2015 WSU Weed Control Report

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Disclaimer

Some of the pesticides discussed in this presentation were tested under an experimental use permit granted by WSDA. Application of a pesticide to a crop or site that is not on the label is a violation of pesticide law and may subject the applicator to civil penalties up to $7,500. In addition, such an application may also result in illegal residues that could subject the crop to seizure or embargo action by WSDA and/or the U.S. Food and Drug Administration. It is your responsibility to check the label before using the product to ensure lawful use and obtain all necessary permits in advance.

Evaluation of herbicides and mowing to control smooth scouringrush in winter wheat
Drew Lyon, Derek Appel and Henry Wetzel

A field study was established on the ground of the Spokane Hutterian Brethren near Reardan, WA to evaluate the effects of mowing and herbicides on the control of smooth scouringrush in a direct-seed system. This study followed a year of chemical fallow. The soil at this location is an Athena silt loam with a pH of 4.9 and 3.3% organic matter. Four of the eight blocks, each block containing a nontreated check and 10 herbicide treatments, were rotary mowed July 24, 2014. Herbicides were applied on July 25th using a CO_2 backpack sprayer set to deliver 15 gpa at 30 psi and 3.5 mph. The air temperature at the time of application was 70°F with 36% relative humidity and the wind was out of the SW at 6 mph. On September 10th, Whetstone hard red winter wheat was seeded with a Bourgault 3710 disc drill on a 10-inch row spacing at the rate of 60 lb/acre. The field was fertilized at the rate of 85-10-15 lb N-P-S per acre at the time of planting.

Visual injury on the smooth scouringrush was assessed on August 20th, 26 days after treatment. Plants treated with Curtail® M, Glean® XP + Rhonox® and Permit® + Rhonox exhibited the most injury. Mowing in combination with the various herbicide treatments did not have a significant effect on smooth scouringrush control, thus treatment means are averaged over the mowing factor. Smooth scouringrush stem counts were taken by placing a meter stick between two wheat rows and counting all the stems between and within the rows. This was done at two locations within each plot. All treatments except Rhonox, Curtail M, Starane® Ultra and RoundUp PowerMax® + Liberty® reduced smooth scouringrush stem counts compared to the nontreated check when evaluated on May 15, 2015. Glean XP + Rhonox was the most effective treatment in reducing smooth scouringrush stems in the spring and on the second evaluation date (August 10th), it was the only treatment that was significantly different from the nontreated check. There were no significant differences among test weight or yield (data not shown) in relation to the herbicide treatments. The average test weight and yield were 55 lb/bu and 72 bu/a, respectively. In this study, the presence of smooth scouringrush in the nontreated checks did not negatively impact winter wheat yield.

Treatment[1]	Rate fl oz pr/a	Injury (%) 8/20/14		Stem counts per linear meter 5/15/15	 8/10/15
Nontreated check	--	--		38 a	38 a
2,4-D LV 6	23.3	33 d[5]		22 b-d	34 a
Rhonox MCPA	34.6	55 c		32 ab	36 a
Curtail M	37.4	70 ab		30 a-c	42 a
Glean XP + Rhonox MCPA	0.5 oz + 34.6	79 a		1 e	2 b
Permit + Rhonox MCPA	1.33 oz + 34.6	67 b		23 b-d	28 a
RoundUp PowerMax[2]	32	17 e		15 d	29 a
RoundUp PowerMax + Sharpen®[2,3]	32.0 + 4.0	10 e		21 b-d	29 a
Starane Ultra	11.2	29 d		28 a-c	36 a
Paramount®[2,4]	5.3 oz	19 e		18 cd	30 a
RoundUp PowerMax + Liberty[2]	21.3 + 30.0	46 c		32 ab	32 a

[1]All treatments, except RoundUp PowerMax plus Sharpen, and Paramount, were applied with 90% nonionic surfactant (R-11) at 0.33% v/v.
[2]These treatments were applied with ammonium sulfate at 50 oz/A.
[3]This treatment was applied with a 99% crop oil concentrate (Agri-Dex) ay 1.0% v/v/.
[4]This treatment was applied with a 98.1% modified vegetable oil (Kalo) at 32 fl oz/A.
[5]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, 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.

Italian ryegrass control in winter wheat using Anthem® Flex

Drew Lyon and Henry Wetzel

A field study was conducted on the WSU Cook Agronomy Farm near Pullman, WA to generate weed control and crop response data for winter wheat treated with Anthem Flex herbicide at various application times. The active ingredient in Anthem Flex that is effective on Italian ryegrass is pyroxasulfone, an inhibitor of very-long-chain fatty acid synthesis (Group 15). This is a newly labeled product that may be very useful for the control of Italian ryegrass, especially as resistance to Group 1 and 2 herbicides in Italian ryegrass populations continues to develop.

The soil at this site is a Palouse silt loam with 4.7% organic matter and a pH of 5.1. Pre-plant herbicide applications were made on October 24, 2014 using a CO_2 backpack sprayer set to deliver 10 gpa at 2.3 mph and 40 psi. Conditions were an air temperature of 53°F, relative humidity of 66% and the wind out of the SE at 8.5 mph. 'ARS-Amber' winter wheat was seeded on October 27th at a rate of 62 lb/acre using a Monosem precision air seed drill with 10-inch row spacing at a depth of 1.5 inches. Soils were dry and hard at planting which resulted in a range of seeding depth from 0.5 to 1.5 inches. Starter fertilizer was applied at a rate of 100 lb N/acre from urea. Post-plant, pre-emerge herbicide applications were applied on October 28th. Conditions were an air temperature of 45°F, relative humidity of 78% and the wind out of the SE at 2.5 mph. Early post-emerge herbicides were applied on March 20, 2015 with a SE wind at 5 mph, relative humidity at 52%, and air temperature at 60°F. Wheat was at the 2- to 4-tiller stage and was 6 inches tall. Italian ryegrass was 3 inches tall at the time of application. Plots were harvested on July 24th with a Kincaid 8XP combine.

The extremely cold temperatures the week of November 9th affected seedling development of Italian ryegrass as well as further fall germination. The majority of the Italian ryegrass germinated from late-winter to early spring, as we experienced a very mild winter, average precipitation with minimal snow cover. The best Italian ryegrass control was achieved with a split application of Anthem Flex, applied pre-plant and in the spring, in combination with PowerFlex® HL in the spring. Although a pre-plant application of Anthem Flex at the rate of 3.75 or 4.5 fl oz/acre provided similar control of Italian ryegrass, it is wise to plan on a spring application of a Group 2 herbicide with activity on Italian ryegrass, like Everest® 2.0, Osprey® or PowerFlex HL, to control later emerging plants and provide a second mechanism of action to reduce the risk of developing Italian ryegrass populations resistant to pyroxasulfone. No significant yield differences were observed amongst the various herbicide treatments (data not shown). The average test weight and yield were 47 lb/bu and 68 bu/a, respectively.

				May 1		June 10
					Italian	Italian
				Crop	Ryegrass	Ryegrass
Treatment	Rate	Application	Application	Injury	Control	Control
	fl oz/A	Date	Description	(0 to 100)	(0 to 100)	(0 to 100)
Nontreated Check				--	--	--
Anthem Flex	2.5	10/24/14	Pre-plant	4 a[1]	67 cd	61 b
Anthem Flex	3.25	10/24/14	Pre-plant	2 a	79 bc	75 ab
Anthem Flex	3.75	10/24/14	Pre-plant	4 a	90 ab	86 a
Anthem Flex	3.75	10/28/14	Post-plant Pre-emerge	0 a	85 ab	75 ab
Anthem Flex	4.5	10/28/14	Post-plant Pre-emerge	5 a	84 a-c	76 ab
Anthem Flex	4.5	10/24/14	Pre-plant	11 a	91 ab	75 ab
Anthem Flex	3.25	10/24/14	Pre-plant	6 a	91 ab	85 a
PowerFlex HL	2.0 oz	3/20/15	Wheat 2-tillers detected			
NIS	0.25 % v/v	3/20/15	Wheat 2-tillers detected			
Anthem Flex	3.25	10/24/14	Pre-plant	11 a	89 ab	76 ab
Everest 2.0	1.0	3/20/15	Wheat 2-tillers detected			
NIS	0.25 % v/v	3/20/15	Wheat 2-tillers detected			
PowerFlex HL	2.0 oz	3/20/15	Wheat 2-tillers detected	6 a	51 d	32 c
NIS	0.25 % v/v	3/20/15	Wheat 2-tillers detected			
Everest 2.0	1.0	3/20/15	Wheat 2-tillers detected	1 a	22 e	25 c
NIS	0.25 % v/v	3/20/15	Wheat 2-tillers detected			
Anthem Flex	2.5	10/24/14	Pre-plant	11 a	96 a	91 a
Anthem Flex	2.0	3/20/15	Wheat 2-tillers detected			
PowerFlex HL	1.4 oz	3/20/15	Wheat 2-tillers detected			
NIS	0.25 % v/v	3/20/15	Wheat 2-tillers detected			

[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 Fisher's protected LSD 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.

Evaluation of DuPont's group 2 herbicides and their effect on downy brome control in winter wheat

Drew Lyon, Derek Appel and Henry Wetzel

A field study was conducted at the Wilke Research Farm near Davenport, WA to evaluate downy brome control in winter wheat. Glean® XP (chlorsulfuron), Ally® XP (metsulfuron), PowerFlex® HL (pyroxsulam), Harmony® (thifensulfuron), Express® (tribenuron), Osprey® (mesosulfuron), and Olympus® (propoxycarbazone) are Group 2 herbicides. Group 2 herbicides are inhibitors of acetolactate synthase (ALS), a key enzyme in the biosynthesis of the branched-chain amino acids isoleucine, leucine, and valine. The objective of the study was to evaluate various herbicide tank mixtures and their effects on downy brome control.

The soil for this site is a Broadax silt loam with 3.2% organic matter and a pH of 4.9. On September 9, 2014, 'ARS-Crescent' winter wheat was planted into chemical fallowed ground using a Case IH, Flexicoil no-till drill with 12-inch row spacing. Seeding rate was 70 lb/acre and seed was planted to a 3-inch depth. Starter fertilizer was applied below the seed at planting at a rate of 10 and 9 lb/acre of P:S. Treatments 2 through 5 were applied early post-emerge (downy brome at 1-leaf stage) on November 2, 2014 using a CO_2 backpack sprayer set to deliver 15 gpa at 30 psi and 3.5 mph. Conditions were an air temperature of 51°F, relative humidity of 48% and the wind out of the southwest at 7 mph. Treatments 6 through 17 were applied at typical spring post-emerge (downy brome at 3-tiller stage) on May 6 using a CO_2 backpack sprayer set to deliver 15 gpa at 30 psi and 3.5 mph. Conditions were an air temperature of 58°F, relative humidity of 38% and the wind out of the south at 7 mph. The plots were harvested on July 30 using a Kincaid 8XP combine.

No significant crop injury was observed in this study (data not shown). Downy brome emergence in the fall was light, but late winter emergence was moderate. There were no significant differences among treatments in relation to downy brome control. Numerically, fall applied treatments (2 through 5) provided the best control of downy brome. Many of the treatments provided excellent control of tumble mustard. The exceptions were PowerFlex HL (2.0 oz/A) and Olympus (0.9 oz/A) applied in the fall. There were no significant differences among the nontreated check and herbicide treatments in relation to test weight and yield (data not shown). The average test weight and yield were 53 lb/bu and 53 bu/a, respectively.

				5/29	
				Downy brome control	Tumble mustard control
Trt#	Treatment	Rate oz/A	Application Date	(0 to 100)	(0 to 100)
1	Non-Treated Check			--	--
2	Glean XP	0.33	11/2/14	91 a[1]	84 a
2	Ally XP	0.083	11/2/14		
2	PowerFlex HL	2.0	11/2/14		
2	NIS	0.25% v/v	11/2/14		
3	Glean XP	0.33	11/2/14	95 a	96 a
3	Ally XP	0.083	11/2/14		
3	PowerFlex HL	2.0	11/2/14		
3	Dagger®	12.8 fl oz	11/2/14		
3	NIS	0.25% v/v	11/2/14		
4	PowerFlex HL	2.0	11/2/14	91 a	19 c
4	NIS	0.25% v/v	11/2/14		
5	Olympus	0.9	11/2/14	90 a	59 b
5	NIS	0.25% v/v	11/2/14		
6	Harmony	0.16	5/6/15	65 a	94 a
6	Express	0.082	5/6/15		
6	Ally XP	0.054	5/6/15		
6	PowerFlex HL	2.0	5/6/15		
6	NIS	0.25% v/v	5/6/15		
7	Harmony	0.16	5/6/15	71 a	97 a
7	Express	0.082	5/6/15		
7	Ally XP	0.054	5/6/15		
7	PowerFlex HL	2.0	5/6/15		
7	2,4-D LV6	11.6 fl oz	5/6/15		
7	NIS	0.25% v/v	5/6/15		
8	Harmony	0.16	5/6/15	77 a	99 a
8	Express	0.082	5/6/15		
8	Ally XP	0.054	5/6/15		
8	PowerFlex HL	2.0	5/6/15		
8	Huskie	13.5 fl oz	5/6/15		
8	NIS	0.25% v/v	5/6/15		
9	Harmony	0.27	5/6/15	74 a	90 a
9	Express	0.136	5/6/15		
9	Ally XP	0.091	5/6/15		
9	PowerFlex HL	2.0	5/6/15		
9	NIS	0.25% v/v	5/6/15		

[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 Fisher's protected LSD 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.

Trt#	Treatment	Rate oz/A	Application Date	5/29 Downy brome control (0 to 100)	5/29 Tumble mustard control (0 to 100)
10	Harmony	0.273	5/6/15	81 a[1]	100 a
10	Express	0.136	5/6/15		
10	Ally XP	0.091	5/6/15		
10	PowerFlex HL	2.0	5/6/15		
10	2,4-D LV6	11.6 fl oz	5/6/15		
10	NIS	0.25% v/v	5/6/15		
11	Harmony	0.273	5/6/15	82 a	100 a
11	Express	0.136	5/6/15		
11	Ally XP	0.091	5/6/15		
11	PowerFlex HL	2.0	5/6/15		
11	Huskie	13.5 fl oz	5/6/15		
11	NIS	0.25% v/v	5/6/15		
12	Harmony	0.273	5/6/15	67 a	95 a
12	Express	0.136	5/6/15		
12	Ally XP	0.091	5/6/15		
12	Osprey	4.75	5/6/15		
12	NIS	0.25% v/v	5/6/15		
13	Harmony	0.06	5/6/15	81 a	99 a
13	Express	0.24	5/6/15		
13	PowerFlex HL	2.0	5/6/15		
13	Huskie	13.5 fl oz	5/6/15		
13	NIS	0.25% v/v	5/6/15		
14	Harmony	0.1	5/6/15	71 a	99 a
14	Express	0.4	5/6/15		
14	PowerFlex HL	2.0	5/6/15		
14	Huskie	13.5 fl oz	5/6/15		
14	NIS	0.25% v/v	5/6/15		
15	Harmony	0.02	5/6/15	75 a	99 a
15	Express	0.08	5/6/15		
15	PowerFlex HL	2.0	5/6/15		
15	Huskie	13.5 fl oz	5/6/15		
15	NIS	0.25% v/v	5/6/15		
16	Harmony	0.1	5/6/15	50 a	92 a
16	Express	0.4	5/6/15		
16	Osprey	4.75	5/6/15		
16	NIS	0.25% v/v	5/6/15		
17	Harmony	0.1	5/6/15	67 a	95 a
17	Express	0.4	5/6/15		
17	Osprey	4.75	5/6/15		
17	Huskie	13.5 fl oz	5/6/15		
17	NIS	0.25% v/v	5/6/15		

[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 Fisher's protected LSD 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.

Everest® 2.0 and PowerFlex® HL for the control of downy brome
Drew Lyon, Derek Appel and Henry Wetzel

A field study was conducted at the Wilke Research Farm near Davenport, WA to evaluate downy brome control in winter wheat. Flucarbazone-sodium and pyroxsulam are Group 2 herbicides. Group 2 herbicides are inhibitors of acetolactate synthase (ALS), a key enzyme in the biosynthesis of the branched-chain amino acids isoleucine, leucine, and valine.

The soil for this site is a Broadax silt loam with 3.2% organic matter and a pH of 4.9. On September 9, 2014, 'ARS-Crescent' winter wheat was planted into chemical fallowed ground using a Case IH, Flexicoil no-till drill with 12-inch row spacing. Seeding rate was 70 lb/acre and seed was planted to a 3-inch depth. Starter fertilizer was applied below the seed at planting at a rate of 10 and 9 lb/acre of P:S. Treatments 2 through 5 were applied early post-emerge (downy brome at 2-leaf stage) on November 2, 2014 using a CO_2 backpack sprayer set to deliver 15 gpa at 30 psi and 3 mph. Conditions were an air temperature of 51°F, relative humidity of 48% and the wind out of the southwest at 7 mph. Treatments 6 through 10 were applied early spring (downy brome at 3-tiller stage) on April 10 using a CO_2 backpack sprayer set to deliver 15 gpa at 30 psi and 3 mph. Conditions were an air temperature of 52°F, relative humidity of 65% and the wind out of the south at 4 mph. Treatments 11 through 14 were applied at typical spring post (downy brome at 3-tiller stage) on May 6 using a CO_2 backpack sprayer set to deliver 15 gpa at 30 psi and 3 mph. Conditions were an air temperature of 56°F, relative humidity of 44% and the wind out of the northwest at 7 mph. The plots were harvested on August 5 using a Kincaid 8XP combine.

No significant crop injury was observed in this study (data not shown). Downy brome emergence in the fall was light, but additional plants emerged over the mild winter and by spring a moderate infestation of downy brome was present. Regardless of timing, Everest 2.0 applied alone at 1.0 fl oz/A or in combination with Audit® 1:1 (0.6 oz/A) did not provide acceptable control of downy brome. Fall applications of Everest 2.0 (1.0 fl oz/A) + PowerFlex HL (1.0 oz/A) or PowerFlex HL (2.0 oz/A) provided excellent control of downy brome. Early spring applications of Everest 2.0 (1.0 fl oz/A) + PowerFlex HL (1.0 oz/A) or Everest 2.0 (1.0 fl oz/A) + PowerFlex HL (0.5 oz/A) provided excellent control of downy brome. Only the Everest 2.0 (1.0 fl oz/A) + PowerFlex HL (1.0 oz/A) provided commercially acceptable control of downy brome at the typical spring post-emerge timing. Fall applied herbicides did not provide good control of tumble mustard, much of which emerged over the winter. With the exception of Everest 2.0 (1.0 fl oz/A), all early spring and typical spring post-emerge treatments provided excellent control of tumble mustard. There were no significant differences among the nontreated check and herbicide treatments in relation to yield and test weight (data not shown). The average test weight and yield were 56 lb/bu and 68 bu/a, respectively.

				5/29/15	
				Downy Brome	Tumble Mustard
Treatment	Rate	Application		Control	Control
	fl oz/A	Date	Application Description	(0 to 100)	(0 to 100)
Nontreated Check				--	--
Everest 2.0	1	11/2/14	Late fall 4-5 weeks after planting	59 de[1]	79 a-c
NIS	0.25% v/v	11/2/14	Late fall 4-5 weeks after planting		
AMS	1 lb/a	11/2/14	Late fall 4-5 weeks after planting		
Everest 2.0	1	11/2/14	Late fall 4-5 weeks after planting	50 e	67 b-c
Audit 1:1	0.6 oz/a	11/2/14	Late fall 4-5 weeks after planting		
NIS	0.25% v/v	11/2/14	Late fall 4-5 weeks after planting		
AMS	1 lb/a	11/2/14	Late fall 4-5 weeks after planting		
Everest 2.0	1	11/2/14	Late fall 4-5 weeks after planting	85 ab	59 cd
PowerFlex HL	1.0 oz/a	11/2/14	Late fall 4-5 weeks after planting		
NIS	0.25% v/v	11/2/14	Late fall 4-5 weeks after planting		
AMS	1.0 lb/a	11/2/14	Late fall 4-5 weeks after planting		
PowerFlex HL	2.0 oz/a	11/2/14	Late fall 4-5 weeks after planting	91 a	56 d
NIS	0.25% v/v	11/2/14	Late fall 4-5 weeks after planting		
AMS	1.0 lb/a	11/2/14	Late fall 4-5 weeks after planting		
Everest 2.0	1	4/10/15	Early Spring	61 c-e	61 cd
NIS	0.25% v/v	4/10/15	Early Spring		
AMS	1.0 lb/a	4/10/15	Early Spring		
Everest 2.0	1	4/10/15	Early Spring	61 c-e	95 a
Audit 1:1	0.6 oz/a	4/10/15	Early Spring		
NIS	0.25% v/v	4/10/15	Early Spring		
AMS	1.0 lb/a	4/10/15	Early Spring		
Everest 2.0	1	4/10/15	Early Spring	85 ab	94 a
PowerFlex HL	1.0 oz/a	4/10/15	Early Spring		
NIS	0.25% v/v	4/10/15	Early Spring		
AMS	1.0 lb/a	4/10/15	Early Spring		
Everest 2.0	1.0	4/10/15	Early Spring	84 ab	84 ab
PowerFlex HL	0.5 oz	4/10/15	Early Spring		
NIS	0.25% v/v	4/10/15	Early Spring		
AMS	1.0 lb/a	4/10/15	Early Spring		
PowerFlex HL	2.0 oz	4/10/15	Early Spring	81 a-c	89 a
NIS	0.25% v/v	4/10/15	Early Spring		
AMS	1.0 lb/a	4/10/15	Early Spring		
Everest 2.0	1	5/6/15	Typical Spring Post	59 de	97 a
NIS	0.25% v/v	5/6/15	Typical Spring Post		
AMS	1.0 lb/a	5/6/15	Typical Spring Post		
Everest 2.0	1	5/6/15	Typical Spring Post	61 c-e	92 a
Audit 1:1	0.6 oz/a	5/6/15	Typical Spring Post		
NIS	0.25% v/v	5/6/15	Typical Spring Post		
AMS	1.0 lb/a	5/6/15	Typical Spring Post		
Everest 2.0	1	5/6/15	Typical Spring Post	78 a-d	92 a
PowerFlex HL	1.0 oz/a	5/6/15	Typical Spring Post		
NIS	0.25% v/v	5/6/15	Typical Spring Post		
AMS	1.0 lb/a	5/6/15	Typical Spring Post		
PowerFlex HL	2.0 oz	5/6/15	Typical Spring Post	69 b-e	92 a
NIS	0.25% v/v	5/6/15	Typical Spring Post		
AMS	1.0 lb/a	5/6/15	Typical Spring Post		

[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 Fisher's protected LSD 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

Pre/Post systems for mixed grass species control in winter wheat
Drew Lyon and Henry Wetzel

A field study was conducted at the Palouse Conservation Field Station near Pullman, WA to generate grassy weed control data in winter wheat. The objective was to evaluate fall, fall plus spring, or spring treatments and their effects on grassy weed control.

The soil at this site is a Thatuna silt loam with 3.9% organic matter and a pH of 4.6. Pre-plant herbicide applications were made on October 24, 2014 using a CO_2 backpack sprayer set to deliver 10 gpa at 2.3 mph and 40 psi. Conditions were an air temperature of 55°F, relative humidity of 70% and the wind out of the SE at 5 mph. 'ARS-Amber' winter wheat was seeded on October 27th at a rate of 62 lb/acre using a Monosem precision air seed drill with 10-inch row spacing at a depth of 1.5 inches. Soils were dry and hard at planting which resulted in a range of seeding depth from 0.5 to 1.5 inches. Starter fertilizer was applied at a rate of 100 lb N/acre from urea. Spring post-emerge herbicides were applied on March 30, 2015 under calm conditions, relative humidity at 52%, and air temperature at 61°F. Wheat was at the 1- to 4-tiller stage and was 6 inches tall.

Jointed goatgrass and wild oats were not uniformly distributed in the plot area, which resulted in a large variance and an inability to detect treatment differences. There were no significant differences among test weight or yield (data not shown) in relation to the herbicide treatments. The average test weight and yield were 48 lb/bu and 64 bu/a, respectively.

				June 12, 2015	
				Wild Oat Control (0 to 100)	Jointed Goatgrass Control (0 to 100)
Treatment	Rate fl oz/A	Application Date	Application Description		
Nontreated Check				--	--
Anthem® Flex	3	10/24/2014	Pre-plant	87 a[1]	17 a
Anthem Flex	3	10/24/2014	Pre-plant	97 a	23 a
Axial® XL	16.4	3/30/2015	Wheat 2-tillers detected		
Anthem Flex	3	10/24/2014	Pre-plant	97 a	48 a
Everest® 2.0	1	3/30/2015	Wheat 2-tillers detected		
Audit® 1:1	0.4 oz/a	3/30/2015	Wheat 2-tillers detected		
NIS	0.25% v/v	3/30/2015	Wheat 2-tillers detected		
AMS	1.0 lb/a	3/30/2015	Wheat 2-tillers detected		
Anthem Flex	3	10/24/2014	Pre-plant	95 a	35 a
PowerFlex® HL	2.0 oz/a	3/30/2015	Wheat 2-tillers detected		
NIS	0.25% v/v	3/30/2015	Wheat 2-tillers detected		
AMS	1.0 lb/a	3/30/2015	Wheat 2-tillers detected		
Everest 2.0	1	3/30/2015	Wheat 2-tillers detected	77 a	27 a
NIS	0.25% v/v	3/30/2015	Wheat 2-tillers detected		
AMS	1.0 lb/a	3/30/2015	Wheat 2-tillers detected		
Everest 2.0	1	3/30/2015	Wheat 2-tillers detected	50 a	37 a
Audit 1:1	0.4 oz/a	3/30/2015	Wheat 2-tillers detected		
NIS	0.25% v/v	3/30/2015	Wheat 2-tillers detected		
AMS	1.0 lb/a	3/30/2015	Wheat 2-tillers detected		
PowerFlex HL	2.0 oz/a	3/30/2015	Wheat 2-tillers detected	70 a	17 a
NIS	0.25% v/v	3/30/2015	Wheat 2-tillers detected		
AMS	1.0 lb/a	3/30/2015	Wheat 2-tillers detected		
Everest 2.0	1.0	3/30/2015	Wheat 2-tillers detected	82 a	27 a
PowerFlex HL	1.0 oz	3/30/2015	Wheat 2-tillers detected		
Audit 1:1	0.4 oz/a	3/30/2015	Wheat 2-tillers detected		
NIS	0.25% v/v	3/30/2015	Wheat 2-tillers detected		
AMS	1.0 lb/a	3/30/2015	Wheat 2-tillers detected		

[1] Means, based on three 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, 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.

Two-gene Clearfield® winter wheat and its tolerance to Beyond® in combination with various broadleaf herbicides

Drew Lyon and Henry Wetzel

A field study was conducted on the WSU Cook Agronomy Farm near Pullman, WA to generate crop response data for two-gene Clearfield winter wheat treated with Beyond herbicide in combination with various broadleaf herbicides.

The soil at this site is a Palouse silt loam with 3.2% organic matter and a pH of 5.6. Nutrients were cultivated in on October 9, 2014, which consisted of 100-15-25-10 lb/acre of N-P-S-Cl. The form of nitrogen used was anhydrous ammonia. WestBred 1081 CL+ winter wheat was seeded on October 13th at a rate of 62 lb/acre using a Monosem precision air seed drill with 10-inch row spacing at a depth of 1.5 inches. Even though the ground was cultivated prior to planting, soils were dry which resulted in a range of seeding depth from 1.0 to 1.5 inches. Post-emergence herbicide applications were made on April 7th. Conditions were an air temperature of 61°F, relative humidity of 26% and the wind out of the E at 2 mph. The majority of the wheat was at the 4-tiller stage and was 6 inches tall.

Essentially, there was no visual crop injury on plants that were treated solely with Beyond + MSO® Conc. with Leci-Tech + UAN, when compared to the nontreated check. The primary injury that was observed was leaf spotting and tip burn and was most pronounced in the Beyond + Huskie, Beyond + Brox®-M + WideMatch® and Beyond + Brox-M + Huskie® treatments. Test weight was reduced in plots treated solely with Beyond + MSO Conc. with Leci-Tech + UAN, Beyond + Brox-M + WideMatch and Beyond + Brox-M + Huskie when compared to the nontreated check. There were no significant differences in yield among any treatments.

		Crop Injury	Test Weight	Yield
	Rate	(0 to 100)	lb/bu	bu/a
Treatment	fl oz/A	4/17	------------------7/22-----------------	
Nontreated Check	--	--	60 a	83 a
Beyond + MSO Conc. with Leci-Tech + UAN	6.0 + 1.0% v/v + 20% v/v	1 ab[2]	57 cd	86 a
Curtail® M[1]	32.0	0 a	60 ab	80 a
Starane® Ultra	6.4	0 a	60 ab	91 a
Rhonox® MCPA	18.0	0 a	59 ab	84 a
2,4-D LV 6	16.0	2 a-c	60 ab	77 a
WideMatch	21.3	2 a-c	60 ab	79 a
Brox-M	32.0	4 a-d	59 ab	86 a
Clarity®	3.0	5 b-d	60 a	89 a
Bronate®	16.0	5 b-d	59 ab	90 a
Huskie	15.0	6 c-e	59 ab	93 a
Brox-M + WideMatch	24.0 + 20.8	7 de	58 bc	79 a
Brox-M + Huskie	24.0 + 15.0	10 e	57 d	84 a

[1] Curtail M and all following treatments were tank-mixed with Beyond (6.0 fl oz/A) + MSO Conc. with Leci-Tech (1.0% v/v) + UAN (20% v/v).

[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 Fisher's protected LSD 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.

Russian-thistle control with Sentrallas® and Travallas® in spring wheat in Lincoln County
Drew Lyon, Derek Appel and Henry Wetzel

A field study was conducted on the Derek Appel Farm near Egypt, WA (Lincoln County) to determine the efficacy of Sentrallas (thifensulfuron + fluroxypyr) and Travallas (metsulfuron + thifensulfuron + fluroxypyr) on Russian-thistle in spring wheat. The soil at the site is a Phoebe sandy loam with 0.9% organic matter and a pH of 4.9. On April 24, 'Glee' soft white wheat was planted at a 2-inch depth using a Yielder 1818 drill on a 10-inch row spacing. The seeding rate was 80 lb/acre and starter fertilizer was applied at a depth of 3.5 inches at a rate of 50-8-8 lb/acre N:P:S. An early post-emergence herbicide application was made on June 2 when the air temperature was 60° F, relative humidity was 46% and the winds were out of the northeast at 4 mph. Wheat was at the 3-tiller stage and Russian-thistle was 2 inches in height. A late post-emergence herbicide application was made on June 15 when the air temperature was 68°F, relative humidity was 32%, and the wind was out of the north at 6 mph. The wheat had reached the end of tillering and was 12 inches tall. Russian-thistle was 4 inches tall. All herbicide applications were completed using a CO_2 backpack sprayer set to deliver 15 gpa at 30 psi and 3 mph.

Sentrallas applied at 8.0 fl oz/A or Travallas applied at either 7.0 or 10 fl oz/A provided significantly better control of Russian-thistle than WideMatch® at 16 fl oz/A, when treated plants were 2 to 4 inches tall. By the second application date, when Russian-thistle plants were 4 to 6 inches in height, none of the herbicides applied provided commercially acceptable control.

				Russian-thistle control	
	Rate	Application	Application	(0 to 100)	
Treatment[1]	fl oz/A	Description	Date	7/1	7/20
Nontreated Check				--	--
Sentrallas	8.0	2 to 4 in. Russian-thistle	6/2	74 b[2]	80 a-c
Travallas	7.0	2 to 4 in. Russian-thistle	6/2	85 ab	87 ab
Travallas	10.0	2 to 4 in. Russian-thistle	6/2	92 a	94 a
Sentrallas	11.0	4 to 6 in. Russian-thistle	6/15	45 cd	67 cd
Travallas	7.0	4 to 6 in. Russian-thistle	6/15	32 de	62 d
Travallas	10.0	4 to 6 in. Russian-thistle	6/15	50 c	70 cd
Travallas	12.0	4 to 6 in. Russian-thistle	6/15	52 c	72 b-d
Huskie® + AMS	15.0 + 16 oz	4 to 6 in. Russian-thistle	6/15	52 c	42 e
WideMatch	16.0	2 to 4 in. Russian-thistle	6/2	37 c-e	32 e
WideMatch	21.3	4 to 6 in. Russian-thistle	6/15	27 e	15 f

[1] All treatments except Huskie and WideMatch were tank mixed with NIS at 0.25%v/v
[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 Fisher's protected LSD 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.

Mayweed chamomile control in winter wheat with an experimental herbicide from Syngenta

Drew Lyon and Henry Wetzel

A field study was conducted on the WSU Cook Agronomy Farm near Pullman, WA to evaluate the efficacy of an experimental herbicide (A19278A + safener A20916A) from Syngenta on mayweed chamomile in winter wheat. The soil at the site is a Palouse silt loam with 3.2% organic matter and a pH of 5.6. On November 6, 2014, 'ARS Amber' winter wheat was planted using a Horsch air drill with 12-inch row spacing. On April 23, herbicides were applied using a CO_2 backpack sprayer set to deliver 10 gpa at 2.3 mph and 40 psi. Conditions were an air temperature of 52°F, relative humidity of 32% and the wind out of the southwest at 5 mph. The wheat had begun to joint. Mayweed chamomile was 2.5-inch in diameter and 1-inch tall. There were approximately 400 mayweed chamomile plants per square meter. Plots were harvested on July 10 using a Kincaid 8XP plot combine.

No crop injury was observed in this experiment (data not shown). A19278A applied at 13.7, 16.0 or 18.2 fl oz/A provided significantly better mayweed chamomile control than Huskie® applied at 11.0, 13.5 or 15.0 fl oz/A. Although Huskie is labeled as providing control of mayweed chamomile in spring wheat, it is only labeled for suppression of mayweed chamomile in winter wheat. There was not a significant rate response among either compound. The addition of Rhonox MCPA seemed to boost Huskie's activity on mayweed chamomile control, but did little to improve the control provided by A19278A. Initially, WideMatch® (16.0 fl oz/A) provided little control of mayweed chamomile, but by the final rating provided similar control to the various rates of A19278A and the Rhonox MCPA + A19278A tank-mix. There were no significant differences among test weight or yield (data not shown) in relation to the herbicide treatments. The average test weight and yield were 47 lb/bu and 43 bu/a, respectively. The experimental herbicide from Syngenta appears to have very good crop safety and provides excellent mayweed chamomile control in winter wheat.

	Rate	Mayweed chamomile control (0 to 100)		
Treatment	fl oz/A	5/14	5/26	6/10
Nontreated Check	--	--	--	--
A19278A	13.7	77 ab[1]	80 ab	89 ab
A20916A	0.197% v/v			
Agri-Dex	1.0% v/v			
A19278A	16.0	76 ab	80 ab	84 ab
A20916A	0.197% v/v			
Agri-Dex	1.0% v/v			
A19278A	18.2	80 a	82 ab	89 ab
A20916A	0.197% v/v			
Agri-Dex	1.0% v/v			
A19278A	16.0	80 a	88 a	94 a
Rhonox MCPA	12.0			
A20916A	0.197% v/v			
Agri-Dex	1.0% v/v			
Huskie	11.0	52 c	51 c	42 d
AMS	1.0 lb/A			
NIS	0.25% v/v			
Huskie	13.5	50 cd	54 c	50 cd
AMS	1.0 lb/A			
NIS	0.25% v/v			
Huskie	15.0	45 cd	49 c	44 d
AMS	1.0 lb/A			
NIS	0.25% v/v			
Huskie	15.0	66 b	72 b	70 bc
Rhonox MCPA	12.0			
AMS	1.0 lb/A			
NIS	0.25% v/v			
WideMatch	16.0	40 d	79 ab	95 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 Fisher's protected LSD 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.

Using Zidua® (pyroxasulfone) for Italian ryegrass control in winter wheat in the Pacific Northwest – a report on Zidua crop safety and weed control

Ian Burke and Louise Lorent

Studies were conducted near Pullman, WA from 2013 to 2015 to evaluate winter wheat and Italian ryegrass response to pyroxasulfone formulated as a dry flowable (Zidua, 85% WDG). Small-plot studies found no wheat injury caused by pyroxasulfone at the doses used (up to 1.75 oz/A). Preemergence (immediately after planting) or delayed preemergence (when 80% of coleoptiles were 1.3 cm long) applications of pyroxasulfone alone controlled more than 90% of Italian ryegrass. In general, late (early postemergence) applications of Zidua resulted in lower control of Italian ryegrass than pre-emergence applications, even when tankmixed with an herbicide with a postemergence activity such as pinoxaden.

In total, 6 studies were conducted in Pullman, WA from 2013 to 2015 on pyroxasulfone. Research objectives were to:

- 1) Evaluate winter wheat and Italian ryegrass responses to dry flowable pyroxasulfone.
- 2) Evaluate the effects of application timing.
- 3) Evaluate the effects of rainfall amounts immediately after planting.

Crop Safety (weed-free trial) of Zidua applied Preemergence or Early Postemergence.

A study was established in the fall of 2013 at the Spillman Agronomy Farm near Pullman, WA. Winter wheat (variety 'ARS-Amber') was planted at a 90 lb/A rate on October 7, 2013 with a Horsch air seed drill. Treatments consisted in different Zidua rates applied alone or with different tankmix partners. One treatment consisted in Axiom® (flufenacet plus metribuzin) applied at a recommended labeled rate to compare crop responses to Zidua with response to another VLCFA inhibitor (flufenacet) labeled in winter wheat. The experimental design was a randomized complete block with 4 replications. Plots were 12 ft wide by 30 ft long. Treatment application details are presented in Table 1.1. PRE and delayed PRE applications were followed by 0.25 in of supplemental water applied through a plot-sized PVC-pipe sprinkler system. Treatments are detailed in Table 1.3. The entire study area was maintained weed-free with Discover® NG, WideMatch® and MCPA at recommended labeled rates.

The study was repeated in the fall of 2014 at the Palouse Conservation Field Station. Winter wheat (variety 'Amber') was planted with a Monosem® precision vacuum planter on October 13th 2014. Treatment application details are presented in Table 1.2. The study was maintained weed-free with MCPA plus bromoxynil (applied March 27th 2015), pyrasulfotole plus bromoxynil and clodinafop (applied April 29th 2015).

No injury was observed on winter wheat during the growing season. Head trapping, a common injury symptom with VLCFA inhibitors, was evaluated by counting the number of trapped head in 2, 2.7 ft^2 quadrats per plot. There were no differences in head trapping among treatments. Plots were harvested using a 5 ft header combine. Treatments did not affect wheat test weight or yield.

In 2015, there was again no differences in winter wheat stands. Observed injury from pyroxasulfone treatments ranged from 1.3% (Zidua applied alone POST) to 11.5% (Zidua applied alone, PRE). Axiom (flufenacet plus metribuzin, applied as a delayed PRE) caused the highest level of injury (18%). We also observed activity of pyroxasulfone (60 to 95% control) on tarweed fiddleneck (*Amsinckia lycopsoides* Lehm.).

Crop Safety and Efficacy on Italian ryegrass of Zidua applied Preemergence or Early Postemergence.

A study was established in the fall of 2013 at the Cook Agronomy Farm near Pullman, WA. Winter wheat (variety 'ARS-Amber') was planted at a 90 lb/A rate on October 22, 2013 with a Monosem precision vacuum planter. Treatments consisted in different Zidua rates applied alone or with different tankmix partners. One treatment consisted of Axiom applied at a recommended labeled rate to compare crop responses to Zidua, since flufenacet, a component of Axiom, is also a VLCFA inhibitor. The experimental design was a randomized complete block with 4 replications. Plots were 12 ft wide by 30 ft long. Treatment application details are presented in Table 2.1. PRE and delayed PRE applications were followed by 0.25 in of supplemental water applied through a plot-sized PVC-pipe sprinkler system. Treatments are detailed in Table 2.2. The entire study area was maintained free of broadleaf weeds by using WideMatch® and MCPA at recommended labeled rates. Wheat injury and Italian ryegrass control were visually evaluated throughout the season. Head trapping, a common injury symptom with VLCFA inhibitors, was assessed by counting the number of trapped head in 2, 2.7 ft^2 quadrats per plot. Plots were harvested using a 5 ft header combine.

The study was repeated in 2014-2015 at the Cook Agronomy Farm. Winter wheat (variety 'Amber') was planted with a Monosem® precision vacuum planter on October 13th 2014. The study was maintained free of broadleaf weeds with MCPA plus bromoxynil (applied March 27th 2015) and pyrasulfotole plus bromoxynil (applied on (applied on April 29th 2015).

In 2014, no significant wheat injury or head trapping was observed (data not presented). Results are presented in Table 2.2. Italian ryegrass control was significantly lower when Zidua was applied early in the spring (application C) than when Zidua was applied shortly after planting (applications A and B). Differences in weed control did not translate into wheat yield or test weight differences.

In 2015, there were again no differences in winter wheat stands. Observed injury from pyroxasulfone treatments ranged from 0% (Zidua applied with Axial POST) to 18% (Zidua applied with metribuzin as a delayed PRE). Axiom (flufenacet plus metribuzin, applied as a delayed PRE) caused the highest level of injury (26%). Control of Italian ryegrass was reduced compared to 2014, but the trends were similar. Zidua plus metribuzin provided the greatest numerical control of Italian ryegrass, but treatments were statistically similar.

In general, late (early post-emergence) applications of Zidua resulted in lower control of Italian ryegrass than pre-emergence applications, even when tankmixed with an herbicide with a postemergence activity such as Axial XL.
The greatest numerical levels of Italian ryegrass control were achieved by Zidua applied with metribuzin as a delayed preemergence treatment (note that use of metribuzin as a delayed preemergence treatment is not permitted by the label). Zidua plus metribuzin provided over 90% control of Italian ryegrass (with Zidua applied either at 1.25 or 1.5 oz/A).

Table 1.1. Treatment application details for the trials conducted at the Spillman Agronomy Farm in 2013-2014, and the Palouse Conservation Field Station in 2014-2015.

Application timing (2013-2014)	October 8, 2013	October 23, 2013	April 2, 2014
Application volume (GPA)	10	10	15
Crop Stage	Preemergence	Delayed preemergence (80% of coleoptiles >0.4 in)	2 to 4 leaves, pre-tillering
Air temperature (°F)	45	55	39
Soil temperature (°F)	46	49	45
Wind velocity (mph)	4.3	5	4.6
Cloud cover (%)	90	0	50
Application timing (2014-2015)	**October 14, 2014**	**October 18, 2014**	**March 30, 2015**
Application volume (GPA)	10	10	15
Crop Stage	Preemergence	Delayed preemergence (80% of coleoptiles >0.4 in)	2 to 4 leaves, pre-tillering
Air temperature (°F)	63	60	57
Soil temperature (°F)	59	54	43
Wind velocity (mph)	3.5	2.4	2.4
Cloud cover (%)	20	0	30

Table 1.2. Winter wheat injury and yield in response to Zidua treatments at the Spillman Agronomy Farm in 2013-2014, and at the Palouse Conservation Field Station in 2014-2015.

Treatment	Simulated rainfall	Application code	Rate	Injury			Wheat yield	
				2014	2015			
			lb ai/A	%			bu/A	
Zidua	1/3 Inch	A	0.027	3	6	5	70	64
Zidua	1/3 Inch	A	0.032	2	12	10	81	61
Zidua		B	0.027	5	5	0	86	82
Zidua		B	0.032	4	9	4	88	68
Zidua + Metribuzin		B	0.027+0.028	4	5	0	71	59
Zidua + Metribuzin		B	0.032+0.028	3	8	5	91	71
Axiom		B	0.137 (fluthiacet) + 0.035 (metribuzin)	5	18	13	72	48
Zidua		C	0.043	-	1	0	85	66
Axial XL		C	0.021	-	8	2.5	95	71
Zidua + Axial XL		C	0.043+0.021	-	4.5	6	83	54
Nontreated				0	0	0	79	48
LSD				-	-	-	-	-

Table 2.1. Treatment application details for the trials conducted at the Cook Agronomy Farm in 2013-2015.

Application code	A	B	C
Application timing (2013-2014)	October 24, 2013	November 6, 2013	April 16, 2014
Application volume (GPA)	10	10	15
Crop Stage	Preemergence	Delayed preemergence (80% of coleoptiles >0.4 in)	2 to 4 leaves, pre-tillering
Air temperature (°F)	54	43	46
Soil temperature (°F)	49	43	43
Wind velocity (mph)	4.3	3	6
Cloud cover (%)	0	99	100
Application timing (2014-2015)	October 14, 2014	October 18, 2014	March 30, 2015
Application volume (GPA)	10	10	15
Crop Stage	Preemergence	Delayed preemergence (80% of coleoptiles >0.4 in)	2 to 4 leaves, pre-tillering
Air temperature (°F)	63	60	57
Soil temperature (°F)	59	54	43
Wind velocity (mph)	3.5	2.4	2.4
Cloud cover (%)	20	0	30

Table 2.2. Italian ryegrass control and winter wheat yield for two trials conducted at the Cook Agronomy Farm in 2013-2015.

Treatment	Simulated rainfall	Application code	Rate	Injury		Italian ryegrass		Wheat yield	
				2014	2015	2014	2015	2014	2015
			lb ai/A	%		% control		bu/A	
Zidua	1/3 Inch	A	0.027	3	10	86	74	55	84
Zidua	1/3 Inch	A	0.032	2	9	95	65	56	81
Zidua		B	0.027	5	5	93	81	55	90
Zidua		B	0.032	4	14	95	86	55	87
Zidua + Metribuzin		B	0.027+0.028	4	6	90	78	56	88
Zidua + Metribuzin		B	0.032+0.028	3	13	94	90	56	90
Axiom		B	0.137 (fluthiacet) + 0.035 (metribuzin)	5	23	93	64	55	82
Zidua		C	0.043	0	4	20	34	55	92
Axial XL		C	0.021	0	10	53	59	55	86
Zidua + Axial XL		C	0.043+0.021	0	5	21	40	55	91
Nontreated				0	0	0	0	56	78
LSD				-	-	18	17	-	-

Evaluating pre-plant in combination with post-emergence herbicides for the control of Italian ryegrass in spring wheat

Drew Lyon and Henry Wetzel

A field study was conducted on the WSU Cook Agronomy Farm near Pullman, WA to evaluate Italian ryegrass control with pre-plant in combination with post-emergence herbicides in spring wheat. Pre-plant herbicides included Zidua and Anthem Flex each of which contain pyroxasulfone (Group 15), and post-emergence products Axial XL (pinoxaden) (Group 1), and Everest 2.0 (flucarbazone) or GoldSky (florasulam + pyroxsulam) (Group 2).

The soil at the site is a Naff silt loam with 3.75% organic matter and a pH of 5.0. On April 21st, pre-plant herbicides were applied with a CO_2 backpack sprayer set to deliver 10 gpa at 40 psi and 2 mph. On April 22nd, spring wheat was planted into heavy winter wheat stubble using a Horsch air drill with 12-inch row spacing. On May 19th, post-emergence herbicide applications were made to wheat that was in the 2-tiller stage and was 6 to 8 inches tall. The air temperature was 67°F, relative humidity was 41% and the wind was out of the west at 1 mph. Italian ryegrass was primarily in the 3-leaf stage and 2 to 4 inches in height. The Italian ryegrass population was high at 76 plants per quarter meter squared. Plots were harvested on August 18th using a Kincaid 8XP plot combine.

The majority of the rain that was received fell between May 12th and June 2nd in the amount of 2.47 inches. In general, the summer was very hot and dry. This trial was located in a sub-irrigated portion of the field, which helped with Italian ryegrass germination and supplying additional moisture for grain fill. In general, pre-plant applications of Anthem® Flex provided the majority of the control of Italian ryegrass. The addition of post-emergence herbicides Axial® XL, Everest® 2.0, Audit® 1:1 or GoldSky® to Anthem Flex, increased Italian ryegrass control, but only slightly and was not significantly different than Anthem Flex applied alone. Pre-plant applications of Zidua® did not perform as well as Anthem Flex, however, the Zidua rates used in this study provided less pyroxasulfone than was provided by the Anthem Flex rate. Post-emergence applications of Everest 2.0 + Audit 1:1, Axial XL or GoldSky did not provide acceptable control of Italian ryegrass. Thus, the results of this trial demonstrated a pre-plant application of Anthem Flex (3.0 fl oz/A) provided good control of Italian ryegrass. There were no significant differences among treatments in relation to test weight and yield (data not shown). The average test weight and yield were 60 lb/bu and 58 bu/a, respectively.

	Rate	Application	Application	Italian Ryegrass control (0 to 100)	
Treatment	fl oz/A	Date	Description	6/4	6/29
Nontreated Check				--	--
Anthem Flex	3	4/21	Pre-plant	71 ab[1]	61 ab
Zidua	1.25 oz	4/21	Pre-plant	57 bc	37 b-d
Anthem Flex	3	4/21	Pre-plant	79 a	61 ab
Everest 2.0	1	5/19	3 leaf IR[2]		
Audit 1:1	0.4 oz	5/19	3 leaf IR		
NIS	0.25% v/v	5/19	3 leaf IR		
AMS	1.0 lb	5/19	3 leaf IR		
Zidua	1.0 oz	4/21	Pre-plant	71 ab	56 a-c
Everest 2.0	1	5/19	3 leaf IR		
Audit 1:1	0.4 oz	5/19	3 leaf IR		
NIS	0.25% v/v	5/19	3 leaf IR		
AMS	1.0 lb	5/19	3 leaf IR		
Anthem Flex	3	4/21	Pre-plant	81 a	66 ab
Axial XL	16.4	5/19	3 leaf IR		
Anthem Flex	3	4/21	Pre-plant	82 a	75 a
GoldSky	16	5/19	3 leaf IR		
NIS	0.25% v/v	5/19	3 leaf IR		
AMS	1.0 lb	5/19	3 leaf IR		
Everest 2.0	1	5/19	3 leaf IR	49 c	44 a-d
Audit 1:1	0.4 oz	5/19	3 leaf IR		
NIS	0.25% v/v	5/19	3 leaf IR		
AMS	1.0 lb	5/19	3 leaf IR		
Axial XL	16.4	5/19	3 leaf IR	17 d	10 d
GoldSky	16	5/19	3 leaf IR	25 d	22 cd
NIS	0.25% v/v	5/19	3 leaf IR		
AMS	1.0 lb	5/19	3 leaf IR		

[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 Fisher's protected LSD 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.

[2] IR = Italian ryegrass.

Managing Bulbous Bluegrass in Pasture

Ian Burke and Louise Lorent

Bulbous bluegrass (*Poa bulbosa* L.) is an invasive grass species. It is a perennial with a short-life span and can reproduce by seed and asexually via basal bulbous sections. It is well adapted to the wet winters and dry summers of Eastern Washington. Its low palatability and high competitiveness make it a problem weed in pasture.

Control methods include intensive grazing, which requires considerable labor and can harm present desirable species. Herbicides labeled for bluegrass control in pasture are limited and their use is problematic because of potential damage to non-target species.

Because of bulbous bluegrass life cycle and early maturity compared to other grass species, a strategy for chemical control involving early applications of herbicides with no soil activity might successfully reduce off-target injury to desirable species.

A trial near Reardan, WA was installed in a severely infested pasture to investigate effective herbicide options and application timings. Other desirable species present were intermediate wheatgrass (*Thinopyrum intermedium* (Host) Barkworth & D.R. Dewey) and smooth bromegrass (*Bromus inermis* L.).

Glyphosate (RT3), imazapic (Plateau), clethodim (Select Max) and triasulfuron (Amber) were applied at recommended labeled rates in late January, late February and early April (Table 1). The study was designed as a randomized complete block system with 4 replications. Plots were 10 ft wide by 30 ft long.

Table 3. Conditions at time of herbicide application. Reardan, WA, 2015.

Application timing	**Date (2015)**	**Growing Degree Day accumulation [1]**	**Air temperature (F)**	**Soil temperature (F)**	**Relative humidity (%)**	**Wind speed (mph)**
A	January 28th	37	34	32	100	3.5
B	February 24th	220	44	38	44	3
C	April 4th	666	52	44	34	8

[1] accumulation since January 1st (base= 32 F)

Bluegrass control and injury to smooth bromegrass was visually rated on a scale of 0 (no control or injury) to 100 (complete control or injury) in early April and late June. Data was analyzed through an analysis of variance (ARM 8.5.0, Gylling Data Management).

Bulbous bluegrass control and intermediate wheatgrass injury ratings are presented in Table 2. Triasulfuron failed to control bulbous bluegrass regardless of time of application. When applied in January, glyphosate controlled over 90% of the bulbous bluegrass and caused less than 30% injury to the intermediate wheatgrass. Later applications of glyphosate controlled over 95% of the bulbous bluegrass but injured intermediate wheatgrass at unacceptable levels (> 80%). Imazapic controlled between 89 and 96% of the bulbous bluegrass depending on application timing, but it caused more than 30% injury to intermediate wheatgrass when applied in January and over 50% injury when applied at later timings. Clethodim offered appealing results, as its application in January controlled over 90% of the bulbous bluegrass without causing any injury to intermediate wheatgrass. Later application of clethodim injured intermediate wheatgrass by over 60%.

Table 4. Bulbous bluegrass and intermediate wheatgrass response to different application timings of imazapic, glyphosate, triasulfuron and clethodim. Reardan, WA, 2015.

Treatment	Rate	Application timing	Bulbous bluegrass	Intermediate wheatgrass	Bulbous bluegrass	Intermediate wheatgrass
			April 3rd, 2015		June 23rd, 2015	
	lb active ingredient/A		----------------------------------%----------------------------------			
Nontreated check	-	-	-	-	-	-
Imazapic (+ MSO)	0.094 (2 pt/A)	A	75	68	93	33
		B	55	63	89	55
		C	-	-	96	83
Glyphosate (+ NIS + AMS)	0.84 (0.25% v/v + 17 lb/100 gal)	A	85	70	93	28
		B	93	94	98	84
		C	-	-	100	100
Triasulfuron (+ NIS)	0.022 (+0.25% v/v)	A	8	0	0	0
		B	13	5	0	0
		C	-	0	0	0
Clethodim (+ COC)	0.121 (+ 1% v/v)	A	585	23	91	0
		B	80	70	86	60
		C	-	-	97	74
LSD			17	7	7	20

Herbicide application timings in chickpeas

Drew Lyon and Henry Wetzel

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. Lack of rainfall to activate herbicides after application has been problematic in recent years. Early pre-plant applications might have more opportunity to be activated by rainfall than herbicides applied post-plant, pre-emerge. The soil at this site is a Thatuna silt loam with pH of 4.8 and organic matter content of 3.0%. The pre-plant applications took place on April 10th and 23rd using a CO_2 backpack sprayer set to deliver 10 gpa at 2.3 mph and 40 psi. Conditions on April 10th were an air temperature of 66°F, relative humidity of 30% and the wind out of the west at 7 mph. Conditions on April 23rd were an air temperature of 55°F, relative humidity of 30% and the wind out of the west at 6 mph. On May 7th, the entire trial area was sprayed with glyphosate to kill the Italian ryegrass that germinated following ground preparation and rain that fell the beginning of April. On May 11th, '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 11th and the conditions were an air temperature of 73°F, relative humidity of 26% and the wind out of the northeast at 2 mph. The trial area was harvested with a Zurn 150 plot combine on September 4th.

Treatments applied on April 10th received 0.11 inches of rain on them on the 11th. The treatments applied on April 23rd essentially had no rain on them until May 12th. On May 12th, 0.38 inches of rain fell. Between May 12th and June 2nd, the crop received the majority of its precipitation in the amount of 2.47 inches. While there was no evidence of crop injury from any of the treatments and their various timings, there was some sort of background issue over the majority of the trial, which was the result of either a lack of adequate soil moisture or a residual herbicide affecting chickpea growth and development. Regardless of application date, within a particular herbicide, common lambsquarters control was similar, thus results are averaged over the three timings (Table 1). Lorox® applied at 20.0 oz/A did not provide commercially acceptable control of common lambsquarters, while Sencor®, Spartan® and Valor® did. Mayweed chamomile control was different in that there was a significant interaction between the herbicide used and date of application (Table 2). This was especially true for the Lorox and Sencor treatments. Lorox only provided commercially acceptable control from the May 11 application. Sencor provided commercially acceptable control from the April 23 and May 11 applications. Spartan and Valor provided excellent control regardless of application date.

Plant density counts were taken for both weeds on June 26th. The counts suggested that application date was not significant, so treatment means are averaged over the three dates (Table 3). Sencor, Spartan and Valor significantly reduced the density of common lambsquarters when compared to Lorox. Lorox's activity on lambsquarters was between the other three herbicides and the nontreated check. Spartan and Valor provided the greatest reduction in mayweed chamomile density. Sencor's activity was similar to Spartan and Valor, but also similar to Lorox, which provided the least reduction in mayweed chamomile density when compared to the nontreated check. Yield and 100-seed-weight were not affected by herbicide application date, thus treatment means over application date were averaged (Table 4). All herbicides significantly improved yield when compared to the nontreated check. Lorox-treated plots did not yield as well as the Sencor-, Spartan- or Valor-treated plots, which all yielded similarly. All herbicide treatments increased 100-seed-weight when compared to the nontreated check, with the exception of Lorox.

Because conditions were mostly dry prior to planting and sufficient rainfall was received to activate the herbicides applied post-plant pre-emerge, no benefit was observed in this study for the early pre-plant treatments. In fact, mayweed chamomile control was reduced with early pre-plant applications of Lorox or Sencor.

Table 1. Herbicide application and its effect on common lambsquarters control in Frontier chickpeas

		Common lambsquarters
	Rate	Control (0 to 100)
Treatment	oz/A	6/19
Nontreated Check		--
Lorox DF	20.0	50 c[1]
Sencor DF	8.0	91 ab
Spartan 4F	8.0	96 a
Valor SX	2.0	79 b

[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 Fisher's protected LSD 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.

Table 2. Herbicide application date and its effect on mayweed chamomile control in Frontier chickpeas

			Mayweed chamomile
	Rate	Application	control (0 to 100)
Treatment	oz/A	Date	6/19
Nontreated Check			--
Lorox DF	20.0	4/10	60 bc[1]
Lorox DF	20.0	4/23	36 c
Lorox DF	20.0	5/11	94 a
Sencor DF	8.0	4/10	64 b
Sencor DF	8.0	4/23	81 a
Sencor DF	8.0	5/11	94 a
Spartan 4F	8.0	4/10	100 a
Spartan 4F	8.0	4/23	96 a
Spartan 4F	8.0	5/11	97 a
Valor SX	2.0	4/10	90 a
Valor SX	2.0	4/23	80 a
Valor SX	2.0	5/11	100 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 Fisher's protected LSD 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.

Table 3. Herbicide application and its effect on common lambsquarters and mayweed chamomile abundance in Frontier chickpea

		Common lambsquarters	Mayweed chamomile
	Rate	Number of plants per square meter	
Treatment	oz/A	-------------------------------6/26--------------------------------	
Nontreated Check		48 a[1]	77 a
Lorox DF	20.0	13 b	9 b
Sencor DF	8.0	0 c	3 bc
Spartan 4F	8.0	0 c	0 c
Valor SX	2.0	2 c	1 c

[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 Fisher's protected LSD 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.

Table 4. Herbicide application and its effect on yield and seed weight in Frontier chickpea

	Rate	Yield (lb/A)	100-seed-weight (g)
Treatment	oz/A	----------------------------9/4------------------------------	
Nontreated Check		84 c	33.7 c
Lorox DF	20.0	421 b	35.4 bc
Sencor DF	8.0	904 a	38.1 a
Spartan 4F	8.0	948 a	37.3 ab
Valor SX	2.0	889 a	37.2 ab

[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 Fisher's protected LSD 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.

Broadleaf weed control in 'Frontier' chickpeas

Drew Lyon and Henry Wetzel

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. The soil at this site is a Thatuna silt loam with pH of 4.8 and organic matter content of 3.0%. On May 7th, the entire trial area was sprayed with glyphosate to kill the Italian ryegrass that germinated following ground preparation and rain that fell the beginning of April. On May 11th, '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 12th and the conditions were an air temperature of 51°F, relative humidity of 82% and the wind out of the west at 4 mph. Immediately after the herbicides were applied, half of the treated area, within each block, received a roller packer treatment by driving perpendicular to the treated area. The other half of the plot remained undisturbed. The trial area was harvested with a Zurn 150 plot combine on September 4th.

On May 12th, approximately 14 hours after the application was made, rain began to fall and amounted to 0.38 inches. Between May 12th and June 2nd, the crop received the majority of its precipitation in the amount of 2.47 inches. Common lambsquarters and mayweed chamomile were the predominate weeds in the study area. Rolling in combination with the Lorox® + Valor® and Lorox + Pursuit® treatments reduced common lambsquarters control (Table 1). Rolling in combination with the Lorox + Pursuit treatment reduced mayweed chamomile control. Common lambsquarters control was excellent with all herbicide treatments and average plant densities on June 26th ranged between 0 and 1 plant/square meter, except in the nontreated check, which averaged 29 plants/square meter (data not shown). This was generally the case for mayweed chamomile as well, except the Lorox + Pursuit treatment that was rolled (Table 1). Rolling did not have a significant effect on yield or 100-seed-weight, thus means are composed of eight replications (Table 2). All herbicide treatments increased yield when compared to the nontreated check. The Lorox + Pursuit-treated plots had the lowest yield among the herbicides evaluated and its 100-seed-weight was comparable to the nontreated check. This is probably due to the fact that this treatment's efficacy was compromised by rolling.

Although light tillage can improve weed control with some herbicides, especially when adequate rainfall to activate the herbicides is not received, it can be detrimental for other herbicides. Growers should be aware of the impact of tillage on the performance of the herbicides they use.

Table 1. Evaluation of the combination of herbicides and soil surface disturbance and their effects on common lambsquaters and mayweed chamomile control in 'Frontier' chickpeas.

Treatment	Rate fl oz/A	Mechanical Treatment	Common lambsquarters control (0 to 100)	Mayweed chamomile control (0 to 100)	Mayweed chamomile plants per sq. meter
			----------6/24----------		6/26
Nontreated Check	--	Not-Rolled	--	--	30 a
Nontreated Check	--	Rolled	--	--	40 a
Sharpen® + Sencor® 75DF	2.0 + 8.0 oz	Not-Rolled	98 a[1]	100 a	0 c
Sharpen + Sencor 75DF	2.0 + 8.0 oz	Rolled	99 a	98 a	0 c
Lorox DF + Spartan® 4F	1.25 lb + 8.0	Not-Rolled	98 a	100 a	0 c
Lorox DF + Spartan 4F	1.25 lb + 8.0	Rolled	96 a	91 a	1 bc
Lorox DF + Valor SX	1.25 lb + 2.0 oz	Not-Rolled	95 a	100 a	0 c
Lorox DF + Valor SX	1.25 lb + 2.0 oz	Rolled	86 b	92 a	0 c
Lorox DF + Pursuit	1.25 lb + 2.0	Not-Rolled	96 a	98 a	0 c
Lorox DF + Pursuit	1.25 lb + 2.0	Rolled	87 b	69 b	6 b
Outlook® + Spartan 4F	21.0 + 8.0	Not-Rolled	100 a	100 a	0 c
Outlook + Spartan 4F	21.0 + 8.0	Rolled	99 a	100 a	0 c

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

Table 2. The effect of herbicides on yield and 100-seed-weight in 'Frontier' chickpeas.

Treatment	Rate fl oz/A	Yield lb/A	100-seed-weight (g)
Nontreated Check	--	801 c[1]	38.0 c
Sharpen + Sencor 75DF	2.0 + 8.0 oz	2030 a	40.3 a
Lorox DF + Spartan 4F	1.25 lb + 8.0	2040 a	39.6 ab
Lorox DF + Valor SX	1.25 lb + 2.0 oz	1880 ab	39.6 ab
Lorox DF + Pursuit	1.25 lb + 2.0	1730 b	38.6 bc
Outlook + Spartan 4F	21.0 + 8.0	2050 a	39.8 ab

[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, 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.

Lorox® tankmix partners for weed control in garbanzo bean
Ian Burke and Louise Lorent

Lorox (linuron) is a broad spectrum herbicide labeled for use in soybean and other crops. A study was conducted at the Cook Agronomy Farm near Pullman, WA, over the years 2012, 2013, 2014 and 2015 to determine whether Lorox could be used tank-mixed with other pre-emergence herbicides in garbanzo bean.

Garbanzo bean (variety 'Sierra') was planted on May 16th 2012, May 8th in 2013, and May 1st in 2014 at a rate of 140 lb/A with a Monosem® precision vacuum planter. In 2015, variety 'Billy bean' was planted with a Horsch no-till disc drill on May 4th. Treatments were applied preemergence in early May each year (Table 1) and consisted in different rates of Lorox tank mixed with Sharpen (saflufenacil), Valor (flumioxazin), metribuzin, Reflex (fomesafen) and Zidua (pyroxasulfone) (Table 2). The experimental design was a randomized complete block with 4 replications. Plots were 8 ft wide by 30 ft long in 2012, 2013 and 2014 and 10 ft by 35 ft in 2015. Weed control was evaluated throughout the season. Common lambsquarters (*Chenopodium album* L.) and mayweed chamomile (*Anthemis cotula* L.) were present every year. Prickly lettuce (*Lactuca serriola* L.) was present in 2012, 2013 and 2014. Italian ryegrass (*Lolium multiflorum* Lam.) was present in 2015. Plots were harvested using a 5 ft wide combine in 2012, 2014 and 2015 and by sampling 22 ft^2 per plot in 2013.

Yields were not significantly different among treatments in 2012 (Table 2), and treatments had no significant effect on garbanzo biomass in 2013 (Table 3). In 2014, some herbicide treatments (mostly Lorox plus Sharpen mixes) resulted in yield over 300% higher than the non-treated check (Table 4). All herbicide treatments in 2015 resulted in higher yields than the non-check (Table 5).

No crop injury was observed in years 2012-2014 (data not shown). In 2015, mixes including Valor caused 14 to 26% injury 17 days after treatment (Table 5). Heavy rain 6 days after planting in 2015 (Table 1) might have leached Valor within the growing point of garbanzo bean seed, which hindered emergence. In other years, rain occurred within 3 days after planting (Table 1). Garbanzo grain yield in plots treated with Valor in 2015 was not lower than in plots treated with any other herbicide (Table 5).

Lorox plus Sharpen mixes provided the highest levels of control of common lambsquarters each year except in 2015 (Tables 2 through 5). Lorox applied at 16 oz/A plus any rate of Sharpen also controlled between 70 and 80% of mayweed chamomile in 2013 (Table 3) and 94% of mayweed chamomile in 2014 (Table 4). Control of mayweed chamomile with Lorox plus Sharpen mixes was above 87% in 2015 (Table 5).

Lorox plus Valor mixes controlled over 80% of common lambsquarters in 2012 (Table 2) and over 70% of common lambsquarters in 2013 (Table 3). In 2014, control of lambsquarters by Lorox plus Valor mixes hovered between only 55% and 75% (Table 4). In 2015, Lorox plus Valor mixes achieved between 65 and 69% control when Valor was used at a rate of 1.5 oz/A, and over 80% when the rate of Valor was 2 oz/A (Table 5).

Lorox plus metribuzin controlled only 29% of prickly lettuce in 2013 (Table 3). It controlled over 90% of the prickly lettuce in 2014, but only 33% of mayweed chamomile (Table 4).

Lorox plus Reflex mixes stand out by providing over 80% control of prickly lettuce in 2014 (Table 4), although they did not provide consistent control in 2013 (Table 3). Reflex has the potential to carryover to wheat, though, and is not currently labeled for use in Washington. Lorox plus Reflex mixes were outperformed by any other herbicide treatment for the control of common lambsquarters in 2015 (Table 5).

Table 1. Treatment application details for chickpea research conducted at the Cook Agronomy Farm near Pullman, WA, in 2012, 2013, 2014 and 2015.

Application date	5/21/2012	5/10/2013	5/2/2014	5/6/2015
Air temperature (F)	54	83	69	50
Soil temperature (F)	57	64	16	59
Wind velocity (mph)	8.4	3.5	0.7	4.4
Cloud cover (%)	100	15	100	30
Next rain occurred on	5/22/2012	5/13/2013	5/4/2014	5/12/2015

Table 2. Weed control 86 days after treatment (DAT) and garbanzo grain yield. Cook Agronomy Farm, 2012.

Treatment	Rate		Weed Control 86 DAT		Garbanzo grain yield
			Common lambsquarters	Mayweed chamomile	
	oz pr/A	lb ai/A	%		lb/A
Lorox	12	0.375	91	74	1550
Sharpen	1	0.022			
Lorox	16	0.5	90	88	1470
Sharpen	1	0.022			
Lorox	12	0.375	78	80	1510
Sharpen	1.5	0.033			
Lorox	16	0.5	83	78	1490
Sharpen	1.5	0.033			
Lorox	12	0.375	84	73	1360
Valor	1.5	0.048			
Lorox	12	0.375	90	89	1050
Valor	2	0.064			
Lorox	16	0.5	89	91	1190
Valor	1.5	0.048			
Lorox	16	0.5	88	83	1660
Valor	2	0.064			
Lorox	20	0.625	70	84	1720
Metribuzin	3	0.14			
Lorox	12	0.375	88	74	1720
Reflex	7.5	0.047			
Lorox	16	0.5	86	80	1130
Reflex	7.5	0.047			
Lorox	12	0.375	89	80	1720
Reflex	14	0.094			
Lorox	16	0.5	93	88	1540
Reflex	14	0.094			
Lorox	12	0.375	88	88	1770
Zidua	1.44	0.076			
Lorox	16	0.5	88	89	1300
Zidua	1.44	0.076			
Nontreated Check			-	-	1340

Table 3. Weed control 70 days after treatment (DAT) and garbanzo total biomass at the Cook Agronomy Farm in 2013.

Treatment	Rate		Weed Control 70 DAT			Garbanzo total biomass
			Common lambsquarters	Mayweed chamomile	Prickly lettuce	
	oz pr/A	lb ai/A	%			lb/A
Lorox	12	0.375	73	59	66	3960
Sharpen	1	0.022				
Lorox	16	0.5	64	60	44	3300
Sharpen	1	0.022				
Lorox	12	0.375	71	80	50	3340
Sharpen	1.5	0.033				
Lorox	16	0.5	79	71	48	2980
Sharpen	1.5	0.033				
Lorox	12	0.375	71	70	55	3770
Valor	1.5	0.048				
Lorox	12	0.375	75	70	63	3720
Valor	2	0.064				
Lorox	16	0.5	73	56	66	2940
Valor	1.5	0.048				
Lorox	16	0.5	74	74	54	3690
Valor	2	0.064				
Lorox	20	0.625	63	74	29	2510
Metribuzin	3	0.14				
Lorox	12	0.375	56	75	41	3150
Reflex	7.5	0.047				
Lorox	16	0.5	51	69	59	3140
Reflex	7.5	0.047				
Lorox	12	0.375	43	78	60	3140
Reflex	14	0.094				
Lorox	16	0.5	55	69	68	4240
Reflex	14	0.094				
Lorox	12	0.375	40	61	58	3630
Zidua	1.44	0.076				
Lorox	16	0.5	55	64	54	3220
Zidua	1.44	0.076				
Nontreated Check			-	-	-	3300

Table 4. Weed control 74 days after treatment (DAT) and garbanzo grain yield at the Cook Agronomy Farm in 2014.

Treatment	Rate		Weed Control 74 DAT			Garbanzo grain yield
			Common lambsquarters	Mayweed chamomile	Prickly lettuce	
	oz/A	lb ai/A	%			lb/A
Lorox	12	0.375	71	75 ab	71 ab	920 a
Sharpen	1	0.022				
Lorox	16	0.5	73	79 ab	89 ab	840 a
Sharpen	1	0.022				
Lorox	12	0.375	86	94 a	81 ab	740 ab
Sharpen	1.5	0.033				
Lorox	16	0.5	89	94 a	80 ab	900 a
Sharpen	1.5	0.033				
Lorox	12	0.375	65	71 ab	53 bc	750 ab
Valor	1.5	0.048				
Lorox	12	0.375	74	64 ab	54 abc	710 ab
Valor	2	0.064				
Lorox	16	0.5	55	59 abc	83 ab	740 ab
Valor	1.5	0.048				
Lorox	16	0.5	75	65 abc	83 ab	560 ab
Valor	2	0.064				
Lorox	20	0.625	75	33 c	91 a	520 ab
Metribuzin	3	0.14				
Lorox	12	0.375	68	49 bc	89 ab	560 ab
Reflex	7.5	0.047				
Lorox	16	0.5	64	62 abc	83 ab	730 ab
Reflex	7.5	0.047				
Lorox	12	0.375	75	81 ab	85 ab	770 a
Reflex	14	0.094				
Lorox	16	0.5	68	81 ab	90 ab	680 ab
Reflex	14	0.094				
Lorox	12	0.375	55	35 c	23 c	520 ab
Zidua	1.44	0.076				
Lorox	16	0.5	48	57 abc	63 ab	660 ab
Zidua	1.44	0.076				
Nontreated check			-	-	-	120 b

Table 5. Garbanzo injury 17 days after treatment (DAT), weed control 59 DAT and garbanzo grain yield, Cook Agronomy Farm, 2015.

Treatment	Rate		Crop injury	Weed Control 2015 59 DAT			Garbanzo grain yield
			17 DAT	Common lambsquarters	Mayweed chamomile	Italian ryegrass	
	oz/A	lb ai/A			%		lb/A
Lorox Sharpen	12 1	0.375 0.022	6 de	61 abc	87 a	47 bc	1450
Lorox Sharpen	16 1	0.5 0.022	3 de	70 abc	92 a	70 ab	1530
Lorox Sharpen	12 1.5	0.375 0.033	8 cd	72 abc	90 a	47 bc	1790
Lorox Sharpen	16 1.5	0.5 0.033	8 cd	73 abc	92 a	23 cd	1910
Lorox Valor	12 1.5	0.375 0.048	14 bc	69 abc	76 ab	25 cd	1940
Lorox Valor	12 2	0.375 0.064	20 ab	89 a	87 a	18 cd	2040
Lorox Valor	16 1.5	0.5 0.048	18 b	65 abc	84 ab	40 bcd	1880
Lorox Valor	16 2	0.5 0.064	26 a	80 ab	91 a	20 cd	1870
Lorox Metribuzin	20 3	0.625 0.14	0 e	59 abcd	65 b	45 bc	1920
Lorox Reflex	12 7.5	0.375 0.047	1 de	48 cd	90 a	42 bcd	2060
Lorox Reflex	16 7.5	0.5 0.047	1 de	28 d	85 ab	25 cd	1960
Lorox Reflex	12 14	0.375 0.094	5 de	56 bcd	80 ab	0 d	1770
Lorox Reflex	16 14	0.5 0.094	1 de	71 abc	89 a	0 d	1900
Lorox Zidua	12 1.44	0.375 0.076	0 de	61 abc	89 a	94 a	1780
Lorox Zidua	16 1.44	0.5 0.076	1 de	60 abc	92 a	74 ab	1700
Nontreated			-	-	-	-	820

Precipitation data (September 1, 2014 to August 31, 2015) from AgWeatherNet station Pullman NE, Cook Agronomy Farm East

Date	Precipitation (in.)	Date	Precipitation (in.)	Date	Precipitation (in.)	Date	Precipitation (in.)
9/30/14	0.01	10/2	0.04	11/1	0.06	12/2	0.01
		10/15	0.18	11/4	0.24	12/4	0.24
		10/22	0.09	11/6	0.01	12/5	0.01
		10/23	0.20	11/9	0.22	12/6	0.31
		10/24	0.05	11/20	0.06	12/9	0.04
		10/28	0.28	11/21	0.33	12/11	0.10
				11/22	0.22	12/12	0.53
				11/23	0.12	12/18	0.06
				11/24	0.10	12/19	0.56
				11/25	0.75	12/20	0.81
				11/26	0.04	12/21	0.31
				11/28	0.25	12/23	0.04
				11/29	0.10	12/24	0.60
						12/27	0.17
						12/28	0.01

Date	Precipitation (in.)	Date	Precipitation (in.)	Date	Precipitation (in.)	Date	Precipitation (in.)
1/4/15	0.22	2/1	0.02	3/14	0.19	4/1	0.06
1/5	0.04	2/2	0.29	3/15	0.43	4/6	0.23
1/10	0.01	2/4	0.02	3/17	0.23	4/9	0.03
1/11	0.03	2/5	0.09	3/18	0.17	4/11	0.11
1/13	0.02	2/6	0.01	3/21	0.04	4/14	0.12
1/16	0.24	2/7	0.35	3/23	0.50		
1/17	0.90	2/8	0.01	3/24	0.52		
1/18	0.46	2/9	1.04	3/25	0.08		
1/22	0.03	2/10	0.08	3/27	0.06		
1/30	0.01	2/19	0.12	3/28	0.29		
		2/20	0.02				
		2/26	0.01				

Precipitation data (September 1, 2014 to August 31, 2015) from AgWeatherNet station Pullman NE, Cook Agronomy Farm East, Con't

Date	Precipitation (in.)	Date	Precipitation (in.)	Date	Precipitation (in.)	Date	Precipitation (in.)
5/12	0.38	6/1	0.24	7/10	0.26	8/29	0.11
5/13	0.64	6/2	0.03	7/11	0.04		
5/15	0.26						
5/16	0.47						
5/17	0.02						
5/21	0.01						
5/22	0.04						
5/23	0.18						
5/26	0.12						
5/27	0.01						
5/31	0.07						

Precipitation data (September 1, 2014 to August 31, 2015) from AgWeatherNet station Davenport

Date	Precipitation (in.)	Date	Precipitation (in.)	Date	Precipitation (in.)	Date	Precipitation (in.)
9/3/14	0.03	10/14	0.03	11/1	0.04	12/5	0.01
9/30	0.02	10/15	0.26	11/4	0.19	12/6	0.17
		10/17	0.01	11/5	0.01	12/9	0.29
		10/18	0.06	11/6	0.07	12/10	0.02
		10/20	0.03	11/9	0.14	12/11	0.05
		10/22	0.51	11/21	0.54	12/12	0.03
		10/23	0.05	11/25	0.24	12/18	0.04
		10/24	0.01	11/26	0.02	12/19	0.13
		10/25	0.02	11/27	0.01	12/20	0.61
		10/28	0.22	11/28	0.03	12/24	0.07
		10/29	0.01			12/27	0.01
		10/30	0.01				
		10/31	0.04				

Date	Precipitation (in.)	Date	Precipitation (in.)	Date	Precipitation (in.)	Date	Precipitation (in.)
1/5/15	0.14	2/1	0.03	3/14	0.11	4/6	0.35
1/7	0.09	2/2	0.11	3/15	1.14	4/7	0.05
1/12	0.11	2/3	0.01	3/17	0.10	4/25	0.01
1/16	0.15	2/4	0.02	3/24	0.20		
1/17	0.51	2/5	0.33	3/25	0.13		
1/18	0.41	2/6	0.45	3/26	0.06		
1/23	0.11	2/7	0.27	3/28	0.12		
1/25	0.01	2/9	0.12				
1/29	0.03						

Precipitation data (September 1, 2014 to August 31, 2015) from AgWeatherNet station Davenport, Con’t

Date	Precipitation (in.)	Date	Precipitation (in.)	Date	Precipitation (in.)
5/12	0.03	7/10	0.04	8/30	0.06
5/13	0.32	7/27	0.01		
5/14	0.01				
5/25	0.01				
5/26	0.79				
5/29	0.19				
5/30	0.08				