4/28	80 a-c	56 bc
flumioxazin	0.064	5/18	52 b-d	52 bc

[1] Herbicide application date had a significant (Pr>F 0.0467) effect on CHEAL control.

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

Table 3. Herbicide application and its effect on CHEAL abundance July 6, 2016 in 'Frontier' chickpeas near Pullman, Washington.

Treatment	Rate	CHEAL
	lb ai/A	plants per sq. meter
sulfentrazone	0.25	3 a[1]
metribuzin	0.375	6 ab
flumioxazin	0.064	8 b
linuron	0.625	23 c
nontreated check	--	40 d

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

Table 4. Herbicide application and its effect on yield and seed weight September 15, 2016 in 'Frontier' chickpeas near Pullman, Washington.

Treatment	Rate	Yield	100-seed-weight
	lb ai/A	lb/A	g
sufentrazone	0.25	1330 a[1]	38.5 a
flumioxazin	0.064	1330 a	37.6 a
metribuzin	0.375	829 b	37.1 a
linuron	0.625	697 b	36.3 a
nontreated check	--	675 b	37.0 a

[1] Means, based on twelve replicates, within a column, followed by the same letter are not significantly different at P = 0.05 as determined by LSMEANS test, which means that we are not confident that the difference is the result of treatment rather than experimental error or random variation associated with the experiment.

Effects of tillage for herbicide incorporation on broadleaf weed control in 'Frontier' chickpeas. Henry Wetzel and Drew Lyon. (Dept. of Crop & Soil Sciences, Washington State Univ., Pullman, WA 99164-6420) A study was conducted at the Cook Agronomy Farm near Pullman, WA to evaluate herbicides for the control of broadleaf weeds. In addition, we evaluated if soil disturbance, after treatments were applied, affected product efficacy. On May 13th, the entire trial area was sprayed with glyphosate (1.69 lb ae/A) to kill the common lambsquarters (CHEAL) and Italian ryegrass (LOLUM) that germinated following conventional ground preparation and rain that fell throughout April. On May 15th, the trial area received 0.57 of an inch of rainfall that most likely stimulated weed seed germination. On May 18th, 'Frontier' chickpeas were planted at a rate of 175 lb/acre at a depth of 1.5 inches using a Monosem vacuum planter with a 10-inch row spacing. Plots were 10 ft by 66 ft arranged in a randomized complete block design with four replications. The post-plant, pre-emerge application took place on May 18th (Table 1). Each herbicide treatment was applied to a 10 ft by 66 ft area. On May 19th, half of the treated area (10 ft by 33 ft), within each block, received a roller packer treatment perpendicular to the treated area. The other half of the plot remained undisturbed. The experimental design was a split-block (roller packer) with subplots (herbicide treatments) in a randomized complete block. Visual ratings of CHEAL were taken on June 17th and 30th. CHEAL plant counts were taken on July 6th by counting the number of plants within a quarter meter square quadrat at two locations within the plot. The values presented are an average of the two counts taken and are presented as the number of CHEAL plants per square meter. The trial area was harvested with a Kincaid 8XP plot combine on September 16th.

Table 1. Application and soil data.

Location	Cook Agronomy Farm, Pullman, Washington
Application date	May 18, 2016
Chickpea growth stage	Beginning of imbibition
Air temperature (F)	75
Relative humidity (%)	34
Wind (mph, direction)	4,W
Cloud cover (%)	80
Soil temperature at 6 in (F)	61
pH	4.8
OM (%)	3
Texture	Silt loam

During the two weeks after application, only 0.15 of an inch of rainfall was received. This lack of rainfall after herbicide application likely contributed to the poor weed control observed in this trial. Poor herbicide activation by insufficient rainfall is often cited by growers as the reason for using light tillage to incorporate and activate herbicides. Between May 20th and September 6th, the crop received 2.21 inches of precipitation, with rainfall events being fairly spread out. CHEAL was the only broadleaf weed uniformly distributed within the trial area. Crop injury was not noted with any treatments in this trial. The initial visual weed control rating taken on June 17th did not suggest that rolling had an impact on CHEAL control with the herbicides tested (Table 2). Linuron + sulfentrazone and dimethenamid + sulfentrazone were providing the best control of CHEAL. However, on the second evaluation (June 30th), none of the treatments were providing acceptable control of CHEAL. Rolling did reduce weed control in plots treated with safluenacil + metribuzin, linuron + sulfentrazone and linuron + flumioxazin. When it came to our final evaluation on July 6th, rolling did not have a significant effect on CHEAL density. Rolling did not have a significant effect on yield or 100-seed-weight, thus data were combined across rolling treatments and means are composed of eight replications (Table 3). All herbicide treatments increased yield when compared to the nontreated check. Mechanical incorporation of herbicides did not improve weed control in this study despite a lack of sufficient rainfall for herbicide activation. In 2015, a year with sufficient rainfall for post-plant, pre-emerge herbicide activation, rolling also reduced weed control with some of the herbicide treatments. Growers should be sure to check herbicide labels before using tillage to incorporate herbicides.

Table 2. Evaluation of the combination of herbicides and soil surface disturbance and their effects on CHEAL control in ‘Frontier’ chickpeas near Pullman, Washington in 2016.

Treatment	Rate	Mechanical treatment	CHEAL Control 6/17	CHEAL Control 6/30[2]	CHEAL
	lb ai/A		---------------%---------------		plants per m^2
Nontreated check	--	Not-Rolled	--	--	89 e[1]
Nontreated check	--	Rolled	--	--	97 e
safluenacil + metribuzin	0.044 + 0.375	Not-Rolled	47 bc[1]	35 c[1]	47 b-d
safluenacil + metribuzin	0.044 + 0.375	Rolled	40 cd	21 e	53 cd
linuron + sulfentrazone	0.625 + 0.25	Not-Rolled	85 a	59 a	27 ab
linuron + sulfentrazone	0.625 + 0.25	Rolled	80 a	47 b	32 a-c
linuron + flumioxazin	0.625 + 0.064	Not-Rolled	56 b	55 ab	25 ab
linuron + flumioxazin	0.625 + 0.064	Rolled	45 c	34 cd	33 a-d
linuron + imazethapyr	0.625 + 0.031	Not-Rolled	32 d	27 c-e	56 d
linuron + imazethapyr	0.625 + 0.031	Rolled	35 cd	24 de	55 cd
dimethenamid + sulfentrazone	0.984 + 0.25	Not-Rolled	85 a	55 ab	23 a
dimethenamid + sulfentrazone	0.984 + 0.25	Rolled	81 a	50 ab	20 a

[1]Means, based on four replicates, within a column, followed by the same letter are not significantly different at P = 0.05 as determined by the LSMEANS test.
[2]Mechanical treatment had a significant (Pr>F 0.0261) effect on CHEAL control.

Table 3. The effect of herbicides on yield and 100-seed-weight in ‘Frontier’ chickpeas near Pullman, Washington on September 16, 2016.

Treatment	Rate	Yield	100-seed-weight
	lb ai/A	lb/A	g
Nontreated check	--	878 b[1]	38.4 a
safluenacil + metribuzin	0.044 + 0.375	1302 a	39.1 a
linuron + sulfentrazone	0.625 + 0.25	1322 a	38.6 a
linuron + flumioxazin	0.625 + 0.064	1167 a	38.5 a
linuron + imazethapyr	0.625 + 0.031	1140 a	38.6 a
dimethenamid + sulfentrazone	0.984 + 0.25	1320 a	37.8 a
LSD (0.05)		250	ns

[1] Means, based on eight replicates, within a column, followed by the same letter are not significantly different at P = 0.05 as determined by Fisher's protected LSD test.

Postemergence weed control with atrazine, tembotrione, thiencarbazone, and dicamba in corn resistant to glufosinate and glyphosate. Randall S. Currie and Patrick W. Geier. (K-State Southwest Research-Extension Center, 4500 E. Mary Street, Garden City, KS 67846) An experiment conducted at the Kansas State University Southwest Research-Extension Center near Garden City, KS to evaluate early postemergence weed control in corn with resistance to glufosinate and glyphosate. All treatments were applied on June 17, 2016 when corn had two true leaves. A tractor-mounted, compressed-CO^2 sprayer delivering 20 gpa at 3.0 mph and 30 psi was used to apply all treatments. Plots were 10 by 35 feet, and arranged in a randomized complete block design with four replications. Soil was a Ulysses silt loam with pH of 8.0, 1.4% organic matter, and cation exchange capacity of 18.4. Weed control was determined visually on June 24 and August 18, 2016, which was 7 and 62 days after treatment (DAT), respectively. Corn yield was determined October 3, 2016 by mechanically harvesting the center two rows of each plot and adjusting grain weights to 15.5% moisture.

All herbicides controlled quinoa 100% regardless of the evaluation date (data not shown). Control of kochia, Palmer amaranth, and crabgrass was 96% or more with all herbicides at 7 DAT. By 62 DAT, control of these three weed species was generally best when glyphosate, atrazine, and dicamba were included in the herbicide mixture. Herbicide-treated corn yielded 40 to 66 bu/A more grain than untreated corn, but yields did not differ between any herbicide treatment.

Table. Postemergence herbicides in resistant corn.

Treatment[a]	Rate	Palmer amaranth		Green foxtail		Crabgrass		Corn yield
		7 DAT[b]	62 DAT	7 DAT	62 DAT	7 DAT	62 DAT	
	lb ai/A	—— % Control ——		—— % Control ——		—— % Control ——		bu/A
S-metolachlor/ Glyphosate/ Mesotrione +	1.94	100	99	100	99	100	98	117.1
Dicamba +	0.25							
Atrazine +	1.0							
NIS +	0.25%							
AMS	2 lb							
Glufosinate +	0.53	100	91	100	89	100	76	113.4
Dicamba/ Tembotrione	0.304							
Atrazine +	1.0							
AMS	3 lb							
Glufosinate +	0.53	96	85	100	91	98	86	113.6
Thiencarbazone/ Tembotrione +	0.081							
AMS	3 lb							
Glyphosate +	1.13	100	94	100	98	99	91	139.5
Thiencarbazone/ Tembotrione +	0.081							
Atrazine +	1.0							
Dicamba +	0.25							
Superb HC +	0.5%							
AMS	2 lb							
Untreated	---	0	0	0	0	0	0	73.1
LSD (0.05)		1	5	NS	6	3	8	26.7

[a] AMS is ammonium sulfate and NIS is nonionic surfactant.
[b] DAT is days after herbicide treatment.

Topramezone, dicamba, saflufenacil, and dimethenamid for sequential weed control in corn. Randall S. Currie and Patrick W. Geier. (K-State Southwest Research-Extension Center, 4500 E. Mary Street, Garden City, KS 67846) An experiment conducted at the Kansas State University Southwest Research-Extension Center near Garden City, KS evaluated sequential (preemergence followed by postemergence) herbicide applications for weed control in corn. A single early postemergence treatment was included for comparison purposes, and was applied when the corn had two visible leaf collars (V2). The postemergence treatments were applied when corn had five visible leaf collars (V5). Application dates and environmental conditions are shown in Table 1. All herbicides were applied using a tractor-mounted or backpack delivering 19.5 or 20 gpa at 3.0 mph and 30 or 27 psi. Plot sizes were 10 by 35 feet, and were arranged in a randomized complete block design with four replications. Soil was a Ulysses silt loam with 1.4% organic matter, pH of 8.0, and cation exchange capacity of 18.4. Visual weed control was determined June 17 and August 18, 2016, which was 1 and 63 days after the postemergence applications (DA-C). Yields were determined on September 26, 2016 by mechanically harvesting the center two rows of each plot and adjusting weights to 15.5% moisture.

Table 1. Application information.

Application timing	Preemergence	Early postemergence	Postemergence
Application date	May 13, 2016	June 1, 2016	June 16, 2016
Air temperature (F)	80	66	75
Relative humidity (%)	36	61	52
Soil temperature (F)	63	61	73
Wind speed (mph)	6 to 9	2 to 4	6 to 8
Wind direction	West-Southwest	West	South
Soil moisture	Good	Excellent	Good

Quinoa and common sunflower control was 98 to 100% regardless of treatment or evaluation date (data not shown). Kochia control was 95% or more with all treatments at 1 DA-C, and 100% regardless of treatment at 63 DA-C. Palmer amaranth and green foxtail control was 93 to 100% and 83 to 93%, respectively, with all treatments at 1 DA-C. However, complete control of Palmer amaranth and green foxtail occurred with all sequential treatments at 63 DA-C. The single early postemergence treatment controlled Palmer amaranth and green foxtail 90 and 91% at 63 DA-C. Herbicide-treated corn yielded 180 to 193 bu/A, but did not differ between treatments and did not differ from the yield of the untreated control (data not shown).

Table 2. Topramezone, dicamba, saflufenacil, and dimethenamid in corn.

Treatment[a]	Rate	Timing[b]	Kochia 1 DA-C[c]	Kochia 63 DA-C	Palmer amaranth 1 DA-C	Palmer amaranth 63 DA-C	Green foxtail 1 DA-C	Green foxtail 63 DA-C
	lb ai/A		—— % Control ——		—— % Control ——		—— % Control ——	
Saflufenacil/	0.435	PRE	100	100	98	100	88	100
Dimethenamid +								
Atrazine	0.5	PRE						
Dicamba/	0.175	V5						
Diflufenzopyr +								
Atrazine +	0.5	V5						
Glyphosate +	1.13	V5						
MSO +	1%	V5						
AMS	2%	V5						
Saflufenacil/	0.435	PRE	100	100	100	100	83	100
Dimethenamid +								
Atrazine	0.5	PRE						
Topramezone/	0.67	V5						
Dimethenamid +								
Atrazine +	0.5	V5						
Glyphosate +	1.13	V5						
COC +	1%	V5						
AMS	2%	V5						
Saflufenacil/	0.326	PRE	95	100	96	100	84	100
Dimethenamid +								
Atrazine	0.5	PRE						
Topramezone/	0.84	V5						
Dimethenamid +								
Atrazine +	0.5	V5						
Glyphosate +	1.13	V5						
COC +	1%	V5						
AMS	2%	V5						
Pyroxasulfone +	0.108	PRE	100	100	98	100	93	100
Saflufenacil +	0.045	PRE						
Atrazine	0.5	PRE						
Topramezone/	0.84	V5						
Dimethenamid +								
Atrazine +	0.5	V5						
Glyphosate +	1.13	V5						
COC +	1%	V5						
AMS	2%	V5						
Topramezone/	0.84	V2	98	100	93	90	91	91
Dimethenamid +								
Atrazine +	0.5	V2						
Glyphosate +	1.13	V2						
COC +	1%	V2						
AMS	2%	V2						
Untreated	---		0	0	0	0	0	0
LSD (0.05)			4	NS	6	3	5	3

[a] AMS is ammonium sulfate, COC is crop oil concentrate, and MSO is methylated seed oil.
[b] PRE is preemergence, V2 is postemergence to corn with 2 visible leaf collars, and V5 is postemergence to corn with 5 visible leaf collars.
[c] DA-C is days after V5 applications.

Acetochlor, clopyralid, flumetsulam, and mesotrione application timings in corn. Randall S. Currie and Patrick W. Geier. (K-State Southwest Research-Extension Center, 4500 E. Mary Street, Garden City, KS 67846) An experiment conducted at the Kansas State University Southwest Research-Extension Center near Garden City, KS evaluated the efficacy of preplant or preemergence followed by postemergence applications in corn. All herbicides were applied using compressed-CO^2 backpack sprayer delivering 20 gpa at 3.0 mph and 27 psi. Application dates, timings, and environmental conditions are shown in Table 1. Soil was a Ulysses silt loam with 1.4% organic matter, pH 8.0, and cation exchange capacity of 18.4. Plots were 10 by 35 feet, and arranged in a randomized complete block with four replications. Visual estimates of weed control were taken on May 26, and July 7, 2016, which was 30 days after preemergence and 22 days after postemergence applications, respectively. Corn yields were determined September 26, 2016 by mechanically harvesting the two center rows of each plot and adjusting weights to 15.5% moisture.

Table 1. Application information.

Application timing	19 days preplant	Preemergence	Postemergence
Application date	April 7, 2016	April 26, 2016	June 6, 2016
Air temperature (F)	49	81	75
Relative humidity (%)	47	10	83
Soil temperature (F)	47	68	70
Wind speed (mph)	7 to 10	4 to 6	5 to 7
Wind direction	North	South-Southeast	South
Soil moisture	Fair	Good	Excellent

Kochia, Russian thistle, and green foxtail control was 98% or more regardless of herbicide treatment on May 26. Kochia control remained at 98% or more on July 7, while all herbicides provided complete Russian thistle and green foxtail control at the later rating date. Palmer amaranth control was 100% regardless of treatment or evaluation date (data not shown). Herbicide-treated corn yielded 219 to 235 bu/A, which was 86 to 102 bu/A more than nontreated corn; however, no differences in yield occurred among herbicide treatments (data not shown).

Table 2. Acetochlor, clopyralid, flumetsulam, and mesotrione timings in corn.

Treatment[a]	Rate	Timing[b]	Kochia		Russian thistle		Green foxtail	
			May 26	July 7	May 26	July 7	May 26	July 7
	lb ai/A							
Acetochlor/	2.06	19 DPP	100	100	98	100	99	100
Mesotrione/								
Clopyralid +								
Atrazine +	1.0	19 DPP						
Glyphosate +	1.0	19 DPP						
2,4-D ester +	0.5	19 DPP						
AMS	2.5%	19 DPP						
Glyphosate +	1.0	POST						
AMS	2.5%	POST						
Acetochlor/	2.8	PRE	99	100	100	100	100	100
Atrazine +								
Flumetsulam/	0.196	PRE						
Clopyralid +								
Glyphosate +	1.0	PRE						
AMS	2.5%	PRE						
Glyphosate +	1.0	POST						
AMS	2.5%	POST						
Acetochlor/	1.13	PRE	99	98	100	100	99	100
Flumetsulam/								
Clopyralid +								
Atrazine +	1.0	PRE						
Glyphosate +	1.0	PRE						
AMS	2.5%	PRE						
Glyphosate +	1.0	POST						
AMS	2.5%	POST						
Acetochlor/	2.06	PRE	100	100	100	100	100	100
Mesotrione/								
Clopyralid +								
Atrazine +	1.0	PRE						
Glyphosate +	1.0	PRE						
AMS	2.5%	PRE						
Glyphosate +	1.0	POST						
AMS	2.5%	POST						
Acetochlor/	1.03 qt	PRE	100	100	100	100	98	100
Mesotrione/								
Clopyralid +								

Atrazine +	1.0	PRE						
Glyphosate +	1.0	PRE						
AMS	2.5%	PRE						
Acetochlor/ Mesotrione/ Clopyralid +	1.03	POST						
Atrazine +	0.5	POST						
Glyphosate +	1.0	POST						
AMS	2.5%	POST						
Untreated	----	---	0	0	0	0	0	0
LSD (0.05)			2	2	2	NS	3	NS

[a] AMS is ammonium sulfate.

[b] 19 DPP is 19 days preplant, PRE is preemergence and POST is postemergence when corn was 20 to 24 inches tall.

Efficacy of preplant and early postemergence herbicides in corn. Randall S. Currie and Patrick W. Geier. (K-State Southwest Research-Extension Center, 4500 E. Mary Street, Garden City, KS 67846) An experiment conducted at the Kansas State University Southwest Research-Extension Center near Garden City, KS evaluated weed control with single and sequential herbicide treatments in corn. Single treatments were applied on May 23, 2016, which was 11 days prior to planting (11 DPP); sequential treatments consisted of 11 DPP treatments followed by early postemergence applied on June 17, 2016. The early postemergence treatments were applied when corn had two true leaves (V2). All herbicides were applied using a tractor-mounted, compressed-CO^2 sprayer delivering 20 gpa at 3.0 mph and 30 psi. Plots were 10 by 35 feet, and treatments were arranged in a randomized complete block with four replications. Soil was a Ulysses silt loam with 1.4% organic matter, pH of 8.0, and cation exchange capacity of 18.4. Visual weed control was determined on June 2 and August 18, 2016, which was 10 days after the preplant applications (10 DA-A) and 62 days after the early postemergence applications (62 DA-B), respectively. Corn yield was determined September 29, 2016 by mechanically harvesting the center two rows of each plot and adjusting grain weights to 15.5% moisture.

Quinoa and common sunflower control was 95 to 100% regardless of treatment or evaluation date (data not shown), while kochia control was 97% or more. At 63 DA-B, Palmer amaranth control was greater than 96% with all herbicides except isoxaflutole/thiencarbazone plus atrazine and glyphosate (93%). Green foxtail control was generally best (95 to 99%) when sequential herbicides were applied. Corn yields ranged from 138 to 167 bu/A, and did not differ between any treatment (data not shown).

Table. Preplant and early postemergence herbicides in corn.

			Kochia		Palmer amaranth		Green foxtail	
			10	62	10	62	10	62
Treatment[a]	Rate	Timing[b]	DA-A[c]	DA-B[c]	DA-A[c]	DA-B[c]	DA-A[c]	DA-B[c]
	lb ai/A		% Control		% Control		% Control	
Glyphosate +	1.0	11 DPP	0	0	0	0	0	0
AMS	2%	11 DPP						
S-metolachlor/	2.15	11 DPP	99	100	100	100	99	89
Atrazine/								
Mesotrione/								
Bicyclopyrone +								
Atrazine +	0.4	11 DPP						
Glyphosate +	1.0	11 DPP						
AMS	2%	11 DPP						
S-metolachlor/	2.15	11 DPP	100	100	100	100	100	93
Atrazine/								
Mesotrione/								
Bicyclopyrone +								
Atrazine +	0.4	11 DPP						
Dicamba +	0.188	11 DPP						
2,4-D ester +	0.188	11 DPP						
Glyphosate +	1.0	11 DPP						
AMS	2%	11 DPP						
S-metolachlor/	1.29	11 DPP	100	100	95	97	100	95
Atrazine/								
Mesotrione/								
Bicyclopyrone +								
Atrazine +	0.25	11 DPP						
Glyphosate +	1.0	11 DPP						
AMS	2%	11 DPP						
S-metolachlor/	1.94	V2						
Glyphosate/								
Mesotrione +								
Atrazine +	0.5	V2						
NIS +	0.25%	V2						
AMS	2%	V2						
S-metolachlor/	1.29	11 DPP	99	100	100	99	100	97
Atrazine/								
Mesotrione/								
Bicyclopyrone +								
Atrazine +	0.25	11 DPP						
Dicamba +	0.188	11 DPP						
2,4-D ester +	0.188	11 DPP						
Glyphosate +	1.0	11 DPP						
AMS	2%	11 DPP						
S-metolachlor/	1.94	V2						
Glyphosate/								
Mesotrione +								
Atrazine +	0.5	V2						
NIS +	0.25%	V2						
AMS	2%	V2						
S-metolachlor/	1.08	11 DPP	99	100	100	98	100	98
Atrazine/								
Mesotrione/								
Bicyclopyrone +								
Atrazine +	0.2	11 DPP						

Glyphosate +	1.0	11 DPP						
AMS	2%	11 DPP						
S-metolachlor/	1.08	V2						
Atrazine/								
Mesotrione/								
Bicyclopyrone +								
Atrazine +	0.2	V2						
Glyphosate +	1.0	V2						
AMS	2%	V2						
S-metolachlor/	1.08	11 DPP	100	100	100	98	100	99
Atrazine/								
Mesotrione/								
Bicyclopyrone +								
Atrazine +	0.2	11 DPP						
Dicamba +	0.188	11 DPP						
2,4-D ester +	0.188	11 DPP						
Glyphosate +	1.0	11 DPP						
AMS	2%	11 DPP						
S-metolachlor/	1.08	V2						
Atrazine/								
Mesotrione/								
Bicyclopyrone +								
Atrazine +	0.2	V2						
Glyphosate +	1.0	V2						
AMS	2%	V2						
S-metolachlor/	2.48	11 DPP	100	100	100	98	100	88
Atrazine/								
Mesotrione +								
Atrazine +	0.4	11 DPP						
Glyphosate +	1.0	11 DPP						
AMS	2%	11 DPP						
Isoxaflutole/	0.115	11 DPP	98	97	97	93	100	92
Thiencarbazone +								
Atrazine +	1.0	11 DPP						
Glyphosate +	1.0	11 DPP						
AMS	2%	11 DPP						
LSD (0.05)			2	2	4	4	1	6

[a] AMS is ammonium sulfate and NIS is nonionic surfactant.
[b] 11 DPP is 11 days prior to corn planting and V2 is corn with 2 visible leaf collars.
[c] DA-A is days after 11 DPP applications, and DA-B is days after V2 application.

Single and sequential applications of pyroxasulfone, fluthiacet, and mesotrione in corn. Randall S. Currie and Patrick W. Geier. (K-State Southwest Research-Extension Center, 4500 E. Mary Street, Garden City, KS 67846) An experiment conducted at the Kansas State University Southwest Research-Extension Center near Garden City, KS evaluated the efficacy of single and sequential herbicide applications in corn. Treatments were applied preemergence followed by early postemergence (V4) or postemergence (V8) or as early postemergence (V4) alone. All herbicides were applied using a tractor-mounted, compressed-CO^2 sprayer delivering 20 gpa at 3.0 mph and 30 psi. Soil was a Ulysses silt loam with 1.4% organic matter, pH of 8.0, and cation exchange capacity of 18.4. Plots were 10 by 35 feet and arranged in a randomized complete block design with four replications. Visual weed control was determined July 13, 2016, which was 27 days after the V8 applications (27 DA-C). Grain yields were determined September 20, 2016 by mechanically harvesting the center two rows of each plot and adjusting the weights to 15.5% moisture.

Table 1. Application information.

Application timing	Preemergence	V4 corn	V8 corn
Application date	May 6, 2016	June 2, 2016	June 16, 2016
Air temperature (F)	60	76	79
Relative humidity (%)	55	47	46
Soil temperature (F)	57	64	72
Wind speed (mph)	8 to 10	4 to 6	7 to 10
Wind direction	South	South	South
Soil moisture	Good	Good	Good

Quinoa and common sunflower control was 100% regardless of treatment at 27 DA-C (data not shown). All herbicides provided excellent control of kochia, velvetleaf, Palmer amaranth, and green foxtail when applied as sequential treatments. Single applications at the V4 stage, although still good, showed a reduced level of Palmer amaranth and green foxtail control compared to sequential treatments. Herbicide-treated corn yielded 179 to 197 bu/A and did not differ between treatments. Untreated corn yielded 188 bu/A. (data not shown).

Table 2. Pyroxasulfone, fluthiacet, and mesotrione in corn.

Treatment[a]	Rate	Timing[b]	Kochia 27 DA-C[c]	Velvetleaf 27 DA-C	Palmer amaranth 27 DA-C	Green foxtail 27 DA-C
	lb ai/A		% Control			
Pyroxasulfone/ Fluthiacet	0.134	PRE	100	100	100	96
Fluthiacet/ Mesotrione +	0.078	V4				
Atrazine +	1.0	V4				
Glyphosate +	1.13	V4				
COC +	0.5%	V4				
AMS	1%	V4				
Pyroxasulfone/ Fluthiacet +	0.134	PRE	100	100	98	98
Atrazine	1.0	PRE				
Fluthiacet/ Mesotrione +	0.078	V4				
Atrazine +	0.5	V4				
Glyphosate +	1.13	V4				
COC +	0.5%	V4				
AMS	1%	V4				
Pyroxasulfone/ Fluthiacet +	0.134	PRE	100	99	100	100
Atrazine +	1.0	PRE				
Isoxaflutole	0.031	PRE				
Glyphosate +	1.13	V4				
AMS	1%	V4				
Saflufenacil/ Dimethenamid	0.696	PRE	93	98	99	100
Glyphosate +	1.13	V8				
AMS	1%	V8				
Pyroxasulfone/ Fluthiacet +	0.134	PRE	98	98	100	100
Saflufenacil	0.045	PRE				
Glyphosate +	1.13	V8				
AMS	1%	V8				
Pyroxasulfone/ Fluthiacet +	0.134	PRE	100	100	100	100
Isoxaflutole	0.047	PRE				
Glyphosate +	1.13	V8				
AMS	1%	V8				
S-metolachlor/ Glyphosate/ Mesotrione +	1.94	V4	98	100	93	95
NIS +	0.25%	V4				
AMS	1%	V4				
Fluthiacet/ Mesotrione +	0.098	V4	100	100	89	88
Atrazine +	1.0	V4				
Glyphosate +	1.13	V4				
COC +	0.5%	V4				
AMS	1%	V4				
Fluthiacet/ Mesotrione +	0.078	V4	98	100	83	85
Pyroxasulfone/ Fluthiacet +	0.067	V4				

Glyphosate +	1.13	V4				
COC	0.5%	V4				
Fluthiacet/	0.078	V4	100	100	91	91
Mesotrione +						
Pyroxasulfone/	0.067	V4				
Fluthiacet +						
Atrazine +	0.5	V4				
Glyphosate +	1.13	V4				
COC	0.5%	V4				
Pyroxasulfone/	0.134	PRE	100	100	100	100
Fluthiacet +						
Atrazine	1.0	PRE				
Glyphosate +	1.13	V8				
AMS	1%	V8				
S-metolachlor/	2.15	PRE	100	100	100	100
Atrazine/						
Mesotrione/						
Bicyclopyrone						
Glyphosate +	1.13	V8				
AMS	1%	V8				
Isoxaflutole/	0.115	PRE	100	100	100	100
Thiencarbazone +						
Atrazine	1.0	PRE				
Glyphosate +	1.13	V8				
AMS	1%	V8				
Untreated	---	---	0	0	0	0
LSD (0.05)			4	3	5	4

[a] AMS is ammonium sulfate, COC is crop oil concentrate, and NIS is nonionic surfactant.
[b] PRE is preemergence, V4 is corn with 4 visible leaf collars, and V8 is corn with 8 visible leaf collars.
[c] DA-C is days after V8 applications.

<u>Dicamba, tembotrione, atrazine, and glyphosate for efficacy in corn.</u> Randall S. Currie and Patrick W. Geier. (K-State Southwest Research-Extension Center, 4500 E. Mary Street, Garden City, KS 67846) An experiment conducted at the Kansas State University Southwest Research-Extension Center near Garden City, KS evaluated the efficacy of preemergence (PRE), early postemergence (EPOST) and sequential (preemergence followed by postemergence) herbicides in corn. All herbicide treatments were applied using a compressed-CO^2, backpack sprayer delivering 20 gpa at 3.0 mph and 27 psi. Application dates and environmental conditions are given in Table 1. Soil was a Ulysses silt loam with pH 8.0, 1.4% organic matter and cation exchange capacity of 18.4. Plot size was 10 by 35 feet. The experiment was a randomized complete block with each treatment replicated four times. Visual weed control was determined on June 3 and July 7, 2016, which was 9 days after early postemergence and 31 days after the postemergence treatments, respectively. Corn yields were determined September 26, 2016 by mechanically harvesting the center two rows of each plot and adjusting grain moisture to 15.5%.

Table 1. Application information.

Application timing	Preemergence	Early postemergence	Postemergence
Application date	April 28, 2016	May 25, 2016	June 6, 2016
Air temperature (F)	42	64	75
Relative humidity (%)	62	77	40
Soil temperature (F)	53	65	69
Wind speed (mph)	5 to 8	4 to 6	5 to 7
Wind direction	North	West-Northwest	South
Soil moisture	Good	Good	Good

Control of quinoa and Russian thistle was essentially complete regardless of herbicide treatment or evaluation date (data not shown). Kochia control was 95% or more on June 3 regardless of herbicide treatment, and 100% by July 7. Common sunflower control was complete with all EPOST and sequential treatments on July 7. All herbicides controlled green foxtail 95% or more on July 7 except isoxaflutole/thiencarbazone plus atrazine preemergence or the EPOST treatments containing glufosinate. No visible corn injury was observed with any treatment except those containing glufosinate. Glufosinate-containing treatments caused 68 to 70 and 88 to 91% corn injury June 3 and July 7, respectively (data not shown). The corn hybrid used in the study was supposed to be resistant to glyphosate and glufosinate, but it was determined after the early postemergence treatments were applied that the hybrid was not glufosinate-resistant. The high degree of corn injury with the glufosinate treatments severely limited corn yield. All other herbicide-treated corn yielded 21 to 45 bu/A more grain than untreated corn.

Table 2. Dicamba, tembotrione, atrazine, and glyphosate in corn.

Treatment[a]	Rate	Timing[b]	Kochia June 3	Kochia July 7	Common sunflower June 3	Common sunflower July 7	Green foxtail June 3	Green foxtail July 7	Grain yield
	lb ai/A		% control		% control		% control		bu/A
Isoxaflutole +	0.125	PRE	100	100	86	86	100	99	232
Acetochlor/	3.6	PRE							
Atrazine									
Isoxaflutole/	0.115	PRE	100	100	90	85	91	86	226
Thiencarbazone +									
Atrazine	1.0	PRE							
Isoxaflutole +	0.094	PRE	100	100	78	100	90	99	234
Atrazine	1.0	PRE							
Glyphosate +	1.13	POST							
Thiencarbazone/	0.081	POST							
Tembotrione +									
Atrazine +	0.5	POST							
Dicamba +	0.25	POST							
Superb HC +	0.5%	POST							
AMS	2 lb	POST							
Isoxaflutole/	0.068	PRE	100	100	94	100	89	100	221
Thiencarbazone +									
Atrazine	1.0	PRE							
Glyphosate +	1.13	POST							
Tembotrione +	0.082	POST							
Atrazine +	0.5	POST							
Dicamba +	0.25	POST							
Destiny HC +	1%	POST							
AMS	2 lb	POST							
Isoxaflutole/	0.068	PRE	100	100	89	100	91	100	231
Thiencarbazone +									
Atrazine	1.0	PRE							
Glyphosate +	1.13	POST							
Dicamba/	0.304	POST							
Tembotrione +									
Atrazine +	0.5	POST							
Destiny HC +	1%	POST							
AMS	2 lb	POST							
S-metolachlor/	1.94	EPOST	95	100	100	100	100	95	230
Glyphosate/									
Mesotrione +									

Dicamba +	0.25	EPOST							
NIS +	0.25%	EPOST							
AMS	3 lb	EPOST							
Glufosinate +	0.53	EPOST	96	100	100	100	98	65	53
Dicamba/	0.304	EPOST							
Tembotrione +									
Atrazine +	1.0	EPOST							
AMS	3 lb	EPOST							
Glufosinate +	0.53	EPOST	100	100	100	100	97	75	17
Thiencarbazone/	0.081	EPOST							
Tembotrione +									
Atrazine +	1.0	EPOST							
AMS	3 lb	EPOST							
Glyphosate +	1.13	EPOST	99	100	100	100	100	95	245
Thiencarbazone/	0.081	EPOST							
Tembotrione +									
Atrazine +	1.0	EPOST							
Dicamba +	0.25	EPOST							
Superb HC +	0.5%	EPOST							
AMS	2 lb	EPOST							
Untreated	---	---	0	0	0	0	0	0	200
LSD (0.05)			3	NS	9	6	5	5	13.1

[a] AMS is ammonium sulfate, and NIS is nonionic surfactant.
[b] PRE is preemergence, POST is postemergence, and EPOST is early postemergence.

Glyphosate-resistant junglerice control in corn. Sarah R. Parry, Nicholas E. Clark, Eduardo Padilla, Isaac Giron, Brad Hanson, Anil Shrestha, and Steven D. Wright. (University of California Cooperative Extension, Tulare, CA 93274-9537) The objective of this study was to evaluate five herbicides (Table) in glyphosate-resistant corn for control of glyphosate-resistant junglerice. This study was conducted in Tipton, California in June and July, 2015. Plots were 8 by 30 ft replicated four times in a randomized complete block design. Treatments were applied on June 3, 2015. Air temperature was 70°F, wind speeds ranged from three to five mph, and relative humidity was 42%. Applications were sprayed using a CO_2-pressurized backpack sprayer calibrated to deliver 15 gpa at five mph with TJet 8002 flat fan nozzles at 30 psi. At the time of application, junglerice was three inches wide by three inches tall. Weekly evaluations beginning June 10, 2015, of weed control were made from 7 to 28 days after treatment (DAT). After the 28 DAT evaluation, the junglerice was mowed down and a tank-mix of rimsulfuron, tembotrione, and nicosulfuron were applied to further investigate the efficacy of these products and to clean up the trial area.

Under the conditions of this study, nicosulfuron gave complete control of junglerice with low reemergence. Rimsulfuron plus glyphosate and tembotrione plus glyphosate gave good control of junglerice.

To terminate the study, a tank mix of nicosulfuron, rimsulfuron and glufosinate was sprayed over the top of existing treatments as well as to 15 to 18 inch tall junglerice plants on borders. Approximately 80% control was observed with this tank-mix on tall junglerice plants.

Table. Control of glyphosate-resistant junglerice by different herbicides at several timings after treatment.

Treatment[1]	Rate	Weed control				Weed height[2]
		7 DAT	14 DAT	21 DAT	28 DAT	
	lbs ai/A	-----------------------%			-----------------------	Inches
Untreated Control	-	0	0	0	0	28
Tembotrione	0.08	50	63	70	70	11
Thiencarbazone-methyl/tembotrione	0.01/0.07	20	45	50	70	10
Tembotrione + glyphosate	0.08 + 1.38	60	75	80	75	14
Rimsulfuron + glyphosate	0.02 + 1.38	50	60	80	88	9
Glyphosate	1.38	0	0	0	0	28
Nicosulfuron	0.05	65	85	90	100	6

[1]All treatments included the adjuvants AMS and COC at rates of 0.05 and 1.86 lbs ai/A, respectively, except Nicosulfuron which only included COC.
[2]Weed heights were measured at 28 DAT.

Underseeding clovers in small grains to suppress weeds in organic farming. Randy L. Anderson. (USDA-ARS, Brookings SD 57006). Organic producers would like to reduce the amount of tillage they use to control weeds. To help producers achieve this goal, we proposed a rotation comprised of crops with different life cycles to disrupt population dynamics of weeds.

The proposed rotation includes a winter wheat-oat sequence to provide a contrast in life cycles to corn and soybean. One cultural practice that controls weeds without tillage is underseeding. In this practice, red clover is planted into winter wheat in early April, when wheat is tillering. Seedlings of red clover are able to establish, but shading by winter wheat suppresses their growth until wheat harvest. After harvest, red clover commences growth to suppress weeds. Post-harvest growth of red clover reduced weed biomass and volunteer wheat establishment more than 98% compared with a control in a study at this location. In this study, we used mammoth red clover because it is not as persistent as medium red clover. However, mammoth red clover survived the winter at this location and required tillage to terminate the clover before planting a cereal crop the following growing season.

Therefore, we are evaluating other clovers to replace red clover in either cereal crop of this sequence. If these clovers winterkill, tillage will not be needed to terminate clovers in the following year. This report summarizes results from 2 studies.

Methodology:

Study 1. Three clovers, berseem clover (Balady), crimson clover (Dixie), and annual vetch (variety not stated), were underseeded into winter wheat in early April, 2014. Planting rates were 12 lbs/ac for berseem and crimson clover, and 20 lbs/ac for annual vetch. A control treatment of no cover crops was also included. Clover stand counts and biomass of clovers and weeds were measured in mid-September in 3 randomly-placed 0.33-yd^2 quadrats in each plot. Clover plant density also was recorded in April of the following year.

Study 2. Berseem clover and crimson clover were underseeded into oat at 4 planting dates, 0, 15, 30, and 45 days after oat planting (April 1, 2015). A control treatment of no cover crops was also included. Stand counts and biomass of clovers were measured in mid-September in 3 randomly-placed 0.33-yd^2 quadrats in each plot.

Experimental design for both studies was a randomized complete block, with 6 replications. Winter wheat and oat were harvested for yield with a plot combine to determine if legume growth during the cropping season affected grain yield. Average annual rainfall for the study location is 23 inches per year.

Results:

Study 1. The only clover establishing a dense canopy after winter wheat harvest was crimson. Density of berseem clover was less than 1/3 of crimson clover. Annual vetch also did not establish a dense canopy, with only 8 plants/yd^2. Vetch seed is much larger that either crimson or berseem clover, and potential density of seedlings would differ by 7-fold at the seeding rates used. Also, several vetch plants flowered before winter wheat harvest, and did not regrow after being cut during wheat harvest.

All berseem clover plants winterkilled, but both crimson and annual vetch plants survived the winter. Because crimson and vetch plants survived the winter, tillage will be required to control these species before planting a crop the next growing season.

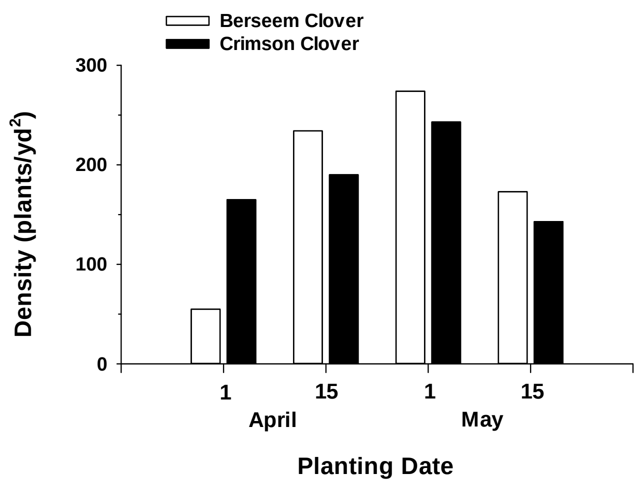
Crimson suppressed weed growth (mainly volunteer wheat) 98% compared to the control, similar to control levels achieved with red clover. Neither berseem clover nor annual vetch suppressed weeds because of low plant densities.

Winter wheat yield was not affected by the presence of any legume, compared with the control treatment of no legumes.

Study 2. Because berseem clover density was so low in the first study, we speculated that berseem clover may not be cold tolerant as crimson. Therefore, we examine clover response to planting dates in our second study to determine if later planting of berseem would minimize cold temperature damage to seedlings. Highest density of berseem occurred when planted on May 1 (See Figure below). Berseem density was 80% lower when planted on April 1 compared with May 1. A surprising trend was that berseem density declined 37% when planted on May 15 compared with the May 1 planting. We speculate that oat competition reduced survival of clover seedlings. On May 15, oat had 3 to 4 leaves, 1-2 tillers, and was 4 to 6 inches tall when berseem was planted. Highest density of crimson clover also occurred with the May 1 planting, and density also declined with the May 15 planting.

Oat yield was not affected by clover interference at any planting date. Winterkill eliminated berseem completely by the following year, but crimson survived the winter, similar to results observed in Study 1.

Figure. Density of berseem clover and crimson clover after oat harvest, when planted at four dates. Oat was planted on April 1.



Management Implications:

Successful establishment of berseem clover in oat when planted on May 1 provides an opportunity for organic producers to suppress weeds after oat harvest. Because berseem winterkills, tillage will not be needed the following year to control berseem plants.

We will be testing this technique in winter wheat also. Crop competition can reduce berseem seedling survival, as shown by the decline in plant density with the May 15 planting in oat. Winter wheat canopy develops faster than oat, thus, later planting dates with berseem may not be effective in winter wheat.

We are encouraging organic producers to consider a 9-year rotation that includes a complexity of crop life cycles. A 2-year interval of small grains will reduce weed density in corn and soybean, if weeds are controlled in the small grains. Underseeded clovers can control after-harvest weeds effectively, and if the clover winterkills, tillage for weed control would not be needed before planting the next crop.

Preemergent control of junglerice and Palmer amaranth. Sarah R. Parry, Nicholas E. Clark, Eduardo Padilla, Isaac Giron, Brad Hanson, Anil Shrestha, and Steven D. Wright. (University of California Cooperative Extension, Tulare, CA 93274-9537) The objective of this study was to evaluate the control of preemergent herbicides at 1x and 2x rates (Table) in a field heavily populated with junglerice and Palmer amaranth. This study was conducted in Tipton, California, in June and July, 2015. Plots were 10 by 30 ft. Each treatment was replicated four times in a randomized complete block design. Treatments were applied June 9, 2015. Air temperature was 82° F, wind speeds ranged from six to eight mph, and relative humidity was 32%. Applications were sprayed at 15 gpa using a CO_2 pressurized backpack sprayer with TJet 8002 flat fan nozzles at 30 psi. Weekly evaluations of weed emergence began seven days after treatment (DAT).

The field was pre-irrigated and disked one week before application. Following application, the field was disked twice at three inches deep within 2 hours after application to incorporate the herbicides. After the 42 DAT rating, there was very little emergence throughout the trial. The highest emergence rates were of junglerice in the untreated control and glyphosate treated plots. Under the conditions of this study, only a few plants emerged. The preemergent herbicides tested, however, showed complete control of junglerice and Palmer amaranth at recommended and double label rates (Table).

Table. Junglerice and Palmer amaranth control by different preemergent herbicide treatments 42 DAT.

Treatment	Rate	Weed control[1]
	lb ai/A	%
Untreated control	-	0
Pendimethalin	1.43	100
Pendimethalin	2.85	100
Trifluralin	1.50	100
Trifluralin	3.00	100
S-metolachlor	1.43	100
Glyphosate[2] + AMS + COC	1.38 + 0.05 + 1.86	0

[1]Measured 42 DAT

[2]Glycine in the form of its potassium salt.

Rates of topramezone/dimethenamid for postemergence weed control in fallow. Randall S. Currie and Patrick W. Geier. (K-State Southwest Research-Extension Center, 4500 E. Mary Street, Garden City, KS 67846) An experiment conducted at the Kansas State University Southwest Research-Extension Center near Garden City, KS evaluated the efficacy of topramezone/dimethenamid rates for postemergence weed control in fallow. All treatments were applied May 16, 2016 when kochia averaged 10 inches tall and 100 plants/m^2 and Russian thistle averaged 4 inches in height and 10 plants/m^2. Herbicides were applied using a compressed-CO^2 backpack sprayer calibrated to deliver 20 gpa at 3.0 mph and 27 psi. Plots were 10 by 35 feet, and arranged in a randomized complete block with four replications. Soil was a Ulysses silt loam with pH 8.0, organic matter of 1.4%, and cation exchange capacity of 18.4. Visual weed control was determined on May 23, June 1, and June 14, 2016, which was 7, 16, and 29 days after treatment (DAT).

At 7 and 16 DAT, control of kochia and Russian thistle generally increased as topramezone/dimethenamid rates increased from 0.59 to 0.84 lb ai/A. By 29 DAT, no differences occurred between herbicide rates. Although these herbicides injured the weeds present, clearly smaller weeds will need to be targeted for effective control.

Table. Topramezone/dimethenamid rates for fallow weed control.

			7 days after treatment		16 days after treatment		29 days after treatment	
Treatment[a]	Rate	Timing	Kochia	Russian thistle	Kochia	Russian thistle	Kochia	Russian thistle
	lb ai/A		% Control		% Control		% Control	
Topramezone/	0.59	POST	27	20	66	73	73	85
Dimethenamid +								
COC +	1%	POST						
AMS	2%	POST						
Topramezone/	0.67	POST	28	18	63	78	70	83
Dimethenamid +								
COC +	1%	POST						
AMS	2%	POST						
Topramezone/	0.75	POST	30	20	68	80	76	86
Dimethenamid +								
COC +	1%	POST						
AMS	2%	POST						
Topramezone/	0.84	POST	35	28	70	80	76	85
Dimethenamid +								
COC +	1%	POST						
AMS	2%	POST						
Untreated	---	---	0	0	0	0	0	0
LSD (0.05)			5	5	7	4	7	6

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

<u>Dicamba, atrazine, saflufenacil, dimethenamid and topramezone application timings for weed control in fallow.</u> Randall S. Currie and Patrick W. Geier. (K-State Southwest Research-Extension Center, 4500 E. Mary Street, Garden City, KS 67846) An experiment was conducted at the Kansas State University Southwest Research-Extension Center near Garden City, KS to examine the efficacy of single and sequential herbicide treatments in fallow. Application, environmental, and weed information are given in Table 1. All herbicides were applied using a compressed-CO^2 backpack sprayer delivering 20 gpa at 3.0 mph and 27 psi. Soil was a Ulysses silt loam with 1.4% organic matter, pH of 8.0, and cation exchange capacity of 18.4. Plots were 10 by 35 feet, arranged in a randomized complete block design with four replications. Control of kochia, Palmer amaranth, and Russian thistle were visually determined on June 9 and July 6, 2016, which was 15 and 42 days after the May 25 application, respectively.

Table 1. Application information.

Application date	March 3, 2016	April 22, 2016	May 11, 2016	May 25, 2016
Air temperature (F)	64	62	50	57
Relative humidity (%)	14	54	64	81
Soil temperature (F)	47	47	60	64
Wind speed (mph)	5	1	5	5
Wind direction	West-Northwest	South	North-Northwest	West-Northwest
Soil moisture	Dry	Good	Fair	Fair
Kochia:				
Height (in)	0.25	0.25	2	3
Density (plants/m^2)	100	75	3	1
Palmer amaranth:				
Height (in)	---	---	2	2
Density (plants/m^2)	0	0	1	1
Russian thistle:				
Height (in)	---	---	---	---
Density (plants/m^2)	0	0	0	0

A single application of dicamba and atrazine applied on March 3rd did not provide more than 93% control of kochia, Russian thistle and Palmer amaranth on June 9th. All other treatments provided 95% or greater control at the June 9th evaluation. Three applications were needed to provide 90% or greater control of all three species through July 6th.

Table 2. Fallow weed control with dicamba, atrazine, saflufenacil, dimethenamid, and topramezone application timings.

			June 9, 2016			July 6, 2016		
Herbicide[a]	Rate	Application date	Kochia	Russian thistle	Palmer amaranth	Kochia	Russian thistle	Palmer amaranth
	lb ai/A		% Control			% Control		
Dicamba +	0.5	March 3	93	88	73	80	88	13
Atrazine +	0.75	March 3						
Glyphosate +	0.77	March 3						
MSO +	1%	March 3						
AMS	2%	March 3						
Dicamba +	0.5	March 3	99	99	95	99	98	61
Atrazine +	0.75	March 3						
Glyphosate +	0.77	March 3						
MSO +	1%	March 3						
AMS	2%	March 3						
Saflufenacil/	0.435	April 21						
Dimethenamid +								
Atrazine +	0.5	April 21						
Glyphosate +	0.77	April 21						
MSO +	1%	April 21						
AMS	2%	April 21						
Dicamba +	0.5	March 3	100	100	100	100	100	90
Atrazine +	0.75	March 3						
Glyphosate +	0.77	March 3						
MSO +	1%	March 3						
AMS	2%	March 3						
Saflufenacil/	0.435	April 21						
Dimethenamid +								
Atrazine +	0.5	April 21						
Glyphosate +	0.77	April 21						
MSO +	1%	April 21						
AMS	2%	April 21						
Topramezone/	0.67	May 25						
Dimethenamid +								
Atrazine +	0.5	May 25						
Glyphosate +	0.77	May 25						
COC +	1%	May 25						
AMS	2%	May 25						
Dicamba +	0.5	March 3	100	100	100	98	100	74
Atrazine +	0.75	March 3						
Glyphosate +	0.77	March 3						

MSO +	1%	March 3						
AMS	2%	March 3						
Topramezone/	0.84	May 12						
Dimethenamid +								
Atrazine +	0.5	May 12						
Glyphosate +	0.77	May 12						
COC +	1%	May 12						
AMS	2%	May 12						
Untreated	---	---	0	0	0	0	0	0
LSD (0.05)			2	3	4	4	4	20

[a] AMS is ammonium sulfate, COC is crop oil concentrate, and MSO is methylated seed oil.

AGH15004 at three rates with several adjuvants for postemergence fallow weed control. Randall S. Currie and Patrick W. Geier. (K-State Southwest Research-Extension Center, 4500 E. Mary Street, Garden City, KS 67846) An experiment conducted at the Kansas State University Southwest Research-Extension Center near Garden City, KS evaluated AGH15004 at three rates and with various adjuvants for weed control in fallow. AGH15004 is a premix of fluroxypyr/bromoxynil/2,4-D ester. All treatments were applied on May 10, 2016 when kochia averaged 5 inches tall and 100 plants/m^2, Russian thistle was 3 inches tall and 3 plants/m^2, and flixweed was 15 inches tall and 10 plants/m^2. Herbicides were applied using a tractor-mounted, compressed-CO^2 sprayer delivering 20 gpa at 3.0 mph and 30 psi. Plots were 10 by 35 feet, and treatments were arranged in a randomized complete block with four replications. Visual weed control was determined on May 24 and June 6, 2016. These dates were 14 and 27 days after herbicide treatment (DAT).

When no adjuvant was included, control of kochia, Russian thistle, and flixweed increased as fluroxypyr/bromoxynil/2,4-D rate increased at 14 DAT. Within herbicide rates, no adjuvant system increased the efficacy of fluroxypyr/bromoxynil/2,4-D alone on any species at 14 DAT. By 27 DAT, Russian thistle and flixweed control was complete regardless of herbicide rate or adjuvant, and kochia control was generally best when fluroxypyr/bromoxynil/2,4-D was applied ate 0.94 lb/A.

AGH15004 rates and adjuvants for postemergence fallow weed control.

Herbicide[a]	Rate	14 days after treatment			27 days after treatment		
		Kochia	Russian thistle	Flixweed	Kochia	Russian thistle	Flixweed
	lb ai/A	% Control			% Control		
Fluroxypyr/ Bromoxynil/ 2,4-D ester	0.56	75	86	71	76	100	100
Fluroxypyr/ Bromoxynil/ 2,4-D ester + Destiny HC + InterLock	0.56 16 oz 4 oz	78	89	78	81	100	100
Fluroxypyr/ Bromoxynil/ 2,4-D ester + AG14039	0.56 16 oz	78	88	75	80	100	100
Fluroxypyr/ Bromoxynil/ 2,4-D ester	0.75	83	90	78	83	100	100
Fluroxypyr/ Bromoxynil/ 2,4-D ester + Destiny HC + InterLock	0.75 16 oz 4 oz	80	93	80	84	100	100
Fluroxypyr/ Bromoxynil/ 2,4-D ester + AG14039	0.75 16 oz	79	91	79	90	100	100
Fluroxypyr/ Bromoxynil/ 2,4-D ester	0.94	85	95	83	91	100	100
Fluroxypyr/ Bromoxynil/ 2,4-D ester + Destiny HC + InterLock	0.94 16 oz 4 oz	83	95	83	91	100	100
Fluroxypyr/ Bromoxynil/ 2,4-D ester + AG14039	0.94 16 oz	83	95	80	85	100	100
Glyphosate + AMS	1.13 2%	45	89	70	83	100	100
Pyraflufen + Dicamba + 2,4-D amine + MSO	0.003 0.006 0.25 1%	79	86	81	78	100	100
Untreated	---	0	0	0	0	0	0
LSD (0.05)		4	3	6	6	NS	NS

[a] AMS is ammonium sulfate, MSO is methylated seed oil.

Isoxaflutole, atrazine, thiencarbazone, iodosulfuron, and dicamba for preemergence kochia control in fallow. Randall S. Currie and Patrick W. Geier. (K-State Southwest Research-Extension Center, 4500 E. Mary Street, Garden City, KS 67846) An experiment was conducted at the Kansas State University Southwest Research-Extension Center near Garden City, KS to examine the efficacy of fall and spring preemergence herbicides in fallow. Fall applications were applied December 3, 2015 and spring treatments were applied March 3, 2016. All herbicides were applied using a tractor-mounted, CO^2-pressurized plot sprayer delivering 20 gpa at 30 psi and 4.1 mph. Soil was a Ulysses silt loam with 1.4% organic matter, pH of 8.0, and a cation exchange capacity of 18.4. Plots were 10 by 35 feet. The experimental design was a randomized complete block and treatments were replicated four times. Visual kochia control was determined on April 6, May 26, and July 28, 2016, which was 5, 12, and 21 weeks after spring applications (WA-B), respectively.

Treatments that provided greater than 93% control 12 weeks after spring treatment were better than most other treatments, but not better than treatments that provided 97% control. These treatments were all various tankmixes of isoxaflutole and atrazine. No treatment provided more than 65% kochia control at 21 weeks after spring application.

Table. Fallow kochia control with isoxaflutole, atrazine, thiencarbazone, iodosulfuron, and dicamba.

Herbicide[a]	Rate	Timing	Kochia 5 WA-B[b]	Kochia 12 WA-B	Kochia 21 WA-B
	lb/A		% Control		
Isoxaflutole +	0.063	Fall	100	84	40
Atrazine	1.0	Fall			
Isoxaflutole +	0.063	Fall	100	86	43
Atrazine +	1.0	Fall			
Iodosulfuron/	0.016	Fall			
Thiencarbazone					
Isoxaflutole/	0.082	Fall	100	86	38
Thiencarbazone +					
Atrazine	1.0	Fall			
Sulfentrazone/	0.338	Fall	99	78	30
Metribuzin					
Atrazine	1.0	Fall	100	80	35
Atrazine +	1.0	Fall	100	87	43
Isoxaflutole +	0.063	Spring			
Metribuzin +	0.375	Spring			
MSO	1%	Spring			
Atrazine +	1.0	Fall	99	89	38
Isoxaflutole/	0.072	Spring			
Thiencarbazone +					
Metribuzin +	0.375	Spring			
MSO	1%	Spring			
Isoxaflutole +	0.063	Spring	100	90	50
Atrazine +	1.0	Spring			
MSO	1%	Spring			
Isoxaflutole +	0.063	Spring	99	93	48
Atrazine +	1.0	Spring			
Dicamba +	0.375	Spring			
MSO	1%	Spring			
Isoxaflutole +	0.063	Spring	100	93	50
Atrazine +	1.0	Spring			
Iodosulfuron/	0.016	Spring			
Thiencarbazone +					
MSO	1%	Spring			
Isoxaflutole +	0.063	Spring	99	95	65
Atrazine +	1.0	Spring			
Iodosulfuron/	0.016	Spring			
Thiencarbazone +					
Dicamba +	0.375	Spring			
MSO	1%	Spring			
Isoxaflutole/	0.072	Spring	99	95	53
Thiencarbazone +					
Atrazine +	1.0	Spring			
MSO	1%	Spring			
Isoxaflutole/	0.082	Spring	100	97	63
Thiencarbazone +					
Atrazine +	1.0	Spring			
Dicamba +	0.375	Spring			
MSO	1%	Spring			
Atrazine +	1.0	Spring	99	89	50
Dicamba +	0.375	Spring			
MSO	1%	Spring			
Sulfentrazone/	0.28	Spring	99	89	25

Metribuzin					
Untreated	---	---	0	0	0
LSD (0.05)			2	4	13

[a] MSO is methylated seed oil.
[b] WA-B is weeks after spring application.

Winter and early spring herbicides for kochia control in fallow. Randall S. Currie and Patrick W. Geier. (K-State Southwest Research-Extension Center, 4500 E. Mary Street, Garden City, KS 67846) An experiment was conducted at the Kansas State University Southwest Research-Extension Center near Garden City, KS to examine the efficacy of winter and early spring herbicide applications for kochia control in fallow. Herbicides were applied December 3, 2015 and March 14, 2016. Soil was a Ulysses silt loam with 1.4% organic matter, pH of 8.0, and cation exchange capacity of 18.4. Plots were 10 by 35 feet and arranged in a randomized complete block replicated four times. A tractor-mounted, compressed-CO^2 sprayer delivering 20 gpa at 3.0 mph and 30 psi was used to apply all herbicides. Kochia plants in the spring averaged less than 0.5 inch tall and 100 plants/m^2 on March 14. Visual weed control was determined on March 7, April 1, and June 8, 2016, which was 95 days after winter applications, and 18 and 86 days after spring applications, respectively.

All herbicide treatments applied in December provided 99 or 100 kochia control on March 7 and April 1, 2016. However, control declined to less than 60% with these treatments by June 8. Spring-applied herbicides were generally more efficacious than winter-applied herbicides on June 8, with the best control from treatments of dicamba plus atrazine with or without pyroxasulfone (88 to 89%).

Table. Winter and spring herbicide applications for kochia control.

Herbicide	Rate	Timing	Kochia March 7	Kochia April 1	Kochia June 8
	lb ai/A		% Control		
Dicamba +	0.5	Winter	100	100	53
Atrazine	0.75	Winter			
Saflufenacil +	0.045	Winter	99	99	45
Atrazine	0.75	Winter			
Saflufenacil +	0.045	Winter	100	100	53
Atrazine +	0.75	Winter			
Dicamba	0.25	Winter			
Pyroxasulfone +	0.13	Winter	100	100	55
Atrazine +	0.75	Winter			
Dicamba	0.25	Winter			
Saflufenacil/	0.085	Winter	100	100	59
Imazethapyr +					
Pyroxasulfone +	0.106	Winter			
Dicamba	0.25	Winter			
Isoxaflutole/	0.068	Winter	100	100	53
Thiencarbazone +					
Atrazine +	0.75	Winter			
Dicamba	0.25	Winter			
Dicamba +	0.5	Spring	---	65	88
Atrazine	0.75	Spring			
Saflufenacil +	0.045	Spring	---	70	74
Atrazine	0.75	Spring			
Saflufenacil +	0.045	Spring	---	70	73
Atrazine +	0.75	Spring			
Dicamba	0.25	Spring			
Pyroxasulfone +	0.13	Spring	---	63	89
Atrazine +	0.75	Spring			
Dicamba	0.25	Spring			
Saflufenacil/	0.085	Spring	---	60	58
Imazethapyr +					
Pyroxasulfone +	0.106	Spring			
Dicamba	0.25	Spring			
Isoxaflutole/	0.068	Spring	---	75	64
Thiencarbazone +					
Atrazine +	0.75	Spring			
Dicamba	0.25	Spring			
Untreated	---	---	0	0	0
LSD (0.05)			2	6	7

<u>Weed management in carbon-seeded tall fescue with preemergence herbicides</u>. Daniel W. Curtis, Kyle C. Roerig, Andrew G. Hulting and Carol A. Mallory-Smith. (Department of Crop and Soil Science, Oregon State University, Corvallis, OR, 97331) This study was conducted to evaluate crop safety in tall fescue grown for seed and evaluate control of diuron resistant annual bluegrass (*Poa annua*) and roughstalk bluegrass (*Poa trivialis*) following applications of preemergence herbicides. 'Rebel XLR' tall fescue was planted in 12 inch rows, 0.25 inches deep with a 1-inch wide band of activated carbon sprayed over the seed rows at 300 lb per acre. Plots were 8 x 35 ft with 24 rows of carbon-seeded tall fescue and had three rows of diuron resistant *Poa annua* and three rows of *Poa trivialis* planted without carbon in a fallow area in the front of each plot. *Poa annua* and *Poa trivialis* were planted immediately following planting of tall fescue. Application and soil data are presented in Table 1. The study was comprised of 13 treatments which included a grower standard of diuron plus pronamide (Table 2). Treatments were arranged in a randomized complete block design with four replications. The study area received 0.20 inches of rain on September 25. Overhead irrigation was started on September 28 with an application of 0.25 inches and irrigation continued through crop emergence. Broadleaf weeds were removed with a broadcast application of pyrasulfotole/bromoxynil plus MCPA ester on November 18. The crop was swathed on June 24, and threshed with a small plot combine on July 15. Seed was cleaned with a Clipper Cleaner and yields were quantified (Table 2).

Table 1. Application and soil data

Planting date	Sept. 23, 2015
Application date	Sept. 24, 2015
Crop growth stage	preemergence
Poa annua growth stage	preemergence
Poa trivialis growth stage	preemergence
Air temperature (F)	73
Relative humidity (%)	65
Wind (mph, direction)	calm
Cloud cover (%)	30
First moisture (inches)	Sept. 25 (0.20)
Soil temperature at 2 inches (F)	67
Soil pH	5.7
Soil OM (%)	4.0
Soil CEC (meq/100g)	8.1
Soil texture	silt loam

An uncontrolled background population of *Poa annua* reduced yield in the untreated check in comparison to the herbicide treatments. Visual evaluations of crop injury indicated that rates of indaziflam above 0.01 lb ai/A led to substantial injury. Slight injury was apparent with pyroxasulfone/flumioxazin applied at greater than 0.07 lb ai/A. By the time of swathing the grass seed crop recovered from the injury. The addition of pronamide to the indaziflam or pyroxasulfone/flumioxazin did not negatively affect yields. Indaziflam controlled both *Poa* species 99 - 100%. Pyroxasulfone/flumioxazin controlled the *Poa annua* 98 - 99%, but control of the *Poa trivialis* was slightly less at 89 - 97%.

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

Treatment	Rate	*Poa annua*	*Poa trivialis*	Crop injury	Clean seed yield
	lb ai/A	------- % control[1]	-------	- % -	lb/A
untreated check	0	0	0	0	613
indaziflam	0.01	99	99	0	847
indaziflam	0.02	100	100	15	989
indaziflam	0.03	100	100	38	897
indaziflam	0.04	100	100	73	729
indaziflam +	0.01	100	100	5	886
pronamide	0.13				
pyroxasulfone/flumioxazin	0.07	99	89	0	692
pyroxasulfone/flumioxazin	0.1	99	91	8	1005
pyroxasulfone/flumioxazin	0.14	99	97	9	1107
pyroxasulfone/flumioxazin +	0.07	98	94	4	978
pronamide					
rimsulfuron + pronamide	0.05 + 0.13	92	99	5	1067
diuron +pronamide	1.6 + 0.13	93	97	0	801
LSD (P = 0.05)		4	4	16	270
CV		3	3	86	21

[1] control and crop injury evaluated May 10, 2016

<u>Weed management in carbon-seeded orchardgrass with preemergence herbicides.</u> Daniel W. Curtis, Kyle C. Roerig, Andrew G. Hulting and Carol Mallory-Smith. (Department of Crop and Soil Science, Oregon State University, Corvallis OR, 97331) This study was conducted to evaluate orchardgrass grown for seed crop safety and control of diuron resistant annual bluegrass (*Poa annua*) and roughstalk bluegrass (*Poa trivialis*) following applications of preemergence herbicides. 'Persist' orchardgrass was planted in 12 inch rows, 0.25 inches deep with a 1-inch wide band of activated carbon sprayed over the seed rows at 300 lb per acre. Treatments were arranged in a randomized complete block design with four replications. Plots were 8 x 35 ft with 24 rows of carbon-seeded orchardgrass and had three rows of diuron resistant *Poa annua* and three rows of *Poa trivialis* planted without carbon in a fallow area in the front of each plot. Applications were made September 24 (Table 1). The study was comprised of 13 treatments which included a grower standard of diuron plus pronamide (Table 2). The study area received 0.20 inches of rain on September 25. Overhead irrigation was started September 28 with an application of 0.25 inches and continued through crop emergence. Broadleaf weeds were removed with a broadcast application of pyrasulfotole/bromoxynil plus MCPA ester on November 18. The crop was swathed on June 21, and threshed with a small plot combine on July 14. Seed was cleaned with a Clipper Cleaner and yields were quantified (Table 2).

Table 1. Application and soil data

Planting date	Sept. 23, 2015
Application date	Sept. 24, 2015
Crop growth stage	preemergence
Poa annua growth stage	preemergence
Poa trivialis growth stage	preemergence
Air temperature (F)	73
Relative humidity (%)	65
Wind (mph, direction)	calm
Cloud cover (%)	30
First moisture (inches)	Sept. 25 (0.20)
Soil temperature at 2 inches (F)	67
Soil pH	5.7
Soil OM (%)	4.0
Soil CEC (meq/100g)	8.1
Soil texture	silt loam

Visual evaluations of crop injury indicated that rates of indaziflam above 0.01 lb ai/A led to substantial injury. Visual injury was also apparent at the highest rate of pyroxasulfone/flumioxazin. The pronounced injury in the high rate of indazaflam resulted in yield loss while the injured pyroxasulfone/flumioxazin treatment recovered by the time of swathing. The addition of pronamide to the indaziflam or pyroxasulfone/flumioxazin did not negatively affect yields. Control of the *Poa* species with indaziflam was 96 – 100%. Control of the *Poa annua* was slightly greater than the control of *Poa trivialis* with pyroxasulfone/flumioxazin, 95 - 99% and 92 - 97% respectively.

Table 2. Control of *Poa* species, crop injury and seed yield with herbicide treatments in carbon-seeded orchardgrass.

Treatment	Rate	*Poa annua*	*Poa trivialis*	Crop injury	Clean seed yield
	lb ai/A	------- % control[1] -------		- % -	lb/A
untreated check	0	0	0	0	301
indaziflam	0.01	100	100	0	370
indaziflam	0.02	100	100	13	355
indaziflam	0.03	100	100	20	320
indaziflam	0.04	100	100	63	192
indaziflam +	0.01	96	98	0	362
pronamide	0.13				
pyroxasulfone/flumioxazin	0.07	96	92	0	368
pyroxasulfone/flumioxazin	0.1	95	94	1	422
pyroxasulfone/flumioxazin	0.14	99	96	20	400
pyroxasulfone/flumioxazin + pronamide	0.07	97	97	0	394
rimsulfuron + pronamide	0.05 + 0.13	95	99	0	326
diuron +pronamide	1.6 + 0.13	95	96	0	371
LSD (P = 0.05)		5	5	24	117
CV		4	4	175	23

[1] control and crop injury evaluated May 10, 2016

Crop safety and weed control with PPO inhibitors and pyroxasulfone in peppermint. Kyle C. Roerig, Andrew G. Hulting, Daniel W. Curtis, and Carol A. Mallory-Smith. (Department of Crop and Soil Science, Oregon State University, Corvallis, OR 97331) A trial was conducted in an established peppermint field to assess the crop safety and weed control efficacy of pyroxasulfone containing products and PPO inhibitor herbicides: saflufenacil, carfentrazone, and flumioxazin. Paraquat was included as a comparison. Pyroxasulfone provides pre-emergent control of many annual broadleaf and grass weeds impacting mint production in western Oregon. Pyroxasulfone treatments were applied with other herbicides in two premixes (pyroxasulfone-carfentrazone and pyroxasulfone-flumioxazin). Treatments were applied at three timings as indicated in Table 1. The plots were harvested June 22, 2016, and sub-samples were collected and distilled to calculate oil yield.

April 21, 2016, applications of the three PPO inhibitors resulted in oil yield lower than the highest yielding treatments (Table 2). Flumioxazin and pyroxasulfone-flumioxazin provided 99% or greater control of purslane speedwell when applied February 9 or March 29, 2016. Saflufenacil applied February 9 or March 29, 2016, and paraquat applied February 9, 2016, provided 97% or more control of common groundsel. Carfentrazone failed to control common groundsel and purslane speedwell at all three timings. Flumioxazin failed to control common groundsel and saflufenacil failed to control purslane speedwell at timings that are safe for mint. These results indicate that products including saflufenacil, carfentrazone, and flumioxazin can be applied safely at the rates tested in dormant or semi-dormant mint in mid-winter to early spring under western Oregon production conditions, but by April 21 there was too much regrowth to safely apply these herbicides.

Table 1. Application description.

Application Date:	2/9/2016	3/29/2016	4/21/2016
Appl. Start Time:	11:00 AM	8:35 AM	4:20 PM
Air Temperature, Unit:	54 F	44 F	72 F
% Relative Humidity:	95	95	48
Dew Presence (Y/N):	No	Yes	No
Soil Temperature, Unit:	46 F	41 F	70 F
Soil Moisture:	WET	MOIST	SLIWET
Crop Stage:	1"	2-3"	2-8"
Common groundsel:	3-5"	blooming	full bloom
Purslane speedwell:		1-4"	2-6"

Table 2. Evaluation of pyroxasulfone containing products and PPO inhibitor timing for weed control crop safety.

	Rate	Applied	Common groundsel		Purslane speedwell		Prickly lettuce count[2]		Peppermint injury[2]		Peppermint oil yield[3]	
			control[1]									
	lb ai/a		----------%----------				#/plot		%		lb/acre	
untreated			0	d	0	f	3.2	a	0	d	50.7	cd
pyroxasulfone-carfentrazone	0.140	2/9/2016	0	d	88	ab	0.5	ab	3	d	56.2	bc
pyroxasulfone-flumioxazin	0.214	2/9/2016	50	bc	100	a	0.0	b	0	d	61.6	ab
paraquat	0.750	2/9/2016	97	a	8	f	0.5	ab	3	d	61.4	ab
saflufenacil	0.045	2/9/2016	99	a	49	cde	0.3	ab	0	d	66.7	a
carfentrazone	0.016	2/9/2016	22	cd	78	abc	0.5	ab	0	d	55.7	bc
flumioxazin	0.080	2/9/2016	8	d	99	a	0.0	b	2	d	57.6	bc
saflufenacil	0.045	3/29/2016	100	a	43	de	0.2	ab	25	c	61.1	ab
carfentrazone	0.016	3/29/2016	35	cd	35	e	1.3	ab	2	d	58.0	bc
flumioxazin	0.080	3/29/2016	32	cd	99	a	1.3	ab	13	cd	56.0	bc
saflufenacil	0.045	4/21/2016	90	a	85	ab	0.0	b	53	a	52.7	cd
carfentrazone	0.016	4/21/2016	18	cd	58	b-e	2.7	ab	15	cd	52.1	cd
flumioxazin	0.080	4/21/2016	68	ab	70	a-d	2.0	ab	42	b	47.1	d
LSD P=.05			23		24		1.8		11		7.8	
Standard Deviation			20		20		1.6		9		6.7	
CV			42		33		164.7		75		11.8	

[1]Evaluated 5/5/16

[2]Evaluated 6/2/16

[3]Harvested 6/22/16

<u>Weed management in non-carbon-seeded perennial ryegrass.</u> Daniel W. Curtis, Kyle C. Roerig, Andrew G. Hulting and Carol A. Mallory-Smith. (Department of Crop and Soil Science, Oregon State University, Corvallis, OR 97331) In Oregon, perennial ryegrass grown for seed is typically planted with a 1-inch band of activated carbon to protect the planted row from an application of a preemergence herbicide. This study was conducted to evaluate crop safety and weed control efficacy of postemergence applications of herbicides typically applied preemergence with carbon-seeding (indaziflam, pyroxasulfone/flumioxazin and bicyclopyrone/mesotrione/s-metolachlor) and postemergence herbicides to a new stand of perennial ryegrass planted without carbon-seeding. 'Silver Dollar' perennial ryegrass was seeded in 12 inch rows, 0.25 in deep on October 20, 2015 (Table 1). Plot size was 8 x 25 ft with four replications in a randomized complete block design. Nine herbicide treatments were applied at the 1 tiller stage of growth. An untreated check treatment was included (Table 2). The water table rose following four days of heavy rainfall following application flooding replications one and two for two days which may have led to the high degree of variability between replications. The perennial ryegrass was swathed on July 7, 2016 and harvested on July 15 with a small plot combine. The seed was cleaned and yield quantified (Table 2).

Table 1. Application and soil data

Planting date	Oct. 20, 2015
Application date	Jan. 27, 2016
Crop growth stage	3 leaf-1tiller
Air temperature (F)	58
Relative humidity (%)	85
Wind (mph, direction)	0-4/SSW
Cloud cover (%)	80
First moisture (inches)	Jan. 28, 2016 (0.43)
Soil temperature at 2 inches (F)	54
Soil pH	5.7
Soil OM (%)	4.0
Soil CEC (meq/100g)	8.1
Soil texture	silt loam

Overall weed populations were low. Postemergence applications of the preemergence herbicides indaziflam, pyroxasulfone/flumioxazin and bicyclopyrone/mesotrione/s-metolachlor resulted in a reduction of *Poa annua* populations with pyroxasulfone/flumioxazin providing 68% control. Bicylopyrone/bromoxynil controlled *Capsella bursa-pastoris*, *Calandrinia ciliata*, *Spergula arvensis*, *Lupinus micranthus*, *Trifolium repens*, *Cerastium glomeratum* and *Scleranthus annus* greater than or equal to 90%. The bicyclopyrone/mesotrione/s-metolachlor controlled *C. bursa-pastoris*, *S. arvensis*, *T. repens*, *C. glomeratum* and *S. annuss*. The halauxifen/florasulam controlled *C. bursa-pastoris*, *C. ciliata*, *L. micranthus*, *T. repens*, and *C. glomeratum*. Mesotrione controlled *C. bursa-pastoris*, *L. micranthus*, *T. repens* and *C. glomeratum*. Saflufenacil controlled *S. arvensis, T. repens*, and *C. glomeratum*. 2,4-D/dicamba controlled *C. ciliata*, *L. micranthus*, *T. repens* and *S. annuss.* Pyroxasulfone/flumioxazin controlled *C. bursa-pastoris*, *S. arvensis*, and *S. annuss*. Pyrasulfotole/bromoxynil controlled *C. bursa-pastoris*, *C. ciliata,* and *L. micranthus.* Indaziflam controlled *S. annuss*. All yields were equivalent to the untreated.

Table 2. Crop injury, weed control and yield of non-carbon-seeded perennial ryegrass grown for seed following postemergence herbicide application, Corvallis, 2015 -2016

Treatment	Rate	Crop injury	*Poa annua*	*Capsella bursa-pastoris*	*Calandrinia ciliata*	*Spergula arvensis*	*Lupinus micranthus*	*Trifolium repens*	*Cerastium glomeratum*	*Scleranthus annuss*	Yield seed
	lb ai/A	--%--				% control Apr. 12, 2016					lb/A
untreated	0	0	0	0	0	0	0	0	0	0	1360
indaziflam	0.01	1	35	58	32	63	50	68	68	93	1203
pyroxasulfone/flumioxazin	0.07	1	68	100	75	100	23	63	63	100	1376
bicyclopyrone/mesotrione/ s-metolachlor	0.82	25	33	100	68	93	88	95	95	93	1144
bicyclopyrone/bromoxynil + sodium bicarbonate	13.7[1] + 5[1]	0	0	100	100	98	90	90	90	98	1445
halauxifen/florasulam	0.75[2]	0	5	100	98	85	100	100	100	50	1513
pyrasulfotole/bromoxynil	0.24	0	0	98	100	45	100	65	65	35	1535
mesotrione	0.09	0	0	100	68	75	100	100	100	88	1646
saflufenacil	0.05	0	0	88	73	100	95	100	100	65	1457
2,4-D/dicamba acid	20[3]	0	0	70	100	8	100	100	45	90	1424
LSD (P = 0.05)		3	12	23	38	33	34	23	42	44	289
CV		75	57	19	37	35	31	21	44	55	14

[1]13.7 fl oz/A product, bicyclopyrone 0.033 lb ai/A, bromoxynil 0.155 lb ae/A, sodium bicarbonate 5 fl oz/A product
[2]0.75 oz/A product, halauxifen-methyl 0.005 lb ae/A, florasulam 0.005 lb ai/A
[3]20 oz product/A, 0.375 lb ae/A

<u>Italian ryegrass control with pyroxasulfone/carfentrazone in wheat</u>. Traci A. Rauch and Joan M. Campbell. (Crop and Weed Science Division, University of Idaho, Moscow, ID 83844-2339) Studies were established to evaluate wheat response and Italian ryegrass (LOLMU) control with pyroxasulfone/carfentrazone near Potlatch, ID in winter wheat and near Pullman, WA in spring wheat. The plots were arranged in a randomized complete block design with four replications and included an untreated check. All herbicide treatments were applied using a CO_2 pressurized backpack sprayer calibrated to deliver 10 gpa at 32 psi and 3 mph (Table 1).

At Potlatch, the study area was oversprayed with glyphosate at 1.1 lb ae/A on September 28 and October 8, 2015. At both sites, studies were oversprayed with thifensulfuron/tribenuron at 0.031 lb ai/A, pyrasulfotole/bromoxynil at 0.193 lb ai/A, and florasulam/fluroxypyr at 0.092 lb ai/A for broadleaf weed control and azoxystrobin/propiconazole at 0.131 lb ai/A for stripe rust control on May 17. Wheat injury and Italian ryegrass control were evaluated visually during the growing season. Grain was harvested with a small plot combine on August 21 and 22 at Pullman and Potlatch, respectively.

Table 1. Application and soil data.

Study - Location	Potlatch, ID			Pullman, WA		
Wheat variety – seeding date	Ovation – 10/19/15			Buck Pronto/Kelse -4/9/16		
Application date	9/28/15	10/20/15	4/27/16	4/9/16	4/16/16	5/4/16
Application timing	preplant	postplant pre	post	preplant	early post	post
Wheat	--	no germ	4 tiller	--	2 tiller	3 tiller
Italian ryegrass	pre	pre	1 tiller	pre	3 leaf	1 tiller
Air temperature (F)	77	56	56	70	67	56
Relative humidity (%)	25	80	77	50	44	65
Wind (mph, direction)	2, SW	1, S	3, SW	1, SE	2, SW	3, W
Cloud cover (%)	10	100	70	30	10	0
Soil moisture	dry	dry	adequate	wet	wet	wet
Soil temperature at 2 inch (F)	52	40	37	50	55	44
Next rain occurred	10/31/15	10/31/15	4/29/16	4/14/16	4/23/16	5/6/16
pH		4.6			4.5	
OM (%)		2.7			3.8	
CEC (meq/100g)		16.8			15.5	
Texture		silt loam			silt loam	

At the Potlatch site, pyroxasulfone/carfentrazone applied postplant preemergence at 0.14 lb ai/A and flufenacet/metribuzin injured wheat 10 and 34%, respectively, on August 1 (Table 2). Pyroxasulfone/carfentrazone applied postplant preemergence controlled Italian ryegrass 94 to 96% but did not differ from any treatments except, pyroxasulfone/carfentrazone at 0.078 lb ai/A, flufenacet/metribuzin, pyroxsulam or flucarbazone applied alone. Pyroxasulfone/carfentrazone applied postplant preemergence controlled Italian ryegrass better than preplant most likely due to timely moisture that activated the herbicide. ALS resistance is the probable cause for poor Italian ryegrass control with pyroxsulam and flucarbazone. Winter wheat yield and test weight did not differ among treatments including the untreated check. Grain yield tended to be lowest with flufenacet/metribuzin due to injury. Italian ryegrass control and wheat yield did not correlate largely due to an irregular wheat stand from standing water.

At the Pullman site, pyroxsulam/fluroxypyr/florasulam treatments injured wheat 14 and 15% on May 17, 2016 (Table 3). Wheat injury was not visible by June 20 (data not shown). Pyroxasulfone/carfentrazone followed by pyroxsulam/fluroxypyr/florasulam or flucarbazone controlled Italian ryegrass 94%, but only differed from the lowest rate of pyroxasulfone/carfentrazone at each timing and pyroxasulfone/carfentrazone applied preplant at 0.117 lb ai/A. Spring wheat yield and test weight did not differ among treatments including the untreated check due to a low Italian ryegrass population.

Table 2. Winter wheat response and Italian ryegrass control with pyroxasulfone/carfentrazone near Potlatch, ID in 2016.

Treatment[1]	Rate	Application timing[2]	Wheat injury[3]	LOLMU control[4]	Wheat[3] Yield	Wheat[3] Test weight
	lb ai/A		%	%	lb/A	lb/bu
Pyroxasulfone/carfentrazone	0.078	preplant	8	68	5457	63.4
Pyroxasulfone/carfentrazone	0.102	preplant	8	88	5083	63.2
Pyroxasulfone/carfentrazone	0.117	preplant	5	86	4877	63.4
Pyroxasulfone/carfentrazone	0.140	preplant	4	82	4979	63.2
Pyroxasulfone/carfentrazone	0.117	postplant pre	2	96	5157	63.1
Pyroxasulfone/carfentrazone	0.14	postplant pre	10	94	5146	63.3
Flufenacet/metribuzin	0.425	postplant pre	34	62	4169	62.8
Pyroxasulfone/carfentrazone +	0.102	preplant				
pyroxsulam	0.016	4 tiller	4	88	5250	63.2
Pyroxasulfone/carfentrazone +	0.102	preplant				
flucarbazone	0.027	4 tiller	2	84	4863	63.4
Pyroxasulfone/carfentrazone +	0.078	preplant				
pyroxasulfone/carfentrazone +	0.062	4 tiller				
pyroxsulam	0.016	4 tiller	1	88	5322	63.3
Pyroxsulam	0.016	4 tiller	1	35	5061	63.2
Flucarbazone	0.027	4 tiller	2	30	5197	63.2
Untreated check			--	--	5183	63.3
LSD (0.05)			7	20	NS	NS
Density (plants/ft^2)			-	20	--	--

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

[2]Application timing based on winter wheat growth stage. Preplant = 21 day before planting. Postplant pre = Wheat planted but not emerged or germinated.

[3]Evaluation date August 1, 2016.

[4]LOLMU = Italian ryegrass. Evaluation date August 1, 2016.

Table 3. Spring wheat response and Italian ryegrass control with pyroxasulfone/carfentrazone near Pullman, WA in 2016.

Treatment[1]	Rate	Application timing[2]	Wheat injury[3]	LOLMU control[4]	Wheat[3] Yield	Wheat[3] Test weight
	lb ai/A		%	%	lb/A	lb/bu
Pyroxasulfone/carfentrazone	0.102	preplant	4	76	5070	63.7
Pyroxasulfone/carfentrazone	0.117	preplant	2	71	4869	63.6
Pyroxasulfone/carfentrazone	0.14	preplant	1	90	5267	64.0
Pyroxasulfone/carfentrazone	0.078	postplant pre	0	79	5231	64.0
Pyroxasulfone/carfentrazone	0.102	postplant pre	0	91	5251	64.1
Pyroxasulfone/carfentrazone	0.117	postplant pre	2	88	5269	63.8
Pyroxasulfone/carfentrazone +	0.102	preplant				
pyrox/fluro/flora	0.105	3 leaf	15	94	5130	64.1
Pyroxasulfone/carfentrazone +	0.102	preplant				
flucarbazone	0.027	3 leaf	7	94	5169	64.0
Pyroxasulfone/carfentrazone +	0.078	preplant				
pyroxasulfone/carfentrazone +	0.062	3 leaf				
pyrox/fluro/flora	0.105	3 leaf	14	91	5404	63.9
Untreated check			--	--	5003	63.5
LSD (0.05)			5	14	NS	NS
Density (plants/ft^2)			-	2	--	--

[1]Pyrox/fluro/flora = pyroxsulam/fluroxypyr/florasulam. A 90% nonionic surfactant at 0.5% v/v and ammonium sulfate at 1.5 lb ai/A was applied with flucarbazone and pyroxsulam/fluroxypyr/florasulam.
[2]Application timing based on spring wheat growth stage. Preplant = Day of planting. Postplant pre = 7 days after planting, wheat germinated but not emerged.
[3]Evaluation date May 17, 2016.
[4]LOLMU = Italian ryegrass. Evaluation date August 1, 2016.

Smooth scouringrush control with fallow-applied herbicides in a winter wheat/spring wheat/fallow rotation. Mark E. Thorne, Derek P. Appel, Henry C. Wetzel and Drew J. Lyon (Dept. of Crop & Soil Sciences, Washington State Univ., Pullman, WA 99164-6420) In 2015, we repeated a 2014 field trial evaluating herbicide control of smooth scouringrush in a no-till winter wheat/spring wheat/fallow cropping system. Smooth scouringrush is a deep-rooted native rhizomatous perennial that is becoming more prevalent in no-till/direct-seed cropping systems in eastern Washington. Current herbicide strategies for in-crop and fallow weed management have failed to reduce or control scouringrush and patches are persisting.

Our study site was located in the intermediate rainfall zone of eastern Washington near Reardan, WA on land owned by the Spokane Hutterian Brethren. The field site was 300 feet upslope from a grass waterway with a gentle northwest slope. Plots were initially established July 24, 2014, in chemical fallow prior to winter wheat seeding (Table 1). The trial consisted of two identical sets of plots. Plots on the right side of the trial had experimental herbicide applications only in 2014 and received a blanket chemical fallow treatment in 2015 similar to that used by the cooperating grower. Plots of the left side had experimental applications in both 2014 and 2015 (Table 2). Herbicides were applied with a CO_2-pressurized backpack sprayer and eight-foot spray boom at 15 gal/A and 30 psi at 3.5 mph. Following the 2014 fallow applications, the field was seeded with 'Whetstone' hard red winter wheat on September 10, 2014 at the rate of 60 lb/A and fertilized with 85-10-0-15 lb N-P-K-S per acre at the time of planting. In 2016, 'Glee' hard red spring wheat was seeded on April 21 at a rate of 80 lb/A and fertilized with 100-40-0-30 lb N-P-K-S per acre plus an additional 0.8 lb boron and 0.6 lb zinc per acre. In both years, wheat was seeded with a Bourgault 3710 disc drill on a 10-inch row spacing, and harvested with a Kincaid plot combine.

Table 1. Application and soil data.

Location		Reardan, WA	
Application date	July 25, 2014		August 10, 2015
Rotation phase	fallow		fallow
Smooth scouringrush stage	standing stems		standing stems
Air temperature (F)	70		84
Relative humidity (%)	36		30
Wind (mph, direction)	6, SW		1 to 3, N
Cloud cover (%)	10		40
Soil temperature at 0 to 6 in (F)	60		-
pH		4.9	
OM (%)		3.3	
Texture		silt loam	

Herbicide efficacy was evaluated both visually and by measuring scouringrush stem density in each plot. Visual ratings were approximately 15 days (15 DAT) and 30 days (30 DAT) after herbicide applications and were based on the degree of herbicide injury to scouringrush stems as a percentage of the non-treated check plots. In 2014, ratings were on August 8 and 20; in 2015, plots were rated on August 28 and September 9. Scouringrush stem densities were counted in and between two 1-meter lengths of wheat rows in May and August of 2015 and 2016. Counts in 2015 evaluated the 2014 herbicide applications. Counts in 2016 evaluated the cumulative effect of the 2014 and 2015 applications to the left-side plots and evaluated the right-side plots two years following the 2014 applications. Visual control ratings were generally higher for treatments that included MCPA ester; however, in 2014 MCPA ester with either clopyralid or chlorsulfuron showed the greatest control at both 15 DAT and 30 DAT (Table 3). Visually, MCPA ester was impressive as it turned the stems black soon after application (personal observation). In 2015, chlorsulfuron + MCPA ester at 30 DAT had the highest control but was not different from glyphosate + glufosinate or MCPA ester alone. Glyphosate + glufosinate was one of the chemical fallow treatments used by the cooperating grower at this field site. Glyphosate by itself, a commonly applied chemical fallow herbicide, or with saflufenacil, showed very little control in either year. Furthermore, very little injury was observed from either 2,4-D ester or quinclorac (Table 3).

Table 2. Herbicides applied to chemical fallow in 2014 and 2015 for control of smooth scouringrush. Experimental treatments were applied to both sides in 2014 and only left-side plots in 2015. In 2015, right-side plots were treated with a blanket chemical fallow treatment.

			Applications per side	
Num	Treatment[1]	Rate	2014	2015
		(lb ae/A) [2]		
1	non-treated	none	left and right	left only
2	2,4-D ester	1	left and right	left only
3	MCPA ester	1	left and right	left only
4	clopyralid + MCPA ester	0.12 + 0.69	left and right	left only
5	chlorsulfuron + MCPA ester	0.0234 + 1	left and right	left only
6	halosulfuron + MCPA ester	0.0623 + 1	left and right	left only
7	glyphosate	1.13	left and right	left only
8	glyphosate + saflufenacil	1.13 + 0.089	left and right	left only
9	fluroxypyr	0.245	left and right	left only
10	quinclorac	0.248	left and right	left only
11	glyphosate + glufosinate	0.75 + 0.55	left and right	left only
Blanket	glyphosate + glufosinate	2 + 1.3		right only

[1]Adjuvants included are as follows:
All treatments except 8 and 11 included non-ionic surfactant at 0.334% v/v rate.
Treatments 7, 8, 10, and 11 included spray grade ammonium sulfate at 3.13 lb/A rate.
Treatment 8 included 1% v/v of crop oil concentrate.
Treatment 10 included 32 oz/A of modified vegetable oil.
Blanket treatment included 1 lb/A of ammonium sulfate.
[2]Rates for chlorsulfuron, halosulfuron, saflufenacil, and glufosinate are expressed as lb ai/A.

Herbicide efficacy based on scouringrush stem density differed considerably from the level of control observed with the visual ratings. Stem density was reduced substantially by chlorsulfuron + MCPA ester in relation to the non-treated plots following the 2014 application. Densities averaged 4.5 and 0.2 stems per 2 linear meters of row in the right and left sides, respectively (Table 4). In contrast, densities in the non-treated plots averaged 85.2 and 61.1 stems in the right and left sides, respectively. However, on the right-side where chlorsulfuron + MCPA ester was applied only in 2014, scouringrush density increased to 31.6 by August 2016. In contrast, scouringrush density on the left side remained low (1.2 stems/2 linear meters of row) through the August 2016 census. In this trial, no other herbicides consistently reduced stem density. Even after causing substantial visual injury, stem densities following MCPA ester applications were not different from the non-treated check at any census date on either the right or left side (Table 4). By the August 2016 census, only chlorsulfuron + MCPA ester had kept stem densities low.

Winter wheat yield in 2015 averaged 72 bu/A, and spring wheat yield in 2016 averaged 55 bu/A; however, differences were not found between any of the treatments in either year (data not shown). This may have been due to the competitiveness of the winter wheat in 2015, and stand variability of the spring wheat in 2016; however, scouringrush density at this site may not have been sufficient to reduce wheat yield.

This study found that herbicide control of smooth scouringrush was only achieved and maintained by application of chlorsulfuron + MCPA ester in both years. Given that MCPA ester by itself had no effect on stand density, it is highly probable that chlorsulfuron alone was effective. Standard chemical fallow treatments, including those with glyphosate, are not effective in controlling smooth scouringrush, even when they cause injury to the stems following application.

Table 3. Scouringrush visual control following herbicide applications in chemical fallow in 2014 and 2015.

	2014		2015	
Treatments[1]	15 DAT	30 DAT	15 DAT	30 DAT
	-----(control as % of non-treated check)[2]-----			
non-treated	0 -	0 -	0 -	0 -
2,4-D ester	35 de	39 ef	27 c	35 cd
MCPA ester	55 bc	55 cd	63 a	66 ab
clopyralid + MCPA ester	75 a	70 ab	42 bc	50 bc
chlorsulfuron + MCPA ester	77 a	79 a	42 bc	87 a
halosulfuron + MCPA ester	65 ab	67 bc	55 ab	60 bc
glyphosate	18 f	17 g	6 d	19 d
glyphosate + saflufenacil	15 f	10 g	7 d	34 cd
fluroxypyr	24 ef	29 f	31 c	32 cd
quinclorac	16 f	18 g	19 c	32 cd
glyphosate + glufosinate	42 cd	46 de	48 a-c	68 ab

[1]See Table 1 for rates and adjuvants.
[2]Means in each column followed by the same letter are not different.

Table 4. Scouringrush stem counts in 2015 and 2016 following each previous year's herbicide applications.

	Stem counts following ---- 2014 treatments ----		Stem counts following ---- 2015 treatments ----	
Herbicide treatments[1]	May 2015	Aug 2015	May 2016	Aug 2016
	--- (stem counts in and between 2 linear meters of row)[2] ---			
Table 2a. Applications to right-side plots in 2014, then a blanket treatment in 2015				
non-treated	85.2 a	73.5 a	52.6 a-d	93.3 a
2,4-D ester	53.4 a-c	77.7 a	40.8 b-d	64.0 ab
MCPA ester	78.6 a-c	81.2 a	65.1 a-c	95.0 a
clopyralid + MCPA ester	80.5 ab	99.6 a	58.0 a-d	105.6 a
chlorsulfuron + MCPA ester	4.5 e	6.0 b	18.4 e	31.6 c
halosulfuron + MCPA ester	58.0 a-c	57.2 a	55.2 a-d	65.1 ab
glyphosate	43.0 cd	74.4 a	74.0 ab	85.1 ab
glyphosate + saflufenacil	43.9 b-d	70.5 a	32.6 de	64.3 ab
fluroxypyr	43.2 cd	72.3 a	57.0 a-d	65.6 ab
quinclorac	24.1 d	63.9 a	39.2 cd	48.1 bc
glyphosate + glufosinate	85.6 a	95.6 a	86.2 a	103.8 a
Table 2b. Applications to left-side plots in 2014 and repeated in 2015				
non-treated	61.1 a	74.2 a	50.6 a	60.7 a
2,4-D ester	32.5 a	46.2 a-d	22.8 cd	40.5 ab
MCPA ester	44.7 a	64.2 ab	30.1 a-d	44.1 ab
clopyralid + MCPA ester	38.0 a	65.5 ab	34.3 a-c	41.1 ab
chlorsulfuron + MCPA ester	0.2 c	0.7 e	0.2 e	1.2 c
halosulfuron + MCPA ester	35.1 a	52.5 a-c	28.1 b-d	42.4 ab
glyphosate	12.5 b	34.2 cd	23.5 cd	50.9 ab
glyphosate + saflufenacil	36.3 a	43.0 b-d	31.8 a-c	37.4 b
fluroxypyr	60.5 a	68.7 ab	31.5 a-c	44.8 ab
quinclorac	44.0 a	55.7 a-c	47.9 ab	50.0 ab
glyphosate + glufosinate	31.4 a	28.1 d	17.6 d	42.3 ab

[1]See Table 1 for rates and adjuvants.
[2]Means in each column within each side followed by the same letter are not different.

Mayweed chamomile control in winter wheat. Traci A. Rauch and Joan M. Campbell. (Crop and Weed Science Division, University of Idaho, Moscow, ID 83844-2339) Two studies were established near Moscow to evaluate winter wheat response and mayweed chamomile (ANTCO) control with bicyclopyrone/bromoxynil or fluroxypyr/thifensulfuron/tribenuron. The studies were arranged in a randomized complete block design with four replications and included an untreated check. All herbicide treatments were applied using a CO_2 pressurized backpack sprayer calibrated to deliver 10 gpa at 32 psi and 3 mph (Table 1). Studies were oversprayed with fluxapyroxad/pyraclostrobin at 0.13 lb ai/A to control stripe rust and pinoxaden at 0.54 lb ai/A to control grass weeds on April 20, 2016. Wheat response and weed control were evaluated visually during the growing season. Grain was harvested in the bicyclopyrone/bromoxynil study with a small plot combine on August 6.

Table 1. Application and soil data.

	Fluroxypyr/thifensulfuron/tribenuron		Bicyclopyrone/bromoxynil
Application date	4/11/16	4/22/16	4/21/16
Winter wheat variety	WB 1529		WB1529
Growth stage			
Winter wheat	3 tiller	3 tiller	3 tiller
Mayweed chamomile (ANTCO)	2 leaf	4 leaf	4 leaf
Air temperature (F)	62	63	83
Relative humidity (%)	67	76	43
Wind (mph), direction	0	3, SE	1, SE
Next moisture occurred	4/14/16	4/23/16	4/23/16
Dew present?	yes	yes	no
Cloud cover (%)	0	80	50
Soil moisture	good	good	good
Soil temperature at 2 inch (F)	40	45	63
pH	4.8		
OM (%)	6.0		
CEC (meq/100g)	27.7		
Texture	silt loam		

In the fluroxypyr/thifensulfuron/tribenuron study, all treatments applied at the 2 two leaf timing injured wheat 7 to 9% on April 30, but injury was not visible by May 11 (Table 2). On May 11, mayweed chamomile control was 93 to 96% with all treatments applied at the two leaf timing. By June 23, all treatments containing bromoxynil/MCPA or fluroxypyr/florasulam controlled mayweed chamomile 88 to 95%.

In the bicyclopyrone/bromoxynil study, no treatment visually injured winter wheat (data not shown). At both evaluation dates, all rates of bicyclopyrone/bromoxynil controlled mayweed chamomile 96 to 99% while pyrasulfotole/bromoxynil did not control mayweed chamomile (Table 3). At 53 DAT, fluroxypyr treatments controlled mayweed chamomile 94 and 98%. Grain yield for all treatments was better than fluroxypyr/clopyralid and the untreated check. Fluroxypyr/clopyralid reduced grain yield but wheat injury was not visible during the growing season due to variety variability. Wheat test weight did not differ among treatments, including the untreated check.

Table 2. Mayweed chamomile control and wheat response with fluroxypyr/thifensulfuron/tribenuron near Moscow, ID in 2016.

Treatment[1]	Rate	Application time[2]	Wheat injury[2]	ANTCO control[3] 5/11	ANTCO control[3] 6/23
	lb ai/A		%	%	%
Fluroxypyr/thifensulfuron/tribenuron +	0.097				
bromoxynil/MCPA	0.625	2 leaf	7	94	93
Fluroxypyr/thifensulfuron/tribenuron +	0.116				
bromoxynil/MCPA	0.625	2 leaf	8	96	92
Fluroxypyr/thifensulfuron/tribenuron +	0.097				
bromoxynil/MCPA +	0.625				
thifensulfuron/tribenuron	0.0625	2 leaf	9	93	89
Fluroxypyr/thifensulfuron/tribenuron +	0.097				
NIS	0.25% v/v	4 leaf	0	70	52
Fluroxypyr/thifensulfuron/tribenuron +	0.116				
NIS	0.25% v/v	4 leaf	0	56	55
Fluroxypyr/thifensulfuron/tribenuron +	0.097				
pyrasulfotole/bromoxynil	0.177	4 leaf	0	58	85
Fluroxypyr/thifensulfuron/tribenuron +	0.116				
pyrasulfotole/bromoxynil	0.177	4 leaf	0	60	83
Fluroxypyr/thifensulfuron/tribenuron +	0.097				
bromoxynil/MCPA	0.625	4 leaf	0	76	92
Fluroxypyr/thifensulfuron/tribenuron +	0.116				
bromoxynil/MCPA	0.625	4 leaf	0	84	90
Fluroxypyr/thifensulfuron/tribenuron +	0.097				
bromoxynil/MCPA	0.78	4 leaf	0	82	95
Fluroxypyr/thifensulfuron/tribenuron +	0.097				
bromoxynil/MCPA +	0.625				
thifensulfuron/tribenuron	0.00625	4 leaf	0	76	89
Fluroxypyr/florasulam	0.093	4 leaf	0	63	95
Fluroxypyr+	0.094				
bromoxynil/MCPA +	0.625				
thifensulfuron	0.014	4 leaf	0	70	88
LSD (0.05)				13	7
Density (plants/ft^2)				15	

[1]NIS is nonionic surfactant.
[2]April 30, 2016 evaluation.
[3]ANTCO= mayweed chamomile.

Table 3. Mayweed chamomile control and wheat response with bicyclopyrone/bromoxynil near Moscow, ID in 2016.

Treatment[1]	Rate	ANTCO control[2] 20 DAT	ANTCO control[2] 53 DAT	Wheat Yield	Wheat Test weight
	lb ai/A	%	%	bu/A	lb/bu
Bicyclopyrone/bromoxynil +	0.193				
sodium bicarbonate +	0.058				
COC	1% v/v	96	98	109	65.1
Bicyclopyrone/bromoxynil +	0.225				
sodium bicarbonate +	0.067				
COC	1% v/v	96	99	110	65.1
Bicyclopyrone/bromoxynil +	0.256				
sodium bicarbonate +	0.076				
COC	1% v/v	97	99	114	65.1
Pyrasulfotole/bromoxynil +	0.177				
NIS	0.25% v/v	52	58	105	65.1
Fluroxypyr/clopyralid	0.188	78	98	90	65.0
Thifensulfuron/tribenuron +	0.0188				
MCPA ester	0.347	78	81	105	65.3
Fluroxypyr/florasulam	0.092	72	94	107	65.1
Untreated check	--	--	--	92	64.8
LSD (0.05)		10	5	7	NS
Density (plants/ft^2)		15			

[1]COC is a crop oil concentrate. NIS is nonionic surfactant. Sodium bicarbonate was used as a buffer.
[2]ANTCO = mayweed chamomile.

Rattail fescue control in winter wheat. Traci A. Rauch and Joan M. Campbell. (Crop and Weed Science Division, University of Idaho, Moscow, ID 83844-2339) Studies were established in 'Westbred 1529' winter wheat to evaluate rattail fescue control with pyroxasulfone containing herbicides alone or in combination at two sites on the University of Idaho Parker Plant Science Farm near Moscow, ID. The plots were arranged in a randomized complete block design with four replications and included an untreated check. All herbicide treatments were applied using a CO_2 pressurized backpack sprayer calibrated to deliver 10 gpa at 32 psi and 3 mph (Table 1). The site was oversprayed with pyrasulfotole/bromoxynil at 0.19 lb ai/A and thifensulfuron/tribenuron at 0.031 lb ai/A for broadleaf weed control and with fluxapyroxad/pyraclostrobin at 0.13 lb ai/A for stripe rust control on April 19, 2016. Crop injury and rattail fescue control were evaluated visually during the growing season. Grain was harvested with a small plot combine on July 29, 2016.

Table 1. Application and soil data.

	Parker Farm - Field 24		Parker Farm - Field 2	
Winter wheat seeding date	10/14/15		10/13/15	
Application date	10/16/15	4/19/16	10/16/15	4/20/16
Growth stage				
Winter wheat	postplant pre –no germ	4 tiller	postplant pre- imbibed	3 tiller
Rattail fescue	pre	4 tiller	pre	2 tiller
Air temperature (F)	78	76	78	78
Relative humidity (%)	33	42	34	42
Wind (mph, direction)	3, SE	3, WNW	3, ESE	4, SE
Cloud cover (%)	10	0	10	0
Next rain occurred	10/31/15	4/23/16	10/31/15	4/23/16
Soil moisture	dry	good	dry	dry
Soil temperature at 2 inch (F)	50	55	50	54
pH	5.6		5.6	
OM (%)	3.4		4.4	
CEC (meq/100g)	16.0		20.7	
Texture	silt loam		silt loam	

In Field 24, wheat injury was not ratable due to a variable crop stand (data not shown). Residue from a heavy rattail fescue population impacted soil to seed contact and caused the poor wheat stand. All treatments containing pyroxasulfone controlled rattail fescue 93 to 98% (Table 2). Flufenacet/metribuzin alone, pyroxsulam and sulfosulfuron did not control rattail fescue (50 to 57%). The residue also caused shallow seeding which may have lead to wheat injury from the flufenacet/metribuzin thus reducing crop competition and therefore, flufenacet/metribuzin efficacy. Flucarbazone was the best postemergence herbicide with 75% rattail fescue control. Grain yield was greater for all herbicide treated plots compared to the untreated check and plots treated with flucarbazone or pyroxsulam alone. Winter wheat test weight was lowest for the untreated check and plots treated with pyroxsulam.

In Field 2, no treatment visibly injured winter wheat (data not shown). All treatments containing flufenacet/metribuzin, except flufenacet/metribuzin plus sulfosulfuron, or pyroxasulfone controlled rattail fescue 96 to 98% (Table 3). Flucarbazone was the best postemergence herbicide with 80% rattail fescue control. Pyroxsulam and sulfosulfuron did not control rattail fescue (40 and 56%). Grain yield was lower in the untreated check and plots treated with pyroxasulfone/fluthiacet plus flucarbazone or postemergence treatments alone. Winter wheat test weight was lower in the untreated check and plots treated with flucarbazone alone compared to all other herbicide treated plots.

Table 2. Rattail fescue control in winter wheat with pyroxasulfone combinations on the University of Idaho Parker Farm in Field 24 in 2016.

Treatment[1]	Rate	Application timing[2]	Rattail fescue control[3]	Winter wheat Yield	Winter wheat Test weight
	lb ai/A		%	bu/A	lb/bu
Flufenacet/metribuzin	0.425	pre	57	67	64.6
Pyroxasulfone	0.08	pre	93	73	64.7
Pyroxasulfone/fluthiacet	0.091	pre	93	72	64.7
Flucarbazone	0.027	4 tiller	75	57	64.4
Pyroxsulam	0.016	4 tiller	50	58	64.1
Sulfosulfuron	0.031	4 tiller	55	64	64.4
Flufenacet/metribuzin +	0.425	pre			
flucarbazone	0.027	4 tiller	94	71	64.5
Flufenacet/metribuzin +	0.425	pre			
pyroxsulam	0.016	4 tiller	94	72	64.7
Flufenacet/metribuzin +	0.425	pre			
sulfosulfuron	0.031	4 tiller	82	71	64.6
Pyroxasulfone +	0.08	pre			
flucarbazone	0.027	4 tiller	95	72	64.6
Pyroxasulfone +	0.08	pre			
pyroxsulam	0.016	4 tiller	95	75	64.5
Pyroxasulfone +	0.08	pre			
sulfosulfuron	0.031	4 tiller	90	73	64.6
Pyroxasulfone/fluthiacet +	0.091	pre			
flucarbazone	0.027	4 tiller	98	73	64.8
Pyroxasulfone/fluthiacet +	0.091	pre			
pyroxsulam	0.016	4 tiller	96	71	64.5
Pyroxasulfone/fluthiacet +	0.091	pre			
sulfosulfuron	0.031	4 tiller	97	70	64.6
Untreated check	--	--		55	64.1
LSD (0.05)			16	5	0.3
Density (plants/ft^2)			10		

[1]All postemergence treatments were applied with a non-ionic surfactant at 0.25% v/v and ammonium sulfate at 1 lb ai/A.
[2]Application timing based on rattail fescue growth stage.
[3]Evaluation date May 30, 2016.

Table 3. Rattail fescue control in winter wheat with pyroxasulfone combinations on the University of Idaho Parker Farm in Field 2 in 2016.

Treatment[1]	Rate	Application timing[2]	Rattail fescue control[3]	Winter wheat Yield	Winter wheat Test weight
	lb ai/A		%	bu/A	lb/bu
Flufenacet/metribuzin	0.425	pre	98	86	64.5
Pyroxasulfone	0.08	pre	96	88	64.7
Pyroxasulfone/fluthiacet	0.091	pre	99	89	64.8
Flucarbazone	0.027	2 tiller	80	80	63.0
Pyroxsulam	0.016	2 tiller	56	83	64.7
Sulfosulfuron	0.031	2 tiller	40	80	64.7
Flufenacet/metribuzin +	0.425	pre			
flucarbazone	0.027	2 tiller	99	86	64.8
Flufenacet/metribuzin +	0.425	pre			
pyroxsulam	0.016	2 tiller	99	88	64.3
Flufenacet/metribuzin +	0.425	pre			
sulfosulfuron	0.031	2 tiller	84	88	64.6
Pyroxasulfone +	0.08	pre			
flucarbazone	0.027	2 tiller	98	88	64.8
Pyroxasulfone +	0.08	pre			
pyroxsulam	0.016	2 tiller	98	85	64.4
Pyroxasulfone +	0.08	pre			
sulfosulfuron	0.031	2 tiller	96	88	64.6
Pyroxasulfone/fluthiacet +	0.091	pre			
flucarbazone	0.027	2 tiller	98	83	64.3
Pyroxasulfone/fluthiacet +	0.091	pre			
pyroxsulam	0.016	2 tiller	99	88	64.4
Pyroxasulfone/fluthiacet +	0.091	pre			
sulfosulfuron	0.031	2 tiller	99	86	64.3
Untreated check	--	--	--	79	62.7
LSD (0.05)			10	4	0.5
Density (plants/ft^2)			3		

[1]All postemergence treatments were applied with a non-ionic surfactant at 0.25% v/v and ammonium sulfate at 1 lb ai/A.
[2]Application timing based on rattail fescue growth stage.
[3]Evaluation date May 30, 2016.

Preemergence and post-harvest kochia control in wheat. Randall S. Currie and Patrick W. Geier. (K-State Southwest Research-Extension Center, 4500 E. Mary Street, Garden City, KS 67846) An experiment was conducted at the Kansas State University Southwest Research-Extension Center near Garden City, KS to examine the efficacy of preemergence and/or post-harvest dicamba tank mixtures in winter wheat. Herbicides were applied March 3, 2016 (preemergence to kochia) and July 11, 2016 (postemergence following wheat harvest). Treatments were applied using a CO^2-compressed, tractor-mounted or backpack sprayer delivering 20 gpa at 3.0 mph and 27 or 30 psi. Soil was a Ulysses silt loam with 1.4% organic matter, pH of 8.0, and cation exchange capacity of 18.4. Plot size was 10 by 40 feet and arranged in a split-plot design replicated four times with preemergence herbicide as the main plot and post-harvest herbicides were the subplots. Wheat was removed from the experiment June 20, 2016, but no yield data was collected. Kochia control was evaluated visually on March 4, July 11, July 25, and August 12, 2016. These dates were 29 and 130 days after the preemergence treatments and 14 and 32 days after the post-harvest treatments, respectively.

Dicamba with any premix partner applied preemergence provided less than 30% kochia control on July 25 and August 12. The addition of glyphosate plus dicamba/diflufenzopyr postemergence increased control 45 to 66% compared to preemergence treatments alone on July 25 and August 12. However, all treatments receiving a postemergence application controlled kochia similarly on August 12.

Table. Preemergence and post-harvest kochia control in wheat.

Herbicide[a]	Rate	Timing	Kochia March 4	July 11	July 25	August 12
	lb ai/A		% Control			
Glyphosate +	1.13	POST-Harvest	-	-	60	85
Dicamba/ Diflufenzopyr +	0.263	POST-Harvest				
COC +	1%	POST-Harvest				
AMS	2%	POST-Harvest				
Dicamba +	0.125	Preemergence	80	25	25	20
MCPA ester +	0.25	Preemergence				
Pyroxasulfone +	0.106	Preemergence				
NIS	0.125%	Preemergence				
Dicamba +	0.125	Preemergence	80	25	70	86
MCPA ester +	0.25	Preemergence				
Pyroxasulfone +	0.106	Preemergence				
NIS	0.12 %	Preemergence				
Glyphosate +	1.13	POST-Harvest				
Dicamba/ Diflufenzopyr +	0.263	POST-Harvest				
COC +	1%	POST-Harvest				
AMS	2%	POST-Harvest				
Dicamba +	0.125	Preemergence	83	33	20	20
MCPA ester +	0.25	Preemergence				
Pendimethalin +	0.95	Preemergence				
NIS	0.125%	Preemergence				
Dicamba +	0.125	Preemergence	83	33	70	85
MCPA ester +	0.25	Preemergence				
Pendimethalin +	0.95	Preemergence				
NIS	0.125%	Preemergence				
Glyphosate +	1.13	POST-Harvest				
Dicamba/ Diflufenzopyr +	0.263	POST-Harvest				
COC +	1%	POST-Harvest				
AMS	2%	POST-Harvest				
Dicamba +	0.125	Preemergence	84	30	28	28
MCPA ester +	0.25	Preemergence				
Pendimethalin +	0.95	Preemergence				
Pyroxasulfone +	0.106	Preemergence				
NIS	0.125%	Preemergence				
Dicamba +	0.125	Preemergence	84	30	73	85
MCPA ester +	0.25	Preemergence				
Pendimethalin +	0.95	Preemergence				
Pyroxasulfone +	0.106	Preemergence				
NIS	0.125%	Preemergence				
Glyphosate +	1.13	POST-Harvest				
Dicamba/ Diflufenzopyr +	0.263	POST-Harvest				
COC +	1%	POST-Harvest				
AMS	2%	POST-Harvest				
Dicamba/ Triasulfuron +	0.16	Preemergence	73	28	23	23
NIS	0.125%	Preemergence				
Dicamba/ Triasulfuron +	0.16	Preemergence	73	28	68	84
NIS	0.125%	Preemergence				

Glyphosate +	1.13	POST-Harvest				
Dicamba/	0.263	POST-Harvest				
Diflufenzopyr +						
COC +	1%	POST-Harvest				
AMS	2%	POST-Harvest				
Untreated	---	---	0	0	0	0
LSD (0.05)			4	8	4	4

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

The effect of disturbance on Italian ryegrass control with pyroxasulfone in winter wheat. Traci A. Rauch and Joan M. Campbell. (Crop and Weed Science Division, University of Idaho, Moscow, ID 83844-2339) A study was established near Moscow, ID to evaluate wheat response and Italian ryegrass (LOLMU) control with pyroxasulfone and pyroxasulfone/carfentrazone in winter wheat applied at four application times: pre-fertilization, post fertilization, postplant preemergence pre-germination, and postplant preemergence post-germination. Anhydrous ammonia fertilizer was applied with a shank style applicator. Pyroxasulfone and pyroxasulfone/carfentrazone were applied at the highest labeled rate for this soil type. The plots were arranged in a randomized complete block design with four replications and included an untreated check. All herbicide treatments were applied using a CO_2 pressurized backpack sprayer calibrated to deliver 10 gpa at 32 psi and 3 mph (Table 1).

The study area was oversprayed with glyphosate at 1.1 lb ae/A on September 25, 2015 and with thifensulfuron/tribenuron at 0.031 lb ai/A, pyrasulfotole/bromoxynil at 0.193 lb ai/A, and florasulam/fluroxypyr at 0.092 lb ai/A for broadleaf weed control and azoxystrobin/propiconazole at 0.131 lb ai/A for stripe rust control on May 11, 2016. Wheat injury and Italian ryegrass control were evaluated visually during the growing season. Grain was harvested with a small plot combine on August 12.

Table 1. Application and soil data.

Wheat variety – seeding date	WB 523 – 10/12/15			
Application date	9/25/15	10/10/15	10/13/15	11/2/15
Application timing	pre-fertilization	post-fertilization	postplant pre- no germ	postplant pre- germ
Wheat	preplant	preplant	no germination	0.5 in root/ 0.125 in shoot
Italian ryegrass	pre	pre	pre	pre
Air temperature (F)	69	76	68	47
Relative humidity (%)	57	51	44	94
Wind (mph, direction)	2, E	2, W	0	1, N
Cloud cover (%)	10	100	90	100
Soil moisture	dry	dry	dry	wet
Soil temperature at 2 inch (F)	48	59	42	35
Next rain occurred	10/7/15	10/31/15	10/31/15	11/5/15
pH	5.3			
OM (%)	3.7			
CEC (meq/100g)	19.0			
Texture	silt loam			

No winter wheat injury was visible at any evaluation date (data not shown). Italian ryegrass control was 89 and 90% when either pyroxasulfone treatment was applied at wheat germination (Table 2). Good control was likely due to adequate moisture soon after application (0.4 inch precipitation three days DAP). Rainfall is needed to activate the herbicide. Moisture was lacking following the other application times and therefore confounded the effect of disturbance on Italian ryegrass control. Wheat grain yield was lowest with the untreated check. Grain yield was greatest with pyroxasulfone alone applied post germination and did not differ from all treatments, except with either pyroxasulfone treatment applied pre-fertilization and pyroxasulfone alone applied post-fertilization. Winter wheat test weight did not differ among treatments including the untreated check.

Table 2. Winter wheat response and Italian ryegrass control with pyroxasulfone treatments applied at four times near Moscow, ID in 2016.

Treatment[1]	Rate	Application timing[2]	Adequate rainfall[3]	LOLMU control[4]	Wheat Yield	Wheat Test weight
	lb ai/A		(DAA)	%	lb/A	lb/bu
Pyroxasulfone	0.08	pre-fert	36	46	4442	61.0
Pyroxasulfone/carfentrazone	0.109	pre-fert	36	60	4329	60.7
Pyroxasulfone	0.08	post-fert	21	67	4784	60.9
Pyroxasulfone/carfentrazone	0.109	post-fert	21	74	5127	60.8
Pyroxasulfone	0.08	postplant-no germ	18	45	4492	60.8
Pyroxasulfone/carfentrazone	0.109	postplant-no germ	18	77	5114	60.6
Pyroxasulfone	0.08	germination	3	90	4936	60.5
Pyroxasulfone/carfentrazone	0.109	germination	3	89	5057	60.6
Flufenacet/metribuzin	0.425	germination	3	64	4834	60.9
Untreated check			--	--	3381	61.2
LSD (0.05)				14	578	NS
Density (plants/ft^2)				20	--	--

[1]Glyphosate at 0.75 lb ai/A and ammonium sulfate at 1 lb ai/A were applied with the pre-fert and post-fert timings.
[2]Pre-fert = Before fertilization. Post-fert= After shank applied deep-band anhydrous ammonia fertilizer. Postplant = Wheat planted but not germinated.
[3]Rainfall over 0.3 inch.
[4]LOLMU = Italian ryegrass. Evaluation date June 8, 2016.

Rush skeletonweed control in winter wheat following CRP takeout. Mark E. Thorne, Henry C. Wetzel and Drew J. Lyon. (Dept. of Crop & Soil Sciences, Washington State Univ., Pullman, WA 99164-6420) Rush skeletonweed is a deep-rooted perennial species that has become well established on thousands of acres across eastern Washington while the land was out of wheat production in the Conservation Reserve Program (CRP). Recent changes to the CRP have resulted in many acres coming back into production and most often without prior skeletonweed control. Uncontrolled skeletonweed in the fallow phase of the rotation reduces seed-zone moisture and leaves inadequate soil moisture for germination of winter wheat in the fall. Areas where wheat fails to emerge are either late-seeded after fall rains replenish soil moisture or are left blank. In either case, crop yield is reduced. Herbicide control in the crop phase is one part of an overall strategy to reduce or eradicate skeletonweed from these production areas.

We applied five different synthetic auxin herbicides to rush skeletonweed infested winter wheat on November 12, 2015, as the wheat was tillering and again prior to stem jointing on March 17, 2016, at a field site near LaCrosse, WA (Table 1). The land had been in CRP until October 2013 and the first post-CRP crop was harvested in 2014. In 2015, the field was in summer fallow and was seeded to 'ORCF-102' winter wheat at 60 lb/A on September 11 with a John Deere HZ616 grain drill. The field had been fertilized prior to seeding with 80 lb nitrogen, 10 lb sulfur, and 10 lb chloride per acre. At both treatment dates, herbicides were applied with a CO_2-pressurized backpack sprayer and 10-ft spray boom delivering 15 gal/A spray volume. Boom pressure was 25 psi and ground speed was 3 mph. Experimental design was a randomized complete block with four replicated blocks and a factorial arrangement of herbicides and timing. Plot dimension was 10 by 35 feet. The plots were harvested on July 20 with a Kincaid plot combine. All grain samples were analyzed for moisture with a Foss grain analyzer. Wheat yield was converted to bu/A and reported on a 12% moisture basis.

Table 1. Application and soil data.

Location		LaCrosse, WA	
Application date	November 12, 2015		March 17, 2016
Wheat growth stage	coleoptile to 8 tillers, majority having 3 tillers		first node present at base of oldest stems
Rush skeletonweed stage	rosette		rosette
Air temperature (F)	48		47
Relative humidity (%)	61		32
Wind (mph, direction)	1, W		2 to 6, SE
Cloud cover (%)	100		10
Soil temperature at 0 to 6 in (F)	41		39
pH		4.9	
OM (%)		1.8	
Texture		silt loam	

Rush skeletonweed density was highly variable across the plot site. The infestation was patchy and non-uniform and difficult to objectively assess for herbicide efficacy on a plant population basis. Therefore, two 1-m quadrats per plot were flagged on April 6, 2016, and all skeletonweed plants in each quadrat, dead or alive, were counted to establish baseline initial densities to follow until crop harvest. Plants that had been killed by the fall applications were still visible and were included in the count. Skeletonweed densities were recounted in all quadrats on June 2 when the wheat was in the soft-dough stage and again on July 20 at crop harvest.

Additionally, herbicide control/injury of skeletonweed was evaluated visually on a whole-plot basis as a percent of the non-treated check plots. Visual ratings on March 8, 2016, evaluated fall-applied herbicides and were taken prior to the spring-applied treatments. March 31 ratings evaluated control two weeks following spring applications as well as fall applications. Follow-up ratings were made on June 2 and July 20.

Aminopyralid and clopyralid applied either in the fall or spring were most effective at reducing skeletonweed density. Both herbicides reduced original densities to less than one plant/m^2 by the June 2 census (Table 2). Although we reported plant densities for the fall-applied aminopyralid and clopyralid treatments averaging 6.9 and 4.8 plants/m^2 at the April 6 census, most of these plants were dead but were included to represent the initial density in November when treatments were applied (data not shown). In contrast, aminocyclopyrachlor, was only effective in reducing skeletonweed density when applied in spring with a 56% reduction by July 20. Currently, aminopyralid and aminocyclopyrachlor are not labeled in wheat and appropriate rates and timing have not yet been established.

Dicamba was not effective at reducing skeletonweed density at either application date. In contrast, 2,4-D did reduce plant numbers by 64% when applied in the fall, and 55% when applied in the spring (Table 2).

Table 2. Rush skeletonweed density over time in relation to each individual treatment following fall and spring herbicide applications to winter wheat.

		Rush skeletonweed census dates[2]		
Treatments[1]	Rate	April 6	June 2	July 20
	(lb ae/A)	-------------------------(plants/m^2)[3]----------------------		
Fall-applied herbicides				
non-treated	--	9.6 a	9.3 a	7.9 a
aminopyralid	0.0093	6.9 a	0.1 b	1.0 b
clopyralid	0.1875	4.8 a	0.1 b	0.3 b
aminocyclopyrachlor	0.013	4.4 a	3.1 a	2.6 a
dicamba	0.125	5.5 a	4.4 a	4.4 a
2,4-D ester	0.375	8.3 a	4.6 b	3.0 b
Spring-applied herbicides				
non-treated	--	8.8 a	8.5 a	9.0 a
aminopyralid	0.0093	6.5 a	0.6 b	1.3 b
clopyralid	0.1875	4.8 a	0.0 b	0.5 b
aminocyclopyrachlor	0.013	9.4 a	4.0 b	4.1 b
dicamba	0.125	4.6 a	3.3 a	3.4 a
2,4-D ester	0.375	13.0 a	10.1 b	5.8 c

[1]All herbicide applications included a non-ionic surfactant at 0.25% v/v rate. Fall treatments were applied on November 12, 2015; spring treatments were applied on March 17, 2016.
[2]Counts on April 6, 2016, represent initial density present at the fall application and included all plants, dead or alive, in two 1-m permanent quadrats per plot. Counts on subsequent dates are of living plants, only.
[3]Counts (LSMeans) in each row followed by the same letter are not different at $p \leq 0.05$ and measure change in density for each treatment over the course of the trial.

Skeletonweed visual control ratings on March 8 were variable and confounded by winter injury symptoms observed on the rosettes. The majority of plants in the aminopyralid and clopyralid plots were completely dead and thus clearly controlled (Table 3); however, it was difficult to assess efficacy of the other three herbicides. By March 31, clear differences were observed in the fall-treated plots between dead plants and live rosettes recovering from winter stress and producing new leaves. Aminopyralid and clopyralid control averaged near 90% each while aminocyclopyrachlor and 2,4-D averaged only 10 and 15% control, respectively (Table 3). The March 31 visual ratings were two weeks after the spring treatments were applied and very few herbicide injury symptoms could be detected.

Herbicide control was visually greatest by the June 2 rating and approached 100% for the fall-applied aminopyralid and clopyralid treatments and for clopyralid applied in the spring, while control for the other herbicides averaged only 37 to 53% (Table 3). By this time, skeletonweed had begun to bolt in the non-treated check plots and in a few of the herbicide-treated plots (data not shown). By the July 20 harvest census, flowers were observed on a few skeletonweed plants, primarily in the non-treated check plots. At this census, fall-applied aminopyralid and clopyralid had maintained nearly the same level of control observed at the June 2 census (Table 3); however, control in the spring-applied plots averaged only 76 and 78%, respectively, and was not different from the 66% control by 2,4-D. This reduction in control rating was due to the presence of bolting stems originating from rosettes that previously appeared nearly or completely dead (data not shown).

Wheat yield was variable across the study site due to poor emergence following the September 2015 seeding. This resulted from inadequate soil moisture in the seed zone likely caused by a combination of low rainfall in 2015 and moisture depletion by skeletonweed in the denser patches. Rosette density in the non-treated check plots ranged from 1.4 to 89 plants/m^2 at the beginning of the trial in November 2015. At harvest the low-density plot yielded 89 bu/A and the high-density plot yielded 75 bu/A. In spite of stand variability, differences were seen in wheat yield in relation to the herbicide treatments. Plots treated with aminopyralid, clopyralid, and dicamba averaged the highest yields in both the fall and spring applications and were not different from the fall-applied non-treated check (Table 3). In contrast, yield was lowest with the aminocyclopyrachlor and 2,4-D fall-applied treatments averaging 76 bu/A, each. Yields for these two herbicide treatments were also lowest among the spring-applied treatments. The 2,4-D treatment averaged 76 bu/A, while the spring-applied aminocyclopyrachlor caused kernel abortion and blank heads resulting in a wheat yield of only 48 bu/A (Table 3.)

In this trial, fall applications of aminopyralid or clopyralid substantially controlled rush skeletonweed in the crop phase of the rotation without reducing grain yield. The aminocyclopyrachlor and 2,4-D treatments did not control skeletonweed well and appeared to reduce yield. Dicamba did not lower yield, but also did not control skeletonweed.

Table 3. Visually rated control of rush skeletonweed, and wheat grain yield in relation to herbicide applications in winter wheat.[1]

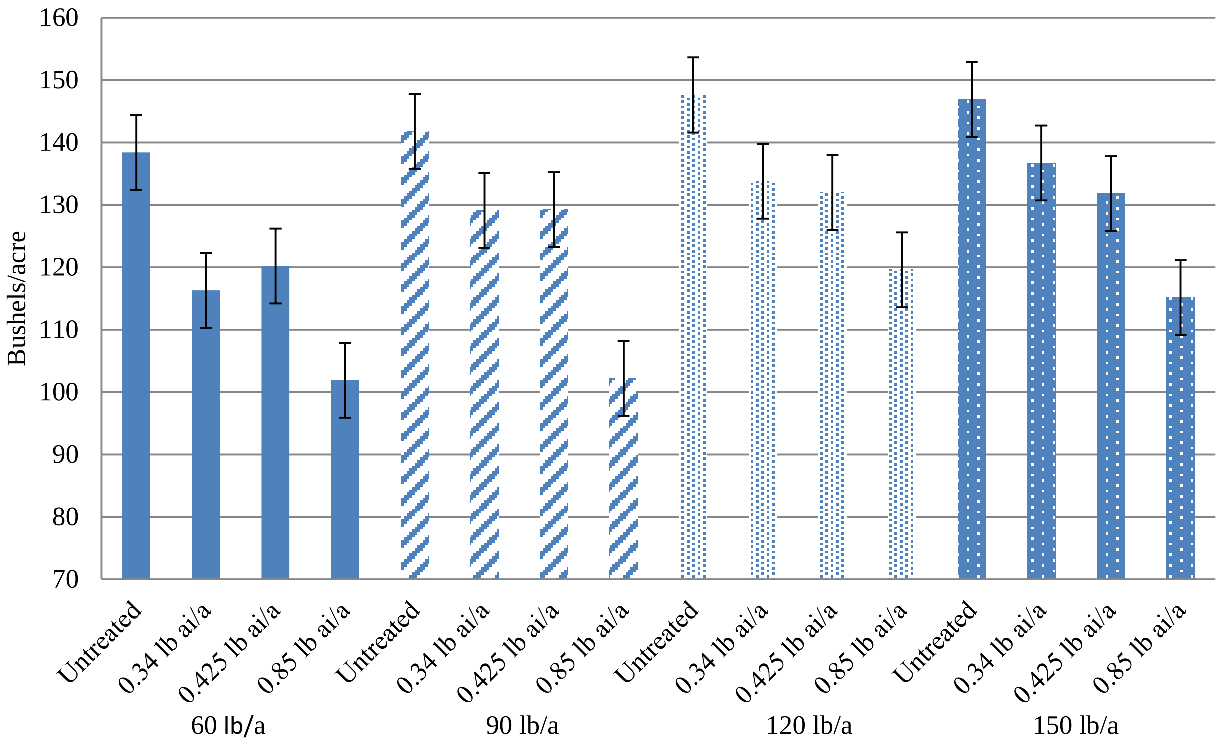
		Visual control ratings[3]				
Treatments[2]	Rate	March 8	March 31	June 2	July 20	Wheat yield
	(lb ae/A)	-------(% of non-treated check)-------				(bu/A)
Fall-applied herbicides						
non-treated	--	0 -	0 -	0 -	0 -	84 ab
aminopyralid	0.0093	83 a	88 a	98 a	89 a	90 a
clopyralid	0.1875	87 a	92 a	98 a	96 a	87 a
aminocyclopyrachlor	0.013	50 a	10 c	40 b	47 b	76 b
dicamba	0.125	63 a	58 b	37 b	45 b	92 a
2,4-D ester	0.375	42 a	15 c	48 b	37 b	76 b
p-value		0.0815	<0.0001	<0.0001	0.0041	0.0181
Spring-applied herbicides						
non-treated	--	0 -	0 -	0 -	0 -	79 bc
aminopyralid	0.0093	0 -	6 a	94 a	76 a	87 ab
clopyralid	0.1875	0 -	10 a	100 a	78 a	90 a
aminocyclopyrachlor	0.013	0 -	3 a	53 b	35 b	48 d
dicamba	0.125	0 -	5 a	50 b	32 b	83 a-c
2,4-D ester	0.375	0 -	5 a	53 b	66 a	76 c
p-value		----	0.1459	<0.0001	0.0043	<0.0001

[1]Numbers (LSMeans) in each column followed by the same letter are not different at p≤0.05.
[2]All herbicide applications included a non-ionic surfactant at 0.25% v/v rate. Fall treatments were applied on November 12, 2015; spring treatments were applied on March 17, 2016.
[3]March 8 ratings were prior to spring applications; March 31 ratings were 2 weeks following spring applications; June 2 ratings were at wheat soft dough stage; July 20 ratings were made just prior to harvest.

‘Bobtail’ winter wheat sensitivity to flufenacet-metribuzin by seeding rate and herbicide application rate. Kyle C. Roerig, Andrew G. Hulting, Daniel W. Curtis, and Carol A. Mallory-Smith. (Department of Crop and Soil Science, Oregon State University, Corvallis, OR 97331) In previous studies, ‘Bobtail’ winter wheat was injured by flufenacet-metribuzin applied at the label rate of 0.425 lb ai/a. The injury was assessed visually as stand reduction and as a reduction in harvested wheat yield (Roerig et al. 2014). The following study was designed to assess the relationship between seeding rate and the rate of flufenacet-metribuzin to determine whether a reduced rate of flufenacet-metribuzin or an increased seeding rate may mitigate injury and achieve maximum yield. ‘Bobtail’ wheat was planted October 13, 2015, at a depth of 1.5 inches. The experiment was a strip-plot design. Planting rates were not randomized. Flufenacet-metribuzin was applied October 20, 2015, to germinated wheat just prior emergence. The rates used were 0.34, 0.425 and 0.85 lb ai/a. Typically, western Oregon experiences frequent, regular rainfall and wet soils during the fall. To compensate for lower than average rainfall and simulate a wet year, 0.5 inches of water was applied five days prior to the application of flufenacet-metribuzin and again immediately following herbicide applications.

Yield in the untreated plots planted at 120 and 150 lb/a was higher than in the 60 lb/a plot. The untreated 60 lb/a plot did not differ significantly from the untreated 90 lb/a. The 0.34 and 0.425 lb ai/a rate reduced yield by 9-16% and the 0.85 lb ai/a rate reduce yield by 19-29% relative to the untreated plots of the same seeding rate. Wheat yield at the 0.34 and 0.425 lb ai/a rate did not differ at any seeding rate (p-value 0.05). These results indicate that neither increasing the seeding rate nor decreasing the rate of flufenacet-metribuzin can fully prevent a reduction in ‘Bobtail’ wheat yield under the high moisture condition of this experiment. In a separate, adjacent trial that was planted and irrigated in the same manner, pyroxasulfone applied at 0.093 and 0.186 lb ai/a did not reduce wheat yield when applied preemergence and delayed preemergence.

Table. Wheat yield by seeding rate and flufenacet-metribuzin rate. Error bars represent LSD at p-value 0.05.



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Preemergent control of junglerice and Palmer amaranth in a greenhouse. Sarah R. Parry, Nicholas E. Clark, Eduardo Padilla, Isaac Giron, Walter Martinez, Brad Hanson, Steven D. Wright, and Anil Shrestha. (University of California Cooperative Extension, Tulare, CA 93274-9537) The objective of this study was to evaluate the efficacy of preemergent herbicides for use in control of junglerice and Palmer amaranth seedlings of abraded and non-abraded seeds. This study was conducted at the California State University, Fresno campus greenhouse in Fresno, California, in July and August, 2015. Herbicide treatments were pendimethalin and trifluralin at 1x and 2x rates, as well as *S*-metolachlor and indaziflam at label rates, and an untreated control (Table). Seeds were either abraded or non-abraded. Each treatment combination was replicated four times in a split-split plot design. Main plots were herbicide treatment, sub-plots were weed species, and sub-sub plots were seed abrasion treatment. Each sub-plot was 11 by 21.37 by 2.44 inches in propagation trays. Treatments were applied July 24, 2015. Air temperature was 82°F, wind speed ranged from four to six mph, and relative humidity was 29%. Treatment applications were sprayed at 15 gpa using a CO_2 pressurized backpack sprayer with TJet 8002 flat fan nozzles at 30 psi. Weekly evaluations of weed emergence percentage began seven days after treatment (DAT).

Soil for this study was collected in the certified organic field at the Kearney Agricultural Research and Extension Center, in Parlier, California. The soil was sterilized on July 22, 2015, and July 23, 2015, using steam. Steam was applied for 45 minutes at 212° F. The soil was stirred, moisture was added, and the soil was sterilized again for 1 hour. Soil was sterilized in a tarp covering one cubic yard container with a perforated door which steam entered at 700 lbs/hour. Soil was divided among 56 ‘1020’ propagation trays. Twenty-eight trays each were used for junglerice and Palmer amaranth. The soil was amended with slow release fertilizer granules. Amendment was applied and mixed by hand at 0.4 oz/tray. Junglerice and Palmer amaranth seed was collected prior to this study in 2011 and 2013 in Davis, California and Tulare, California, respectively. Fifty seeds were applied to each soil-filled tray. Trays were divided into two sections. Twenty-five abraded seeds were placed in one section, and twenty-five non-abraded seeds were place in the other section. Seeds were covered with one cm of soil then treated with herbicides. Trays were irrigated using a shower nozzle on a water hose with 0.5 inch of water per tray to incorporate the herbicides.

After seven DAT, there was little to no emergence of either the junglerice or Palmer amaranth seed. The greatest germination was in the abraded Palmer amaranth, untreated control sub-sub-plots with 9 to 15 emerged plants per tray. The second highest germination rate was in sub-plots treated with pendimethalin at 2.85 lbs ai/A. In the untreated control, germination ranged from 9 to 15 seeds out of 25 total. There was complete control of trays treated with pendimethalin at 2.85 lbs ai/A by 14 DAT. Under the conditions of this study, the greatest emergence was of Palmer amaranth in the untreated control. The junglerice seed did not emerge in any treatment (data not shown).

Table. Palmer amaranth control by different herbicides at three post-treatment timings.

		Weed control		
Treatment	Rate	7 DAT	14 DAT	21 DAT
	lbs ai/A	----------------------------	%	----------------------------
Untreated control	-	0	0	0
Pendimethalin	1.43	100	100	100
Pendimethalin	2.85	100	100	100
Trifluralin	1.50	100	100	100
Trifluralin	3.00	100	100	100
S-metolachlor	1.43	100	100	100
Indaziflam	0.08	100	100	100

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