2018 WSU Weed Control Report

Drew Lyon, Extension Small Grains, Professor, Weed Science
D. Appel, M. Thorne & H. C. Wetzel, Res. Assoc.
J. Fischer, Grad. Res. Asst.

Ian Burke, Professor, Weed Science
D. Appel, C. McFarland & R. Zuger, Res. Assoc.

Partial Research Support Provided by:
The Washington Grain Commission, The Washington State Oilseed Cropping Systems Project, The USA Dry Pea & Lentil Council, Bayer Crop Science, Syngenta Crop Protection, Valent USA LLC

Additional Support Provided by:
Albaugh LLC, Alligare LLC, Arysta Life Science, Columbia Pulp, Corteva AgriSciences, FMC Corporation, Gowan Company, Helena Chemical Company, ISK Biosciences Corporation, National Crop Insurance Services, Nufarm Americas Inc., Organic Research Extension Initiative, The Washington Turfgrass Seed Commission, TKI NovaSource, Winfield United

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Evaluation of Talinor™ in tank mix combinations for crop safety and downy brome control in Clearfield® Plus winter wheat

Henry Wetzel and Drew Lyon

A field study was conducted at Buck Farms near Almota, WA to evaluate crop safety and downy brome control with Talinor in tank mix combinations with group 2 herbicides including Beyond®, Osprey® and PowerFlex® HL. In addition, some treatments contained urea ammonium nitrate (UAN) at 1.5 gal/A. The field, in which the study was conducted, had been in a two-year rotation of winter wheat and chickpeas. The winter wheat variety 'UI Magic CL +' was seeded at the rate of 117 lb/A with a Krause drill on a 7.5-inch row spacing at 1.25 inch depth between October 7 & 17, 2017. Soil at this site is an Athena silt loam with 4.3% organic matter and a pH of 5.1. On April 3, 2018, treatments were applied with a CO_2-powered backpack sprayer set to deliver 10 gpa at 43 psi at 2.3 mph. Wheat was at the beginning of stem elongation and was 10 inches tall. The air temperature was 50°F, relative humidity was 27% and the wind was out of the west at 4 mph.

In 2016, we saw significant crop injury in plots treated with Talinor + CoAct+ + Beyond + UAN (18.2 + 3.6 + 6.0 fl oz/A + 2.0 gal/A) tank mixed with either 1.0% v/v MSO or 0.25% v/v NIS. The injury symptoms were longitudinal bleached streaks on the leaf blade. In this study, we saw crop injury in plots treated with Talinor + CoAct+ + UAN + NIS (13.7 fl oz/A + 2.75 fl oz/A + 1.5 gal/A + 0.25% v/v) and Talinor + CoAct+ + Beyond + UAN + NIS (13.7 fl oz/A + 2.75 fl oz/A + 6.0 fl oz/A + 1.5 gal/A + 0.25% v/v). In the 2016 study, crop injury was noted soon after application because the air temperature at application was 79°F on May 3rd and in turn symptoms persisted longer in the canopy. In this study, the application was made much earlier and under cooler conditions. Crop injury symptoms were slower to come on and did not persist as long in this study. In both studies, it seemed that the newest emerged leaf that was present at the time of application was the one affected. Crop injury was not noted in leaves that emerged after the spray application. In both studies, UAN appeared to aid Talinor movement into the plant, but the herbicide does not appear to be entering the vascular system and translocating. It seems that when Osprey and PowerFlex HL are tank mixed with Talinor and UAN, those products provide a sufficient safener load and that crop injury was not noted. It was observed that UAN was essential for the Osprey to provide acceptable downy brome control. The level of downy brome control provided by Beyond and PowerFlex HL was not compromised when tank mixed with Talinor. Although not statistically significant, the results suggest that downy brome control may have been slightly reduced when Talinor was tank mixed with Osprey. None of the treatments in this study affected the yield and test weight when compared to the nontreated check. The average yield and test weight were 138 bu/A and 60.8 lb/bu, respectively.

		Crop injury		Downy brome control	
		4/18	5/3	5/10	5/29
Treatment	Rate	15 DAT	30 DAT	37 DAT	56 DAT
	fl oz/A	-------------------%--------------------		-------------------%--------------------	
Nontreated Control	--	--	--	--	--
Talinor + CoAct+[1]	13.7 + 2.75	0 a[2]	0 a	5 d	5 d
Talinor + CoAct+ + UAN	13.7 + 2.75 + 1.5 gal	19 c	4 b	3 d	3 d
Beyond + UAN	6.0 + 1.5 gal	0 a	0 a	85 ab	99 ab
Osprey + UAN	4.75 oz + 1.5 gal	0 a	0 a	72 bc	84 bc
PowerFlex HL + UAN	2.0 oz + 1.5 gal	0 a	0 a	83 a-c	100 a
Talinor + CoAct+ + Beyond	13.7 + 2.75 + 6.0	0 a	0 a	80 a-c	91 ab
Talinor + CoAct+ + Beyond + UAN	13.7 + 2.75 + 6.0 + 1.5 gal	14 b	4 b	88 a	100 a
Talinor + CoAct+ + Osprey	13.7 + 2.75 + 4.75 oz	0 a	0 a	13 d	5 d
Talinor + CoAct+ + Osprey + UAN	13.7 + 2.75 + 4.75 oz + 1.5 gal	0 a	0 a	69 c	70 c
Talinor + CoAct+ + PowerFlex HL	13.7 + 2.75 + 2.0 oz	0 a	0 a	76 a-c	90 ab
Talinor + CoAct+ + PowerFlex HL + UAN	13.7 + 2.75 + 2.0 oz + 1.5 gal	0 a	0 a	91 a	100 a

[1]All treatments were tank mixed with NIS 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.

Crop Tolerance of Talinor with Slow Release Fertilizers in Winter Wheat and Mayweed Chamomile Control

Zuger, R.J. & I.C. Burke

Fig 1 (above). Flag leaf bleaching following applications of Talinor + CoAct with UAN in the same tank 13 days after treatment (DAT).

The objective of the study was to evaluate crop tolerance of Talinor with the addition of a slow release fertilizer on winter wheat. We also looked at mayweed chamomile (*Anthemis cotula* L.) control when using a slow release fertilizer compared to no fertilizer added and urea ammonium nitrate (UAN). Crop injury with Talinor applied with UAN has been observed, usually causing bleaching of the wheat flag leaf. UAN is also thought increase adsorption and speed up metabolic responses with in plants, for example, allowing Clearfield crops to metabolize the imazamox more rapidly to reduce crop injury. Alternative fertilizers options include slow release fertilizers to reduce crop injury. However, slow release fertilizers can be expensive as they are typically marketed for specialty horticultural crops.

The study was established at the Cook Agronomy Farm near Pullman, WA. Talinor was applied May 8, 2018 to winter wheat at stage Feekes 5. Fertilizer was either applied with Talinor or 7 days after Talinor application, detailed in Table 1 and Table 2. Mayweed chamomile was at 2 inches in diameter when Talinor was applied. The study was conducted in a randomized complete block with 4 replications. Plots were 10' by 30' long. Winter wheat, variety PNW Trooper Blend (Puma, SY107, Ovation), was planted on October 10, 2017. The trial site had been treated with 1.75 oz A^{-1} of Zidua as a delayed preemergence (PRE) on October 12, 2017 for Italian ryegrass and mayweed chamomile control. Axial XL at a rate of 16.4 fl oz A^{-1} was applied POST on April 19, 2018 for Italian ryegrass control.

Crop necrosis was visually assessed 13 days after the first application timing (DAAT). Crop bleaching injury was assessed 13 and 21 DAAT. Crop injury and mayweed chamomile control was visually assessed 35 DAAT. Plots were harvested by a 5 ft. header plot combine on August 2, 2018. All data was subjected to an analysis of variance using the statistical package built into the Agricultural Research Manager software system (ARM 8.5.0, Gylling Data Management).

Results

Overall, UAN (32-0-0) applied with Talinor had the greatest crop injury and lowest yields. At 13 days after application timing A (DAAT), UAN (32-0-0) and Coron (28-0-0) applied with Talinor were the only treatments to cause significant crop necrosis. UAN caused 14% necrosis and Coron caused 15% necrosis compared to the nontreated control. Plots treated with Coron grow out of the injury by 35 DAAT. UAN + Talinor applied at the same timing had significant crop injury throughout the growing season. Significant crop bleaching was present for UAN + Talinor treatment with 34% 12 DAAT and 28% 21 DAAT compared to all other treatments with less than 5% bleaching (Table 2).

Mayweed chamomile control 35 DAAT was less for all split treatments of fertilizer first and then Talinor 7 days later. There was no difference within timing of treatment. N-Sure (28-0-0) applied first and then Talinor 7 days later had the least weed control with 81% compared to Coron applied with fertilizer which had weed control of 98% 35 DAAT (Table 2).

Although crop injury occurred when UAN and Talinor were applied together, there was no significant difference in winter wheat yield were observed between any treatments (Table 2). However, UAN and Talinor applied together did result in the lowest yields (73 bu A^{-1}). The highest numerical yield (109 bu A^{-1}) was with N-Sure applied first followed by Talinor. No treatment yielded 95 bu A^{-1}.

Fig 2 (left). Crop injury following applications of Talinor + CoAct with UAN in the same tank 13 days after treatment (DAT).

Table 1. *Treatment application details*

Study Application	**A**	**B**
Date	May 8, 2018	May 15, 2018
Application volume (GPA)	15	15
Crop Stage	Feekes 5	Feekes 9
Air temperature (˚F)	70	56
Soil temperature (˚F)	61	62
Wind velocity (mph, direction)	2.5, E	0.4, E
Cloud Cover	40%	10%

Table 2. *Percent crop necrosis, bleaching, mayweed chamomile control and winter wheat yield following application of Talinor with slow-release fertilizers. Pullman, WA, 2018. Means followed by the same letter are not statistically significantly different (α=0.05).*

Treatment	Application Code	Rate		Tank pH (A)	*5/21/2018 (13 DAAT)*		*5/29/2018 (21 DAAT)*	*6/12/2018 (35 DAAT)*		*8/2/2018*
					Crop Necrosis	Crop Bleaching	Crop Bleaching	Crop Injury	ANTCO Control	Yield
		field rate	*lb ai/A*[a]		%	%	%	%	%	bu/A
Nontreated				-	-	-	-	-	-	95
CoAct+ Talinor Induce (NIS)	A A A	2.75 fl oz/A 13.7 fl oz/A 0.25% v/v	0.057 0.190	7.1	0 a	2 a	0 a	0 a	96 a	96
UAN (32-0-0) CoAct+ Talinor Induce (NIS)	A A A A	25% v/v 2.75 fl oz/A 13.7 fl oz/A 0.25% v/v	31.40 0.057 0.190	7.2	14 b	34 b	28 b	21 a	97 a	73
NDemand 30L CoAct+ Talinor Induce (NIS)	A A A A	25% v/v 2.75 fl oz/A 13.7 fl oz/A 0.25% v/v	44.71 0.057 0.190	8.9	3 a	5 a	3 a	0 a	97 a	93
N-Pact (26-0-0) CoAct+ Talinor Induce (NIS)	A A A A	25% v/v 2.75 fl oz/A 13.7 fl oz/A 0.25% v/v	33.97 0.057 0.190	9.6	3 a	1 a	1 a	0 a	97 a	96
Coron (28-0-0) CoAct+ Talinor Induce (NIS)	A A A A	25% v/v 2.75 fl oz/A 13.7 fl oz/A 0.25% v/v	35.14 0.057 0.190	8.4	15 b	1 a	0 a	3 a	98 a	99
N-Sure (28-0-0) CoAct+ Talinor Induce (NIS)	A A A A	25% v/v 2.75 fl oz/A 13.7 fl oz/A 0.25% v/v	42.45 0.057 0.190	8.5	1 a	0 a	0 a	0 a	96 a	92
UAN (32-0-0) CoAct+ Talinor Induce (NIS)	A B B B	25% v/v 2.75 fl oz/A 13.7 fl oz/A 0.25% v/v	31.40 0.057 0.190	7.3*	4 a	3 a	0 a	0 a	88 ab	94
NDemand 30L CoAct+ Talinor Induce (NIS)	A B B B	25% v/v 2.75 fl oz/A 13.7 fl oz/A 0.25% v/v	44.71 0.057 0.190	9.4*	4 a	1 a	0 a	0 a	91 ab	96
N-Pact (26-0-0) CoAct+ Talinor Induce (NIS)	A B B B	25% v/v 2.75 fl oz/A 13.7 fl oz/A 0.25% v/v	33.97 0.057 0.190	9.7*	4 a	1 a	0 a	0 a	89 ab	99
Coron (28-0-0) CoAct+ Talinor Induce (NIS)	A B B B	25% v/v 2.75 fl oz/A 13.7 fl oz/A 0.25% v/v	35.14 0.057 0.190	8.7*	3 a	3 a	0 a	0 a	87 ab	80
N-Sure (28-0-0) CoAct+ Talinor Induce (NIS)	A B B B	25% v/v 2.75 fl oz/A 13.7 fl oz/A 0.25% v/v	42.45 0.057 0.190	8.7*	7 a	0 a	0 a	0 a	81 b	109
				LSD	*5.75*	*8.26*	*2.71*	*4.86*	*8.59*	*NS*

[a] *lb ai/A for nitrogen fertilizers is lb nitrogen/A*

** Tank pH is for fertilizer mixture only (A application code); Talinor was not in tankmix*

Postemergence Mayweed Chamomile Management in Winter Wheat without Clopyralid

Zuger, R.J. & I.C. Burke

The objective of the study was to evaluate mayweed chamomile (*Anthemis cotula* L.) management in winter wheat without the active ingredient clopyralid, a synthetic auxin commonly used for mayweed chamomile control.

The study was established at the Cook Agronomy Farm near Pullman, WA. Treatments were applied to mayweed chamomile at 3 inches or greater in diameter post emergence (POST) in winter wheat, detailed in Table 1 and Table 2. Widematch was included as an industry standard. The study was conducted in a randomized complete block with 4 replications. Plots were 10' by 30' long. Winter wheat, variety PNW Trooper Blend (Puma, SY107, Ovation), was planted on October 10, 2017. The trial site had been treated with 1.75 oz A^{-1} of Zidua as a delayed preemergence (PRE) on October 12, 2017 for Italian ryegrass and mayweed chamomile control. Axial XL at a rate of 16.4 fl oz A^{-1} was applied POST on April 19, 2018 for Italian ryegrass control.

Mayweed chamomile control was visually assessed 29 and 42 days after treatment (DAT). Plots were harvested using a 5 ft wide plot combine on August 2, 2018. All data was subjected to an analysis of variance using the statistical package built into the Agricultural Research Manager software system (ARM 8.5.0, Gylling Data Management).

Results

There was no significant crop injury for any of the treatments 16 DAT. Mayweed chamomile control was greater in treatments containing herbicides when compared to the nontreated 16 DAT. Control of mayweed chamomile was greatest with Huskie with MCPA ester (68%), Brox-M with Affinity Broadspec and MCPA ester (64%), or Widematch (83%) 16 DAT (Table 2). Mayweed chamomile control increased at 42 DAT, and control was greater in all treatments that included herbicides compared to the nontreated control. Mayweed chamomile control was greatest for Huskie with MCPA ester (76%), Peak with Brox-M and Starane Ultra (76%), and Widematch (99%) 42 DAT (Table 2). No significant differences in winter wheat yield were observed (Table 2).

Table 1. *Treatment application details*

Study Application	
Date	May 14, 2018
Application volume (GPA)	15
Crop Stage	8 tillers
Air temperature (˚F)	80
Soil temperature (˚F)	59
Wind velocity (mph, direction)	5, SE
Cloud Cover	0%
Next rain occurred on	May 16, 2018

Table 2. *Percent mayweed chamomile control and winter wheat yield. Pullman, WA, 2018. Means followed by the same letter are not statistically significantly different (α=0.05).*

Treatment	Field Rate	Active Ingredients	lb ai/A	June 12, 2018 (29 DAT) Mayweed Control	June 25, 2018 (42 DAT) Mayweed Control	August 2, 2018 Yield
				%	%	bu/A
Nontreated			-	-	-	93 ab
Huskie MCPA ester NIS	13.5 fl oz/A 1 pt/A 0.5% v/v	pyrasulfotole & bromoxynil MCPA ester	0.033 0.185 0.462	80	88 ab	88 b
Talinor CoAct+ COC	18.2 fl oz/A 3.6 fl oz/A 1% v/v	bicycloprone & bromoxynil	0.044 0.208	87	85 ab	89 ab
Starane Flex MCPA ester NIS	14 fl oz/A 1 pt/A 0.5% v/v	florasulam & fluroxypyr MCPA ester	0.005 0.091 0.462	55	71 ab	93 ab
Starane Ultra Affinity Broadspec MCPA ester NIS	5.7 fl oz/A 1 oz/A 1 pt/A 0.5% v/v	fluroxypyr thifensulfuron & tribenuron MCPA ester	0.125 0.014 0.007 0.462	75	55 b	100 a
Starane Ultra Harmony Extra XP MCPA ester NIS	5.7 fl oz/A 0.45 oz/A 1 pt/A 0.5% v/v	fluroxypyr thifensulfuron & tribenuron MCPA ester	0.125 0.014 0.007 0.462	69	60 ab	97 ab
Orion Starane Ultra NIS	17 fl oz/A 5.7 fl oz/A 0.5% v/v	florasulam & MCPA ester fluroxypyr	0.004 0.310 0.125	46	71 ab	94 ab
Peak Starane Ultra NIS	0.5 oz/A 5.7 fl oz/A 0.5% v/v	prosulfuron fluroxypyr	0.018 0.125	43	54 b	96 ab
Brox-M Starane Flex NIS	14 fl oz/A 14 fl oz/A 0.5% v/v	bromoxynil & MCPA ester florasulam & fluroxypyr	0.219 0.219 0.005 0.091	60	68 ab	100 a
Brox-M Harmony Extra XP NIS	14 fl oz/A 0.45 oz/A 0.5% v/v	bromoxynil & MCPA ester thifensulfuron & tribenuron	0.219 0.219 0.014 0.007	69	61 ab	91 ab
Brox-M Affinity Broadspec MCPA ester NIS	14 fl oz/A 1 oz/A 1 pt/A 0.5% v/v	bromoxynil & MCPA ester thifensulfuron & tribenuron MCPA ester	0.219 0.219 0.016 0.016 0.462	53	65 ab	91 ab
Peak Brox-M Starane Ultra NIS	0.5 oz/A 14 fl oz/A 5.7 fl oz/A 0.5% v/v	prosulfuron bromoxynil MCPA ester fluroxypyr	0.018 0.219 0.219 0.125	75	78 ab	95 ab
Widematch NIS	1.33 pt/A 0.5% v/v	clopyralid & fluroxypyr	0.125 0.125	80	93 a	93 ab
			LSD	*NS*	*21.47*	*6.97*

Preemergence and Postemergence Herbicides for Bromus Spp. Control in Winter Wheat in Anatone, WA

Zuger, R.J., & I.C. Burke

Downy brome (*Bromus tectorum*) continues to be a problematic and widespread weed in inland PNW wheat-fallow rotations. Acetolactate synthase inhibitor resistance continues to spread, and there are very few herbicide options remaining. Sterile brome (*Bromus sterilis*) is another bromegrass invading wheat fields in intermediate and low rainfall zones. Our objective was to identify one or more herbicide treatments with different herbicide modes of action for management of downy brome and sterile brome.

The study was established in a winter wheat field near Anatone, WA. Whole plot treatments were applied delayed preemergence (delayed-PRE) to wheat, some emerged downy brome was present, on October 4, 2017, detailed in Table 1 and Table 2. The whole plots were 10' by 75' long and then split into 10' by 25' long plots in the spring for postemergence (POST) applications. Split plot treatments were applied in the spring POST on April 9, 2018, detailed in Table 1 and Table 3.

Downy brome (*Bromus tectorum*) control was assessed by visual estimation at 177 and 208 days after treatment (DAT) of application of delayed-PRE treatments (A) (Table 2). Downy brome biomass was harvested by collecting two $1/10^{th}$ meter quadrants from each split-plot on May 20, 2018 (Table 2 & 3). Plots were harvested using a Kincaid plot combine with a 5 ft wide header on July 31, 2018.

Data was subjected to an analysis of variance using the statistical package built into the Agricultural Research Manager software system (ARM 8.5.0, Gylling Data Management) and PROC GLIMMIX in SAS (version 9.2, SAS Institute Inc., Cary, NC) with the fixed effects of delayed-PRE treatments and POST treatments and random effect block. Significant differences between treatments were analyzed using Fisher's protected LSD in SAS using the %mult macro.

The combination of both a fall applied delayed-PRE and a spring applied POST herbicide treatment did not impact the efficiency of *Bromus spp.* control or yield. All treatments, except Olympus and Outrider + Metribuzin, controlled the *Bromus spp.* compared to the nontreated control. Zidua (pyroxasulfone) alone and in combination with diclofop (Hoelon) and metribuzin + diclofop had the greatest control of 65 to 68% 177 DAT and 73% to 78% control 208 DAT (Table 2). *Bromus spp.* biomass was significantly less for all treatments, except for Zidua + diclofop, metribuzin (alone), Axoim, and Olympus, when compared to the nontreated control. *Bromus spp.* biomass in the nontreated control was 2809 lb A^{-1} compared to least of 1296 lb A^{-1} *Bromus spp.* biomass for Zidua + metribuzin + diclofop. Zidua alone had 1559 lb A^{-1} and Zidua + metribuzin had 1841 lb A^{-1} biomass.

POST applications of Powerflex and OlympusFlex in the spring had no significant impact on *Bromus spp.* biomass compared to no-POST treatments (Table 3). No visual crop injury was observed for the POST treatments.

There was a significant increase in crop yield when any delayed-PRE treatment was applied except for Olympus. Olympus yield (55 bu A^{-1}) was not different from the nontreated control (47 bu A^{-1}). Zidua + metribuzin + diclofop had the greatest yield of 72 bu A^{-1}. When POST treatments were applied reduction in yield was observed possibly due to the low night time temperature of 41˚F, although not significantly different between Powerflex HL and the no-POST. When no POST treatment was applied yield was 69 bu A^{-1} compared to 65 bu A^{-1} for Powerflex HL and 63 bu A^{-1} for OlympusFlex.

Table 1. *Treatment application details*

Study Application	A	B
Date	10/4/2017	4/9/2018
Application Timing	Delayed PRE	POST
Application volume (GPA)	15	15
Day air temperature (˚F)	45	51
Night air temperature (˚F)	30	35
Soil temperature (˚F)	48	41
Wind velocity (mph, direction)	3.8, N	5.5, SW
Next rain occurred on	10/7/2017	4/10/2018

Table 2. *Percent control and biomass for Bromus spp. (Bromus tectorum and Bromus sterilis) and yield following fall preemergence applications. Anatone, WA, 2017-2018. DAT = days after treatment of preemergence (A). Means followed by the same letter are not statistically significantly different (α=0.05).*

				Downy Brome Control		***Downy Brome Biomass***	***Yield***
Treatment	**Application Timing**	**Rate**		**3/30/2018 177 DAT**	**4/30/2018 208 DAT**	**5/30/2018**	**7/31/2018**
		field rate	**lb ai/A**	**%**	**%**	**LB/A**	**bu/A**
Nontreated	A	-	-	-	-	2809 ab	47 d
Zidua RT3 NIS	A A A	1.50 oz/A 16 fl oz/A 0.25% v/v	0.080 0.690	68 a	75 a	1559 cd	68 ab
Zidua Metribuzin RT3 NIS	A A A A	1.50 oz/A 4.00 oz/A 16 fl oz/A 0.25 % v/v	0.080 0.188 0.690	43 ab	47 ab	1841 bcd	72 ab
Zidua Diclofop RT3 NIS	A A A A	1.50 oz/A 2.66 pt/A 16 fl oz/A 0.25 % v.v	0.080 1.000 0.690	68 a	78 a	2709 ab	72 ab
Zidua Metribuzin Diclofop RT3 NIS	A A A A A	1.50 oz/A 4.00 oz/A 2.66 pt/A 16 fl oz/A 0.25 % v/v	0.080 0.188 1.000 0.690	65 a	73 a	1296 d	72 a
Metribuzin RT3 NIS	A A A	4.00 oz/A 16 fl oz/A 0.25% v/v	0.188 0.690	43 ab	43 ab	2380 abc	63 bc
Diclofop RT3 NIS	A A A	2.66 pt/A 16 fl oz/A 0.25% v/v	1.000 0.690	29 ab	57 ab	1457 cd	71 ab
Metribuzin Diclofop RT3 NIS	A A A A	4.00 oz/A 2.66 pt/A 16 fl oz/A 0.25% v/v	0.188 1.000 0.690	43 ab	50 ab	1429 cd	70 ab
Axoim RT3 NIS	A A A	8 oz/A 16 fl oz/A 0.25% v/v	0.068 0.690	30 ab	37 abc	3061 a	65 ab
Outrider Metribuzin RT3 NIS	A A A A	0.66 oz/A 1.50 oz/A 16 fl oz/A 0.25% v/v	0.031 0.070 0.690	20 b	20 bc	1939 bcd	63 abc
Olympus RT3 NIS	A A A	0.90 oz/A 16 fl oz/A 0.25% v/v	0.039 0.690	0 b	0 c	2990 a	55 cd
RT3 NIS	A A	16 fl oz/A 0.25% v/v	0.690	43 ab	37 abc	1463 cd	66 ab
			LSD	*27.85*	*27.82*	*1049.68*	*9.72*

Table 3. *Bromus spp. (Bromus tectorum and Bromus sterilis) biomass and yield following spring postemergence applications. Anatone, WA, 2017-2018. Means followed by the same letter are not statistically significantly different (α=0.05).*

Treatment	Application Timing	Rate		***Downy Brome Biomass***	***Yield***
				5/30/2018	**7/31/2018**
		field rate	**lb ai/A**	**LB/A**	**bu/A**
No POST		-	-	2215	69 a
Powerflex HL NIS UAN	B B B	2.0 oz/A 0.25 % v/v 2.5 gal/100 gal	0.016	2032	65 ab
OlympusFlex NIS UAN	B B B	3 oz/A 0.25 % v/v 2.5 gal/100 gal	0.013 mesosulfuron 0.009 propoxycarb-azone	1987	63 b
			LSD	*NS*	*4.86*

Thank you to the grower and their family for the use of their land.

Preemergence and Postemergence Herbicides for Control of Bromus Spp. in Winter Wheat in Ewan, WA

Zuger, R.J., & I.C. Burke

Downy brome (*Bromus tectorum*) continues to be a problematic and widespread weed in inland PNW wheat-fallow rotations. Acetolactate synthase inhibitor resistance continues to spread, and there are very few herbicide options remaining. Sterile brome (*Bromus sterilis*) is another bromegrass invading wheat fields in intermediate and low rainfall zones. Our objective was to identify one or more herbicide treatments with different herbicide modes of action for management of downy brome and sterile brome.

Fig 1. Wheat and *Bromus spp.* at application.

The study was established in a Clearfield winter wheat field near Ewan, WA. Whole plot treatments were applied early-postemergence (POST) to 1 to 2-tiller wheat, downy brome was present at 2 to 3-leaf stage, on October 9, 2017, detailed in Table 1 and Table 2. The whole plots were 10' by 75' long and then split into 10' by 25' long plots in the spring for postemergence (POST) applications. Split plot treatments were applied in the spring POST on April 18, 2018, detailed in Table 1 and Table 3.

Downy brome (*Bromus tectorum*) control was assessed by visual estimation at 177 and 208 days after treatment (DAT) of application of early-POST treatments (A) (Table 2). Downy brome biomass was harvested by collecting two 1/10th meter quadrants from each split-plot on May 20, 2018 (Table 2 & 3). Plots were harvested using a Kincaid plot combine with a 5 ft header on July 19, 2018.

Data was subjected to an analysis of variance using the statistical package built into the Agricultural Research Manager software system (ARM 8.5.0, Gylling Data Management) and PROC GLIMMIX in SAS (version 9.2, SAS Institute Inc., Cary, NC) with the fixed effects of delayed-PRE treatments and POST treatments and random effect block. Biomass failed normality and was square root transformed. Significant differences between treatments were analyzed using Fisher's protected LSD in SAS using the %mult macro.

The combination of both a fall applied early-POST and a spring applied POST herbicide treatment did not impact the efficiency of *Bromus spp.* control or yield. All treatments controlled the *Bromus spp.* compared to the nontreated control. Zidua (pyroxasulfone) + metribuzin + diclofop and metribuzin + diclofop had the greatest control of 79 and 81%, respectively (Table 2). Powerflex HL has the worst visual control with only 38% 191 DAT. No differences in *Bromus spp.* biomass resulted from any treatment although the nontreated control had the greatest amount with 1331 lb A^{-1}. Zidua + metribuzin (694 lb A^{-1}), Zidua + metribuzin + diclofop (539 lb A^{-1}), and Axiom (562 lb A^{-1}) had the least amount of *Bromus spp.* biomass.

POST applications of Powerflex and Beyond in the spring had no significant impact on the visual ratings of downy brome control or *Bromus spp.* biomass compared to no-POST treatments (Table 3).

There were no differences in crop yield for the no-POST treatment and the two spring herbicides. The yield loss produced by Beyond (66 bu A^{-1}) is likely attributed to a miss application of Beyond resulting in 2-times the labeled field rate being applied. The spring applied Powerflex HL yielded in 78 bu A^{-1} and the no-POST treatment had 72 bu A^{-1}.

Table 1. *Treatment application details*

Study Application	A	B
Date	10/9/2017	4/18/2018
Application Timing	Early POST	POST
Application volume (GPA)	15	15
Day air temperature (˚F)	64	49
Night air temperature (˚F)	34	38
Soil temperature (˚F)	59	43
Wind velocity (mph, direction)	2.5, SE	2.5, SE
Next rain occurred on	10/12/2017	4/28/2018

Table 2. *Percent control and biomass for Bromus spp. (Bromus tectorum and Bromus sterilis) and yield following fall preemergence applications. Ewan, WA, 2017-2018. DAT = days after treatment of preemergence (A). Means followed by the same letter are not statistically significantly different (α=0.05).*

Treatment	Application Timing	Rate		Downy Brome Control	Downy Brome Biomass	Yield
				4/18/2018 191 DAT	5/23/2018	7/19/2018
		field rate	lb ai/A	%	LB/A	bu/A
Nontreated	A	-	-	-	1331	69
Zidua NIS	A A	1.50 oz/A 0.25% v/v	0.080	53 abc	1009	69
Zidua Metribuzin NIS	A A A	1.50 oz/A 4.00 oz/A 0.25 % v/v	0.080 0.188	70 ab	694	72
Zidua Diclofop NIS	A A A A	1.50 oz/A 2.66 pt/A 0.25 % v.v	0.080 1.000	74 ab	815	83
Zidua Metribuzin Diclofop NIS	A A A A	1.50 oz/A 4.00 oz/A 2.66 pt/A 0.25 % v/v	0.080 0.188 1.000	79 a	539	82
Metribuzin NIS	A A	4.00 oz/A 0.25% v/v	0.188	55 abc	1080	66
Diclofop NIS	A A	2.66 pt/A 0.25% v/v	1.000	65 abc	780	71
Metribuzin Diclofop NIS	A A A	4.00 oz/A 2.66 pt/A 0.25% v/v	0.188 1.000	81 a	1013	69
Axoim NIS	A A	8 oz/A 0.25% v/v	0.068	63 abc	562	75
Outrider Metribuzin NIS	A A A	0.66 oz/A 1.50 oz/A 0.25% v/v	0.031 0.070	55 abc	833	64
Olympus NIS	A A	0.90 oz/A 0.25% v/v	0.039	48 bc	813	74
Powerflex HL NIS	A A	16 fl oz/A 0.25% v/v	0.016	38 c	956	70
			LSD	*19.20*	*NS*	*NS*

Table 3. *Bromus spp. (Bromus tectorum and Bromus sterilis) biomass and yield following spring postemergence applications. Ewan, WA, 2017-2018. Means followed by the same letter are not statistically significantly different (α=0.05).*

Treatment	**Application Timing**	**Rate**		***Downy Brome Biomass***	***Yield***
		field rate	**lb ai/A**	**LB/A**	**bu/A**
No POST		-	-	909	72 ab
Powerflex HL	B	2.0 oz/A	0.016		
NIS	B	0.25 % v/v		948	78 a
UAN	B	2.5 gal/100 gal			
Beyond*	B	12 fl oz/A	0.094		
NIS	B	0.25 % v/v		719	66 b
UAN	B	2.5 gal/100 gal			
			LSD	*NS*	*6.97*

** 2-times the labeled field rate*

Thank you to the grower for the use of their land.

Evaluation of application timings with Zidua® SC for the control of Italian ryegrass in winter wheat

Henry Wetzel and Drew Lyon

A field study was conducted at the Cook Agronomy Farm near Pullman, WA to determine the application timing of Zidua SC that would provide optimum control of Italian ryegrass in winter wheat. We evaluated four herbicide application timings in relation to wheat growth stage: preemergence, delayed preemergence, spike leaf emerged and early tillering.

The soil at this site is a Palouse silt loam with 3.7% organic matter and a pH of 5.2. The trial area followed chickpeas. On October 11, 2017, 'Trooper (blend of Puma, SY107 and Ovation)' winter wheat was seeded at 120 lb seed per acre at a depth of 2.0 inches with a Horsch direct-seed air drill on a 12-inch row spacing. Preemergence treatments were applied on October 12th under calm conditions with an air temperature of 46°F and relative humidity of 67%. Delayed preemergence treatments were applied on October 16th with an air temperature of 62°F, relative humidity of 33% and wind out of the east at 8 mph. Spike leaf treatments were applied on October 30th with an air temperature of 51°F, relative humidity of 25% and wind out of the east at 5 mph. Early tillering treatments were applied on March 29, 2018 with an air temperature of 44°F, relative humidity of 64% and winds out of the west at 6 mph. All herbicide treatments were applied with a CO_2-powered backpack sprayer set to deliver 10 gpa at 48 psi at 2.3 mph. The plots were harvested on August 2nd using a Kincaid 8XP plot combine.

Precipitation was above average during the fall and winter months, which was favorable for Italian ryegrass germination and growth. The crop was in and out of snow cover from December to March, but overall winter conditions were moderate and most likely minimal winterkill occurred in the Italian ryegrass. The results suggest that the best control of Italian ryegrass is achieved when the maximum annual use rate (4.0 fl oz/A) of Zidua SC is applied, but 2.5 to 3.25 fl oz/A of the seasonal maximum use rate needs to be applied around the time of planting, or shortly thereafter, with the remainder applied from spike leaf emergence to early tillering. Although waiting until early tillering to make the second application was effective in this study, this was not the case in a similar study conducted the previous year. A single application at early tillering, which is typically late winter/early spring in Pullman, is too late for Italian ryegrass control, suggesting that the majority of the plants are emerging in the fall. Zidua SC + PowerFlex® HL (4.0 fl oz + 2.0 oz/A), applied at spike leaf, was the only treatment where the addition of PowerFlex HL showed a slight improvement in Italian ryegrass control over Zidua SC applied alone.

Trt#	Treatment	Rate	Application timing[2]	Italian ryegrass control 5/11	7/6	Yield
		fl oz/A		------------------0-100%	-----------------	bu/A
1	Nontreated Check	--	--	--	--	28 c
2	Zidua SC	3.25	preemergence	74 cd[2]	86 a-c	96 a
3	Zidua SC	3.25	delayed preemergence	61 de	75 c	87 a
4	Zidua SC + Sencor®	3.25 + 1.45 oz	delayed preemergence	59 e	75 c	78 ab
5	Zidua SC	4.0	spike leaf	76 bc	81 bc	93 a
6	Zidua SC + PowerFlex HL[1]	4.0 + 2.0 oz	spike leaf	84 ab	88 ab	88 a
7	Zidua SC	4.0	early tillering	70 c-e	40 d	62 b
8	Zidua SC + PowerFlex HL[1]	4.0 + 2.0 oz	early tillering	44 f	35 d	61 b
9	Zidua SC	2.5	preemergence	84 ab	91 ab	90 a
9	Zidua SC	1.5	spike leaf			
10	Zidua SC	2.5	preemergence	82 a-c	93 a	91 a
10	Zidua SC + PowerFlex HL[1]	1.5 + 2.0 oz	spike leaf			
11	Zidua SC	2.5	preemergence	88 ab	94 a	87 a
11	Zidua SC	1.5	early tillering			
12	Zidua SC	2.5	preemergence	91 a	91 ab	84 a
12	Zidua SC + PowerFlex HL[1]	1.5 + 2.0 oz	early tillering			

[1] Treatment was tank mixed with 0.5% NIS and 2.0 qts UAN/A

[2] Dates of application, preemergence (10/12/17), delayed preemergence (10/16/17), spike leaf (10/30/17) and early tillering (3/29/18)

[3] 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 Osprey® Xtra for the control of jointed goatgrass in winter wheat
Henry Wetzel and Drew Lyon

A field study was conducted at Wolf Farms near Johnson, WA to evaluate Osprey Xtra for its postemergence jointed goatgrass control in direct-seeded winter wheat. Osprey Xtra (thiencarbazone + mesosulfuron) active ingredients are both in the Mechanism of Action Group 2, which are compounds that inhibit acetolactate synthase (ALS), a key enzyme in the biosynthesis of the branched-chain amino acids isoleucine, leucine and valine. Osprey Xtra also contains mefenpyr-diethyl, which is used as a safener in combination with the active ingredients for selective weed control in wheat. Osprey Xtra was compared to the current formulation of Osprey, which only contains (mesosulfuron + mefenpyr-diethyl). Osprey Xtra is not yet registered for use in wheat. The addition of one or two broadleaf emulsifiable concentrate (EC) herbicide formulations have been shown to increase the activity of Osprey Xtra on grassy weeds, and is why those treatments were included in this study.

The soil at this site is a Latah silt loam with 4.9% organic matter and a pH of 5.3. The field was previously in chickpeas. On October 4, 2017, 'Trooper (a blend of WB1529, SY Ovation and SY107)' soft white winter wheat blend was seeded at 1 x 10^6 seeds per acre with a Cross Slot® drill on a 10-inch row spacing at a depth of 1.5 inches. The ground was fertilized at the same time with 60 lb N: 30 lb P: 20 lb S per acre. The ground was fertilized with an additional 35 lb N per acre in the spring. Postemergence treatments were applied on April 19, 2018 with a CO_2-powered backpack sprayer set to deliver 10 gpa at 44 psi at 2.3 mph. The applications were made with winds out of the west at 6 mph, air temperature of 57°F and relative humidity of 44%. At the time of application, wheat was at the 2-tiller stage and was 6 inches tall. Jointed goatgrass had 4 tillers and was 2.75 inches tall. The trial was not taken to harvest due to the high density of jointed goatgrass.

Fourteen days after treatment (DAT), all treatments showed a low level of jointed goatgrass control. At 27 DAT, treatments that contained Osprey Xtra or Osprey exhibited a higher level of jointed goatgrass control. At this time, jointed goatgrass plants treated with Osprey Xtra or Osprey were stunted, twisted and darker green than plants in the nontreated check plots. PowerFlex® HL did not control of jointed goatgrass. Osprey Xtra and Osprey provided a similar level of jointed goatgrass control. The addition of one or two emulsifiable concentrate broadleaf herbicides to Osprey Xtra or Osprey did not significantly improve control of jointed goatgrass. At 40 DAT, plants that were treated with Osprey Xtra or Osprey and in combination with various broadleaf herbicides, were beginning to recover from the application.

		Jointed goatgrass control		
		5/3	5/16	5/29
Treatment	rate	14 DAT	27 DAT	40 DAT
	fl oz/A	------------------0-100%--------------------		
Nontreated Check	--	--	--	--
Osprey Xtra[1]	4.75 oz	50 a[3]	68 a	55 ab
Osprey Xtra + Huskie®[2]	4.75 oz + 13.5	44 ab	70 a	60 ab
Osprey Xtra + Huskie + Starane® Flex[2]	4.75 oz + 13.5 + 13.5	43 ab	70 a	60 ab
Osprey Xtra + Huskie + Brox®-M[2]	4.75 oz + 13.5 + 16	40 b	64 a	65 a
Osprey Xtra + Huskie + Quelex®[2]	4.75 oz + 13.5 + 0.75 oz	45 ab	66 a	58 ab
Osprey Xtra + Talinor™ + CoAct+[2]	4.75 oz + 16 + 3.2	43 ab	63 a	53 b
Osprey + Huskie + Brox-M[2]	4.75 oz + 13.5 + 16	48 ab	69 a	60 ab
PowerFlex HL + Huskie + Brox-M[2]	2.0 oz + 13.5 + 16	21 c	0 b	0 c
PowerFlex HL[1]	2.0 oz	29 c	3 b	0 c
Osprey[1]	4.75 oz	48 ab	69 a	55 ab

[1] Treatments were tank mixed with 0.50% v/v NIS + 4.0 pt/A UAN
[2] Treatments were tank mixed with 0.25% v/v NIS + 4.0 pt/A UAN
[3] 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 Aggressor™ herbicide for the control of cereal rye in the CoAXium™ wheat production system

Henry Wetzel and Drew Lyon

The CoAXium™ wheat production system was recently developed by the Colorado Wheat Research Foundation, Inc., Limagrain Cereal Seeds, LLC and Albaugh, LLC. AXigen™ is the non-GMO trait in wheat that confers tolerance to the ACCase inhibitor (Group 1) herbicide Aggressor™ (quizalofop-P-ethyl). The AXigen trait will be made available to both private and public breeders and was one of the reasons we were interested in evaluating the system. Aggressor is labelled to control annual grassy weeds, such as downy brome, jointed goatgrass and feral rye that are problematic in the low to intermediate rainfall zones of eastern WA.

An area on the Cook Agronomy Farm, where previous research trials on feral rye control occurred, was selected for this trial. Since the area was previously in winter wheat, the remaining residue was burnt on September 28, 2017. On October 17th, the trial area was direct-seeded with a John Deere 9400 hoe drill with openers on a 7-inch spacing and a planting depth of 2.0 inches. The area was seeded at the rate of 120 lb/A, 107 lbs CoAxium winter wheat plus 13 lbs cereal rye. The ground was fertilized with 100 lb N per acre from dry urea on March 21, 2018. The soil at this site is a Palouse silt loam with 4.2% organic matter and a pH of 5.0. Early postemergence treatments were applied on April 11th. The applications were made with winds out of the east at 5 mph, air temperature of 56°F and relative humidity of 38%. At the time of application, wheat was at the 2-tiller stage and was 7 inches tall. Cereal rye had one node and was 14 inches tall, which is larger than the 1- to 4-inch height prescribed on the label. Late postemergence treatments were applied on May 4th. The applications were made with winds out of the east at 5 mph, air temperature of 62°F and relative humidity of 51%. At the time of application, wheat had one node and was 14 inches tall. Cereal rye had 3 nodes and was 22 inches tall. Both applications were made with a CO_2-powered backpack sprayer set to deliver 15 gpa at 47 psi at 2.3 mph.

Due to the late establishment of the CoAXium wheat, as well as the prevailing environmental conditions, fall applications of Aggressor did not occur. The Aggressor label only allows applications to be made on 1- to 4-inch tall cereal rye, hence our applications were made outside the label guidelines. Despite the late applications, early spring applications of Aggressor were highly effective for cereal rye control. There were no significant differences among the three rates evaluated, and no differences seen between NIS and MSO. The late spring application was also highly effective. Only Aggressor treatments applied at 8.0 or 10.0 fl oz/A and tank mixed with 1.0% MSO had a few plants that escaped control. There were no significant differences in yield among the Aggressor treatments and the mean was 86 bu/A. The yield in the nontreated check plots was 85 bu/A with 15% foreign material as cereal rye. Aggressor appears to be highly effective for the control of cereal or feral rye in the high rainfall zone. It will be important to evaluate the CoAXium wheat production system in the intermediate to low rainfall zones to determine its effectiveness under those more stressful environmental conditions.

			Cereal rye control		
Treatment	Rate	Application date	5/23	6/22	Yield
	fl oz/A		--------------------0 to 100%------------------		bu/A
Aggressor + MSO	8.0 + 1.0 % v/v	4/11	100 a[1]	100 a	94 a
Aggressor + MSO	10.0 + 1.0 % v/v	4/11	100 a	100 a	93 a
Aggressor + MSO	12.0 + 1.0 % v/v	4/11	100 a	100 a	84 a
Aggressor + NIS	8.0 + 0.25 % v/v	4/11	99 a	100 a	89 a
Aggressor + NIS	10.0 + 0.25 % v/v	4/11	100 a	100 a	88 a
Aggressor + NIS	12.0 + 0.25 % v/v	4/11	100 a	100 a	94 a
Aggressor + MSO	8.0 + 1.0 % v/v	5/4	88 b	97 c	79 a
Aggressor + NIS	10.0 + 0.25 % v/v	5/4	90 b	100 a	83 a
Aggressor + NIS	12.0 + 0.25 % v/v	5/4	90 b	100 a	76 a
Aggressor + MSO	10.0 + 1.0 % v/v	5/4	85 c	98 b	79 a
Aggressor + MSO + UAN	10.0 + 1.0 % v/v + 3 gal	4/11	100 a	100 a	82 a
Aggressor + NIS + UAN	10.0 + 0.25 % v/v + 3 gal	4/11	100 a	100 a	96 a
Nontreated Check	--	--	--	--	85 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.

Smooth Scouringrush control in no-till winter wheat/fallow at Omak, WA

M. Thorne, D. Whaley and D. Lyon

A multi-year study initiated in June 2017 will examine control of smooth scouringrush in no-till winter wheat/fallow near Omak, WA. The study compares applications of Finesse® (chlorsulfuron plus metsulfuron) or Rhonox® (MCPA) during the fallow phase and Amber® (triasulfuron) or Rhonox during the crop phase. From previous research we know that chlorsulfuron controls smooth scouringrush, but a single application will not maintain control over time. This study compares application of Finesse in one and two fallow years of the rotation. Amber is molecularly similar to chlorsulfuron and is included to determine its activity during the crop phase. Rhonox is a control treatment for broadleaf weeds in both the fallow and crop phases when either Finesse or Amber are not applied. It initially burns down smooth scouringrush stems turning them black but does not control smooth scouringrush over time.

Figure 1. Smooth scouringrush in winter wheat next to winter wheat treated with Finesse on left.

The study site is near Omak, WA on land farmed in a no-till winter wheat/fallow rotation; however, winter canola sometimes replaces winter wheat. Plots measure 10 by 30 ft and are arranged in a randomized complete block design with four replications per treatment. All herbicide treatments are applied with a hand-held spray boom with six TeeJet® XR11002 nozzles on 20-inch spacing and pressurized with a CO_2 backpack at 3 mph. Spray output is 15 gpa at 25 psi.

The first-year treatments were applied June 25, 2017 in the no-till fallow phase (Table 1). Glyphosate had been applied over the entire plot area earlier in the year to control volunteer crop and winter annual weeds. Smooth scouringrush emerged following the glyphosate application and was up to 24 inches high and averaged 242 stems/m^2 by June 25 (Table 2). Winter wheat was seeded in November and emerged late due to dry soil conditions. Spring herbicide treatments in the wheat crop were applied April 25, 2018 when the wheat was 6 to 9 inches high and had 1 tiller. This application coincided with the grower's herbicide application to the surrounding field. Smooth scouringrush had not yet emerged by this date.

Table 1. Application and soil data.

Application date	June 25, 2017	April 25, 2018
Growth stage, smooth scouringrush	stems with strobili	not emerged
Growth stage, wheat	n/a	6 to 9 leaves, 1 tiller
Air temperature	85	76
Relative humidity (%)	23	24
Wind (mph, direction)	0-3, NW	2-4, N
Cloud cover (%)	70	0
Soil temperature at 6 inches (F)	86	65
Soil texture	sandy loam	
Soil pH (0-6 inches)	5.7 to 6.3	

Smooth scouringrush stems were initially counted in four ¼ m^2 quadrats per plot on June 25, 2017. Four quadrats were counted per plot in the first census to better measure variability across the study site. In the following censuses, stem density was counted in two ¼ m^2 quadrats placed several paces in from the end of each plot, which is consistent with previous work done with this species. Smooth scouringrush density was counted May 25, 2018 when the wheat crop was heading and again on August 13, 2018 just prior to crop harvest. All plots were harvested with a Wintersteiger plot combine. Grain samples were bagged, cleaned, weighed, and subsampled for grain moisture. Grain weight was converted to bu/A on a 12% moisture basis.

Figure 2. Smooth scouringrush stem with spore-producing strobili.

As of the August 2018 census, the 2017 application of Finesse had maintained near 100% control of smooth scouringrush. Due to near complete control with Finesse, it was not yet evident if Amber added to the overall control. Smooth scouringrush density was zero in all 2017 Finesse-treated plots at the May 25 census (Table 2). By the August 13 census, a few plants were counted in several of the Finesse-treated plots but these counts did not correlate with any specific treatment. The Rhonox-only treated plots averaged 254 stems/m^2 on August 13, which was similar to the initial density of 234 stems/m^2 in 2017. This is further evidence that Rhonox does not control smooth scouringrush over time. Wheat yield from the 2018 harvest was not different between any of the treatments (Table 2), which is interesting given the high density of smooth scouringrush in the Rhonox-only plots compared with the Finesse-treated plots.

In 2019, only three treatments will include Finesse, therefore, the 2020 censuses will assess the efficacy of the single Finesse treatment applied in 2017. Final assessments will be made in 2021.

Table 2. Scouringrush control in wheat/fallow with Finesse – Omak, WA

Herbicide application timing[1]				Scouringrush density[2]			
Fallow 2017	Crop 2018	Fallow 2019	Crop 2020	Summer 6-25-17	Spring 5-25-18	Summer 8-13-18	Wheat Yield
				-----------(stems/m^2)-----------			(bu/A)
Finesse	Amber	Finesse	Amber	259 a	0 b	0.2 b	27 a
Finesse	Amber	Finesse	Rhonox	201 a	0 b	0 b	28 a
Finesse	Amber	Rhonox	Rhonox	261 a	0 b	0 b	32 a
Finesse	Rhonox	Rhonox	Rhonox	227 a	0 b	0 b	26 a
Finesse	Rhonox	Finesse	Rhonox	271 a	0 b	0.1 b	28 a
Rhonox	Rhonox	Rhonox	Rhonox	234 a	111 a	254 a	32 a

[1] Finesse (chlorsulfuron/metsulfuron) applied at 0.5 oz/A with 0.33% NIS surfactant.
Amber (triasulfuron) applied at 0.56 oz/A with 0.33% NIS surfactant.
Rhonox (MCPA) applied at 34.6 oz/A in fallow and 24 oz/A in crop.
Fallow treatments in 2017 were applied June 28, 2017.
Crop treatments in 2018 were applied May 25, 2018.

[2] Values in each column followed by the same letter are not different (α=0.05).

2017 Hail Damage Studies

Zuger, R.J. & I.C. Burke

The objective of the study was to evaluate the effects of hail damage at different wheat stages on yield and end quality. This study was repeated in 2018 and will be repeated a third time in 2019.

Five studies were established around the PNW in four different wheat varieties; two soft white winter wheat Puma studies, one winter club Cara study, one soft white spring Seahawk study, and one hard red winter wheat study. Treatments were applied by hand at specific wheat stages to both below and above flag leaves (FL), detailed in Table 1 through 5. Each study was conducted in a randomized complete block with 4 replications with plots 5' by 10' long plots. All studies were harvested in August by hand cutting wheat heads from a 1-meter quadrant in each plot. The Central Ferry soft white winter wheat studies was the only exception and was harvested in mid-July. Heads were sorted between broken and nonbroken stems in the field and placed in separate bags to make subsamples and then counted in the lab. Head count data for the soft white winter wheat were square-root transformed. Tillers without heads or absent heads were counted in the field and added to the total number of tillers. Broken and nonbroken sub-samples weighs were combined to calculate yield. One hundred seeds were randomly selected from each sub-sample and weighed, and protein content and falling numbers were determined by the WSU Wheat Quality Lab. All data were subjected to an analysis of variance using the statistical package built into the Agricultural Research Manager software system (ARM 8.5.0, Gylling Data Management).

Broken head counts were the majority of the harvested heads in most treatments. Watery ripe, milk, soft dough, and hard dough stages had mostly broken heads. The above flag leaf treatments commonly had less broken heads than the below flag leaf treatments within a wheat stage. Stems of plants treated at the boot stage and the anthesis stage recovered with all varieties, except the winter club, having more nonbroken heads than broken. Treatments at anthesis resulted in 50/50 broken and nonbroken heads for most varieties, except the soft white winter wheat, one study had more nonbroken heads and the other had more broken heads.

There were no differences total number of tillers for any treatment and any variety.

Overall, below leaf flag treatments applied at anthesis and watery ripe stages caused yield loss compared to the nontreated control. Soft white winter wheat study 1 had the lower yields for anthesis below flag leaf, watery ripe below flag leaf, and milk above flag leaf treatments than the nontreated control and all other treatments. For study 2, watery ripe below flag leaf was the only treatment to cause yields lower then the nontreated. No other treatment had a significant effect on yield for the soft white winter wheat. Similar results were found for the hard red winter wheat with lower yields for anthesis and watery ripe applied below flag leaf with no other treatment causing a significant lose in yield. There was no difference in yield for the club winter wheat and soft white spring wheat.

For 100 seed weight, overall either treatment applied at watery ripe or milk stage caused a reduction in 100 seed weight for the broken heads for all varieties. The winter club resulted a reduction in 100 seed weight of broken heads for all treatments. There was no difference in 100 seed weight of nonbroken heads for any variety except the winter club wheat which had a reduced weight for both milk treatments and the above flag leaf soft dough and hard dough treatments.

Protein content for the broken heads significantly reduced for the soft white winter wheat, hard red winter wheat, and the winter club wheat as the hail damage was applied at later stages. The nonbroken heads for the soft white winter wheat had no difference in protein content, and the nontreated control on the lowest protein content for the hard red winter wheat and winter club wheat. There was no difference in protein content for either the broken or nonbroken heads for the soft white spring wheat.

There was no effect on falling number for any variety except the hard red winter wheat which had lower falling number as treatments were applied at later stages.

Table 1 (ICB2217). *Soft white winter wheat total number of heads, total number of tillers, yield, 100 seed weight, protein content, and falling numbers following hail damage treatments. All treatments were applied by hand at wheat stage indicated in treatment timing. FL = flag leaf. Pullman, WA, 2017. Means followed by the same letter are not statistically significantly different (α=0.05).*

Soft White Winter Wheat (Pullman, WA) – ICB2217												
Trt Timing *Wheat Stage*	Application Date	Application Description	*Head Counts*		*Tillers*	*Yield*	*100 Seed Weight*		*Protein Content*		*Falling Number*	
			Broken	Nonbroken	Total	Total	Broken	Nonbroken	Broken	Nonbroken	Broken	Nonbroken
			#/m²	#/m²	#/m²	bu/A	g	g	%	%	#	#
Nontreated	-	-	10 f	680 a	700 ab	149 ab	3.76 ab	3.67	-	9.33	-	462 a
Boot	June 7	Below FL	70 e	600 ab	680 ab	152 a	3.54 ab	3.76	10.15 abcd	10.20	483	462 a
Anthesis	June 16	Below FL	430 abc	120 d	580 b	107 d	3.77 ab	3.89	10.85 ab	9.60	433	382 b
		Above FL	160 d	460 b	630 ab	125 abcd	3.74 ab	3.63	11.40 abc	9.70	430	470 a
Watery ripe	June 28	Below FL	620 a	50 e	670 ab	114 cd	3.10 cd	3.95	11.13 a	-	415	-
		Above FL	530 ab	220 cd	750 a	130 abcd	3.01 d	3.71	11.00 ab	10.20	436	453 a
Milk	July 5	Below FL	610 a	50 e	660 ab	132 abcd	3.48 bc	3.85	9.65 bcd	-	423	-
		Above FL	400 bc	200 cd	610 ab	118 bcd	3.49 bc	3.84	9.93 abcd	9.93	438	471 a
Soft dough	July 13	Below FL	590 ab	40 e	620 ab	141 abc	3.81 ab	3.75	8.98 d	-	440	-
		Above FL	330 c	310 c	640 ab	141 abc	3.70 ab	3.67	8.98 d	9.50	435	437 a
Hard dough	July 24	Below FL	550 ab	10 e	570 b	135 abcd	4.06 a	3.80	9.35 cd	-	445	-
		Above FL	470 abc	190 cd	670 ab	143 abc	3.72 ab	3.79	8.78 d	9.13	455	451 a
		LSD	*2.92t*	*3.14t*	*99.97*	*20.69*	*0.33*	*NS*	*0.92*	*NS*	*NS*	*29.81*

Table 2 (ICB2317). *Hard red winter wheat total number of heads, total number of tillers, yield, 100 seed weight, protein content, and falling numbers following hail damage treatments. All treatments were applied by hand at wheat stage indicated in treatment timing. FL = flag leaf. Davenport, WA, 2017. Means followed by the same letter are not statistically significantly different (α=0.05).*

Hard Red Winter Wheat (Davenport, WA) – ICB2317												
Trt Timing *Wheat Stage*	Application Date	Application Description	*Head Counts*		*Tillers*	*Yield*	*100 Seed Weight*		*Protein Content*		*Falling Number*	
			Broken	Nonbroken	Total	Total	Broken	Nonbroken	Broken	Nonbroken	Broken	Nonbroken
			#/m²	#/m²	#/m²	bu/A	g	g	%	%	#	#
Nontreated	-	-	4 c	570 a	570	154 a	4.45	3.89	-	11.3 b	-	538 ab
Boot	June 6	Below FL	70 c	470 b	540	127 abc	4.50	3.94	15.0 a	11.7 ab	682 a	558 ab
Anthesis	June 13	Below FL	250 b	150 d	400	84 c	4.33	4.10	13.3 b	12.6 ab	715 a	594 a
		Above FL	190 b	360 c	550	137 abc	4.40	3.87	11.6 bcd	12.0 ab	556 b	540 ab
Watery ripe	June 27	Below FL	420 a	20 f	450	102 bc	3.73	3.71	12.4 bc	-	543 b	-
		Above FL	420 a	110 de	530	127 abc	3.70	3.95	12.5 bc	13.6 a	471 b	491 b
Milk	July 7	Below FL	480 a	10 f	490	134 ab	3.91	3.90	11.5 cd	-	543 b	-
		Above FL	450 a	100 de	550	137 ab	3.83	3.82	11.3 cd	12.4 ab	535 b	581 a
Soft dough	July 11	Below FL	440 a	40 ef	480	127 abc	4.03	4.01	11.3 cd	-	551 b	-
		Above FL	460 a	70 ef	530	131 ab	3.83	3.95	11.3 cd	-	546 b	-
Hard dough	July 25	Below FL	450 a	10 f	460	124 abc	3.99	3.60	11.4 cd	-	551 b	-
		Above FL	460 a	40 ef	500	135 ab	4.05	3.90	10.6 d	-	495 b	-
		LSD	*113.96*	*51.53*	*NS*	*28.94*	*NS*	*NS*	*1.03*	*1.27*	*80.55*	*56.65*

Table 3 (ICB2417). *Soft white spring wheat total number of heads, total number of tillers, yield, 100 seed weight, protein content, and falling numbers following hail damage treatments. All treatments were applied by hand at wheat stage indicated in treatment timing. FL = flag leaf. Pullman, WA, 2017. Means followed by the same letter are not statistically significantly different (α=0.05).*

Soft White Spring Wheat (Pullman, WA) – ICB2417												
Trt Timing *Wheat Stage*	Application Date	Application Description	*Head Counts*		*Tillers*	*Yield*	*100 Seed Weight*		*Protein Content*		*Falling Number*	
			Broken	**Nonbroken**	**Total**	**Total**	**Broken**	**Nonbroken**	**Broken**	**Nonbroken**	**Broken**	**Nonbroken**
			#/m²	#/m²	#/m²	bu/A	g	g	%	%	#	#
Nontreated	-	-	0 e	440 a	440	63	-	3.53	-	8.9	-	408
Boot	June 26	Below FL	20 e	450 a	470	57	3.33	3.24	9.0	9.4	424 ab	414
Anthesis	July 5	Below FL	270 c	210 c	480	58	3.07	3.25	9.9	9.4	460 ab	430
		Above FL	190 d	290 b	480	64	3.35	3.40	9.1	9.0	415 ab	420
Watery ripe	July 12	Below FL	410 ab	70 ef	480	52	2.98	3.40	9.9	9.2	476 a	437
		Above FL	310 c	190 cd	500	59	3.08	3.25	9.6	9.5	427 ab	416
Milk	July 17	Below FL	430 a	50 f	480	59	3.03	3.35	10.2	-	446 ab	-
		Above FL	290 c	120 de	410	52	3.42	3.27	8.8	-	399 b	-
Soft dough	July 20	Below FL	400 ab	20 f	420	58	3.43	3.27	8.8	-	429 ab	-
		Above FL	320 bc	130 de	460	60	3.47	3.29	9.0	-	400 b	-
Hard dough	August 2	Below FL	440 a	40 f	480	63	3.45	3.12	9.0	-	426 ab	-
		Above FL	340 bc	150 cd	490	62	3.45	3.08	8.8	-	419 ab	450
		LSD	*68.47*	*57.18*	*NS*	*NS*	*NS*	*NS*	*NS*	*NS*	*43.37*	*NS*

Table 4 (ICB2517). *Winter club wheat total number of heads, total number of tillers, yield, 100 seed weight, protein content, and falling numbers following hail damage treatments. All treatments were applied by hand at wheat stage indicated in treatment timing. FL = flag leaf. Pullman, WA, 2017. Means followed by the same letter are not statistically significantly different (α=0.05).*

Winter Club Wheat (Pullman, WA) – ICB2517												
Trt Timing *Wheat Stage*	Application Date	Application Description	*Head Counts*		*Tillers*	*Yield*	*100 Seed Weight*		*Protein Content*		*Falling Number*	
			Broken	**Nonbroken**	**Total**	**Total**	**Broken**	**Nonbroken**	**Broken**	**Nonbroken**	**Broken**	**Nonbroken**
			#/m²	#/m²	#/m²	bu/A	g	g	%	%	#	#
Nontreated	-	-	1 c	520 a	520	123	3.71 a	3.11 a	-	11.0 b	-	511
Boot	June 6	Below FL	200 b	270 bc	470	100	3.14 b	3.39 a	12.4 ab	11.2 b	517	517
Anthesis	June 13	Below FL	190 b	350 b	540	97	2.75 bcd	2.75 ab	13.6 a	11.5 b	526	513
		Above FL	90 bc	510 a	590	124	3.03 bc	3.17 a	12.3 ab	11.2 b	477	501
Watery ripe	June 27	Below FL	520 a	20 d	540	102	2.64 bcd	3.01 a	12.7 ab	-	464	-
		Above FL	440 a	130 cd	580	111	2.59 cd	2.58 ab	12.5 ab	12.7 ab	507	552
Milk	July 7	Below FL	520 a	60 d	580	98	2.35 d	2.15 b	12.4 ab	-	497	-
		Above FL	450 a	150 cd	600	102	2.44 d	2.18 b	11.8 b	-	518	-
Soft dough	July 18	Below FL	510 a	10 d	520	106	2.75 bcd	2.79 ab	11.6 b	-	529	-
		Above FL	470 a	140 cd	610	113	2.59 cd	2.11 b	11.4 b	13.2 a	528	589
Hard dough	July 25	Below FL	520 a	20 d	540	115	2.78 bcd	2.79 ab	11.3 b	-	508	-
		Above FL	490 a	100 d	590	120	2.73 bcd	2.20 b	11.6 b	-	525	-
		LSD	*113.00*	*109.53*	*NS*	*NS*	*0.34*	*0.53*	*1.02*	*1.25*	*NS*	*NS*

Table 5 (ICB3117). *Soft white winter wheat total number of heads, total number of tillers, yield, 100 seed weight, protein content, and falling numbers following hail damage treatments. All treatments were applied by hand at wheat stage indicated in treatment timing. FL = flag leaf. Central Ferry, WA, 2017. Means followed by the same letter are not statistically significantly different (α=0.05).*

Soft White Winter Wheat (Pullman, WA) – ICB3117													
Trt Timing *Wheat Stage*	Application Date	Application Description	*Head Counts*		*Tillers*	*Yield*	*100 Seed Weight*		*Protein Content*		*Falling Number*	
			Broken	**Nonbroken**	**Total**	**Total**	**Broken**	**Nonbroken**	**Broken**	**Nonbroken**	**Broken**	**Nonbroken**
			$\#/m^2$	$\#/m^2$	$\#/m^2$	bu/A	g	g	%	%	#	#
Nontreated	-	-	0 c	390 a	390	98 a	3.61 bcd	3.73	-	10.2	-	394
Boot	May 10	Below FL	10 c	340 a	350	90 ab	3.86 abc	3.90	-	9.7	-	374
Anthesis	May 18	Below FL	40 b	310 a	360	86 ab	4.31 a	3.83	-	10.4	-	395
		Above FL	10 c	350 a	360	98 a	3.88 abc	3.79	-	9.8	-	375
Watery ripe	June 6	Below FL	350 a	20 cd	380	75 b	3.16 de	3.52	10.8 ab	-	390	-
		Above FL	310 a	70 b	380	77 ab	3.04 e	3.45	11.2 ab	-	387	-
Milk	June 12	Below FL	340 a	10 d	360	81 ab	3.42 bcde	3.44	11.4 a	-	375	-
		Above FL	250 a	90 b	340	76 ab	3.32 cde	3.40	10.6 ab	-	378	-
Soft dough	June 23	Below FL	300 a	20 cd	330	84 ab	4.02 ab	3.60	9.6 ab	-	374	-
		Above FL	240 a	110 b	350	96 ab	4.04 ab	3.68	9.4 b	9.9	351	359
Hard dough	June 29	Below FL	300 a	40 c	360	92 ab	3.95 ab	3.75	9.6 ab	10.2	359	405
		Above FL	230 a	120 b	360	91 ab	3.95 ab	3.67	9.8 ab	-	382	-
		LSD	*2.84t*	*2.00t*	*NS*	*13.28*	*0.39*	*NS*	*1.21*	*NS*	*NS*	*NS*

Evaluation of GoldSky®, OpenSky™, PerfectMatch™, Starane® Flex and tank mix partners for the control of common lambsquarters in 'Seahawk' spring wheat

Henry Wetzel and Drew Lyon

A study was conducted to evaluate Corteva's herbicide premixtures for common lambsquarters control in spring wheat. GoldSky contains florasulam, fluroxpyr and pyroxsulam. OpenSky contains fluroxpyr and pyroxsulam. PerfectMatch contains clopyralid, fluroxpyr and pyroxsulam. Starane Flex contains florasulam and fluroxpyr. Tank mix partners for these products included Quelex® (halauxifen-methyl + florasulam) and 2,4-D ester.

The spring wheat variety 'Seahawk' was seeded at the rate of 90 lb/A with a John Deere drill on a 7-inch row spacing at 1.5 inch depth on April 19th. Soil at this site is a Thatuna silt loam with 3.0% organic matter and a pH of 5.0. On May 24th, treatments were applied with a CO_2-powered backpack sprayer set to deliver 10 gpa at 48 psi at 2.3 mph. Wheat was at the two tiller stage and was 10 inches tall. The air temperature was 79°F, relative humidity was 32% and the wind was out of the west at 4 mph.

There was no significant crop injury observed among any treatments evaluated in this study. Fourteen days after application, OpenSky or PerfectMatch tank mixed with 2,4-D ester were providing the best control of common lambsquarters. One month after application, OpenSky, PerfectMatch or Starane Flex tank mixed with 2,4-D provided excellent control of common lambsquarters. Prior to use, the labels of GoldSky, OpenSky and PerfectMatch should be read carefully if pulse crops are part of your planned rotation.

		Common lambsquarters control		
Treatment	rate	6/7	6/15	6/22
	fl oz/a	-------------------------0 to 100%-------------------------		
Nontreated Check	--	--	--	--
GoldSky[1]	16	64 bc[3]	70 b	73 c
OpenSky[1]	16	65 bc	75 b	84 b
OpenSky + 2,4-D Ester LV[2]	16 + 8	73 a	91 a	100 a
OpenSky + Quelex[1]	16 + 0.75 oz	63 bc	76 b	86 b
PerfectMatch[1]	16	60 c	79 ab	90 b
PerfectMatch + 2,4-D Ester LV[2]	16 + 8	70 ab	89 a	100 a
Starane Flex + 2,4-D Ester LV	13.5 + 8	63 bc	89 a	99 a

[1] Treatment was tank mixed with NIS and AMS (0.5% v/v and 1.52 lb/A)
[2] Treatment was tank mixed with AMS (1.52 lb/A)
[3] 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 WideMatch® for the control of common lambsquarters in spring wheat

Henry Wetzel and Drew Lyon

A study was conducted to evaluate WideMatch (clopyralid + fluroxypyr) plus tank mix partners for broadleaf weed control in spring wheat.

The spring wheat variety Seahawk was seeded at the rate of 90 lb/A with a John Deere drill on a 7-inch row spacing at 1.5 inch depth on April 19th. Soil at this site is a Thatuna silt loam with 3.0% organic matter and a pH of 5.0. On May 24th, treatments were applied with a CO_2-powered backpack sprayer set to deliver 10 gpa at 48 psi at 2.3 mph. Wheat was at the two tiller stage and was 10 inches tall. The air temperature was 79°F, relative humidity was 32% and the wind was out of the west at 4 mph.

There was no significant crop injury observed among any herbicide treatments evaluated in this study. Unfortunately, WideMatch is not labelled for the control of common lambsquarters, but this was the only weed species present in the study area. Huskie was the only treatment that provided excellent control of common lambsquarters 7 and 14 days after application. All herbicide treatments, except WideMatch by itself, provided excellent common lambsquarters control one month after application. Prior to use, the labels of Hat Trick and WideMatch should be read carefully if pulse crops are part of your planned rotation.

		Common lambsquarters control			
Treatment	rate	5/31	6/7	6/15	6/22
	fl oz/a	------------------------------------0 to 100%----------------------------------			
Nontreated Check	--	--	--	--	--
WideMatch + Quelex®[1]	16 + 0.75 oz	55 bc[3]	65 de	80 b	95 a
WideMatch + Harmony® + Express®[1]	16 + 0.2 oz + 0.2 oz	60 b	78 bc	89 ab	99 a
WideMatch + Harmony[1]	16 + 0.48 oz	60 b	85 b	88 ab	100 a
WideMatch	16	50 c	58 e	68 c	81 b
Starane® Flex + 2,4-D Ester LV	13.5 + 8	63 b	71 cd	90 ab	100 a
Huskie®[2]	13.5	99 a	100 a	99 a	100 a
Hat Trick®	24	60 b	79 b	95 a	100 a

[1] Treatment was tank mixed with NIS and AMS (0.5% v/v and 1.52 lb/A)

[2] Treatment was tank mixed with AMS (1.52 lb/A)

[3] 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.

Volunteer buckwheat control in irrigated spring wheat – year three

Mark Thorne, Henry Wetzel, Jacob Fischer, Drew Lyon and Tim Waters

Volunteer buckwheat (*Fagopyrum esculentum* Moench) contamination in wheat is a problem for export markets where allergies to buckwheat are a serious health risk. In some areas of the Columbia Basin, buckwheat grown as a crop is followed by spring wheat the next year. Buckwheat germinating from the seed bank can infest the wheat crop and produce seed that will contaminate the grain (Figure 1).

Figure 1. Volunteer buckwheat seeds in spring wheat.

An herbicide trial in 2018 compared early postemergence (EPOST) and late postemergence (LPOST) treatments for control of volunteer buckwheat in spring wheat. The study site was a center-pivot irrigated field near Pasco, WA farmed by WSU Franklin County Extension for agricultural research. Buckwheat seeds were broadcasted at a rate of 50 lb/A over the whole plot area on March 7, 2018 and then incorporated into the soil with a disked harrow to a maximum depth of six inches. The plot area was seeded with hard-red spring wheat (variety not know) at 180 lb/A with a John Deere® Van Brunt drill with double-disc openers on 7 ½ inch spacing.

The EPOST treatments were broadcast-applied when the wheat was beginning to tiller and the buckwheat seedlings were still mostly in the cotyledon stage (Table 1). Volunteer buckwheat density averaged 24 seedlings/m^2. The EPOST treatments were applied on April 20, 2018 with a CO_2 pressurized backpack sprayer and 10-foot spray boom at 3 mph. Application rate was 15 gpa at 25 psi. The LPOST treatments were chemigation-applied on May 11 when the wheat was still in the boot stage and the buckwheat ranged from cotyledon up to seedlings with three leaves. Only the non-treated check plots had larger buckwheat plants with three leaves. The LPOST treatments were applied with a tractor-pulled applicator that simulated center-pivot chemigation. Herbicides were metered into a stream of water flowing into an 11.7-foot spray boom with HH Fulljet nozzles. Volume output was 2774 gpa at 66 psi and moving 1 mph to simulate a 0.1-inch irrigation rate.

Table 1. Application and soil data.

Application timing	Early postemergence	Late postemergence
Application date	April 20, 2018	May 11, 2018
Growth stage, volunteer buckwheat	cotyledon to 1 leaf	cotyledon to 3 leaves
Growth stage, wheat	4 leaves to 1 tiller	1 to 2 tillers, boot stage
Air temperature	71	64
Relative humidity (%)	28	47
Wind (mph, direction)	2 to 4, WSW	3 to 6, SE
Cloud cover (%)	0	50
Soil temperature at 3 inches (F)	82	68
Soil texture	Quincy loamy fine sand	
Soil pH (0-12 inches)	7.9	

The EPOST treatments were applied to all plots except the non-treated checks and included either Huskie® at 13.5 oz/A or GoldSky® at 16 oz/A (Table 2). Applications of Huskie included ammonium sulfate at 1 lb/A as a spray adjuvant. The GoldSky applications included non-ionic surfactant R-11® at 0.5% v/v. The LPOST treatments included Brox 2EC®, Maestro Advanced®, or Starane NXT® and were applied only to plots that had been previously treated with the EPOST herbicides. The non-treated check plots were not treated with any herbicide but were hand weeded to remove all other weeds except the volunteer buckwheat.

Table 2. Early postemergence (EPOST) and late post emergence (LPOST) herbicides applied for control of volunteer buckwheat in irrigated spring wheat.

Trade name	Chemical name	Application	Rate applied
			(fl oz/A)
EPOST treatments			
Huskie	pyrasulfotole/bromoxynil	broadcast	13.5
GoldSky	florasulam/fluroxypyr/pyroxsulam	broadcast	16
LPOST treatments			
Brox 2EC	bromoxynil	chemigation	32
Maestro Advanced	bromoxynil/MCPA	chemigation	25.6
Starane NXT	bromoxynil/fluroxypyr	chemigation	27.4

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Treatment efficacy was assessed by counting buckwheat plants that were flowering or had produced seeds in each of two 1 m^2 quadrats placed in each plot at the beginning of the trial. By May 11, three weeks after the EPOST applications, no buckwheat had yet flowered in any of the EPOST-treated plots, but were stunted or had emerged since the EPOST applications. The non-treated check plots averaged 3.6 flowering plants (Table 3). By the June 1 census, flowering plants were only found in the non-treated check and the EPOST-only plots. GoldSky-only plots average 1.9 plants/m^2, Huskie-only plots averaged 4.4 plant/m^2, and the non-treated check plots averaged 17.8 plants/m^2 (Table 3). By the June 19 harvest census, none of the treatments had maintained 100% control. The treatments with the highest number of plants that had flowered or had produced seeds were Huskie only or GoldSky only and were not different from the non-treated check or GoldSky followed by Maestro Advanced (Table 3). It is not exactly clear why the number of flowered plants in the non-treated checks declined by the June 19 census. Competition from the wheat crop or predation by either rodents or rabbits may have been contributing factors.

Table 3. Volunteer buckwheat control in irrigated spring wheat.

Herbicide treatments[1]		Buckwheat plants with flowers or seeds: May 11[2]	June 1[3]	June 19[4]	Buckwheat contamination
(EPOST)	(LPOST)	-------(flowering plants/m^2)--------			(seeds/kg wheat)
Huskie		0 b	4.4 b	4.1 a	12.3 abc
Huskie	Brox 2EC	0 b	0 d	0.9 bcd	7.3 de
Huskie	Maestro Advanced	0 b	0 d	1.1 bcd	7.0 e
Huskie	Starane NXT	0 b	0 d	0.3 d	6.1 e
GoldSky		0 b	1.9 c	3.6 ab	19.6 ab
GoldSk	Brox 2 EC	0 b	0 d	0.6 cd	14.0 bc
GoldSky	Maestro Advanced	0 b	0 d	1.9 abc	13.1 c
GoldSky	Starane NXT	0 b	0 d	0.9 cd	11.7 cd
Non-treated check		3.6 a	17.8 a	2.9 abc	22.7 a

[1] Means in each column followed by the same letter are not different from each other (α=0.05).
[2] May 11 census was three weeks after EPOST applications.
[3] June 1 census was three weeks after the LPOST applications.
[4] June 19 census was just prior to crop harvest.

At the end of the trial, all plots were harvested with a Wintersteiger plot combine with a 5-ft header. Wheat harvested in each plot was individually bagged to determine yield and buckwheat seed contamination. There was no difference in yield between the treatments, which averaged 96 bu/A. The number of buckwheat seeds per kg of wheat was greatest with the non-treated check and the GoldSky-alone treatments. The Huskie EPOST treatments followed by any of the LPOST treatments resulted in the lowest buckwheat seed contamination averaging between 6 and 7.3 seeds/kg of wheat. The GoldSky treatments followed by a LPOST treatment averaged between 11.7 and 14.0 seeds/kg of wheat but were less than the non-treated check, which averaged 22.7 seeds/kg of wheat. Either Huskie or GoldSky not followed by a LPOST treatment were not different from the non-treated check.

Competition from the wheat crop was also a factor in this trial. Replicates (a block containing all treatments) one and two were in a bottom of a slight draw that traversed the field, consequently they had higher yields compared with replicates three and four, which were upslope (Figure 2). The higher yields in replicates 1 and 2 corresponded to much lower buckwheat contamination, as well.

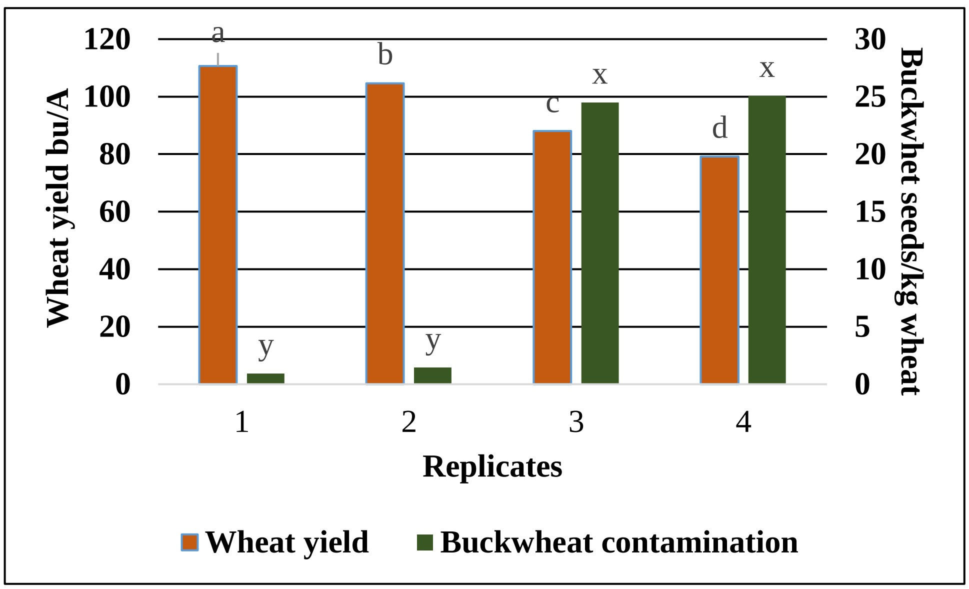


Figure 2. Relationship between wheat yield and buckwheat contamination in each replicate of the trial. Wheat yield columns with the same letter (a-d) are not different. Buckwheat columns with the same letter (x,y) are not different.

The results of this trial suggest a competitive crop is the first line of defense against volunteer buckwheat contamination in irrigated spring wheat. Relying only on a single herbicide application is not likely a good strategy; however, effective control up until harvest is a challenge, even with a follow-up herbicide application at boot stage. It is not exactly clear why the LPOST treatments following GoldSky were not as effect as the LPOST treatments following Huskie. It is possible that Huskie caused greater injury than GoldSky to the earlier establishing buckwheat plants. Weakened plants combined with crop completion may have aided the LPOST treatments in reducing the number of buckwheat seeds produced.

Rush skeletonweed control in winter wheat fallow.

Mark Thorne, Jacob Fischer and Drew Lyon.

Rush skeletonweed (*Chondrilla juncea* L.) established on thousands of acres of rangeland in eastern Washington during the mid-1900s, and then spread into adjacent farmland after the land was enrolled in the Conservation Reserve Program (CRP). When CRP contracts expired, the land was returned to winter wheat production, but the rush skeletonweed persisted. Soil moisture is depleted by rush skeletonweed in the fallow phase of the winter wheat/fallow rotation, which results in poor winter wheat establishment in the fall and reduced yields at harvest.

Rush skeletonweed rosette 4 weeks after autumn Stinger application.

An herbicide trial was initiated near LaCrosse, WA in October 2017 to evaluate fall-, spring-, and summer-applied herbicides for control of rush skeletonweed in the fallow phase of winter wheat/fallow rotation. The study area produced spring wheat in 2017 and the stubble remained standing through the fall and winter. The initial rush skeletonweed density averaged 6 plants/yd^2. By October 2017, most plants had bolted during the summer and the flowering stems were still present; however, some plants consisted of only rosettes. The 2017 spring wheat crop followed winter wheat in 2016, therefore, soil moisture was depleted and signs of drought, including dull leaf color and few leaves were visible on the rush skeletonweed plants at the fall application. During the 2018 fallow period, the plot area was cross cultivated, fertilized, and rod-weeded in late spring, and then rod-weeded in August prior to winter wheat seeding on September 1.

Plots measured 10 by 30 ft and were arranged in a randomized complete block design with four replications per treatment. Herbicides were applied with a hand-held spray boom with six TeeJet® XR11002 nozzles on 20-inch spacing and pressurized with a CO_2 backpack at 3 mph. Spray output was 15 gpa at 25 psi. Fall treatments were applied October 9, 2017, 7 days after the first frost. Spring treatments were applied on April 9, 2018 to coincide with normal spring fallow aid-to-tillage herbicide applications. Summer treatments were applied June 26, 2018 when rush skeletonweed plants were bolting (Table 1). Herbicide efficacy was assessed by counting all rush skeletonweed plants in a 6.5 by 28 ft strip through the middle of each 10 by 30 ft plot at several times throughout the year.

Table 1. Application and soil data.

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

Rush skeletonweed density at the time of the fall applications averaged 84 plants/plot and ranged from 66 to 97 plants/plot. By the following spring, all fall-applied treatments had substantially reduced rush skeletonweed density. At the April 25, 2018 census, rush skeletonweed were not yet present in plots treated with Stinger®, Milestone®, Curtail® at 64 oz/A, or Tordon® (Table 2). Plots treated with Curtail + Finesse® averaged 0.3 plants/plot and RT 3® + 2,4-D LV6® treated plots averaged 2.5 plants/plot, but these densities were not different from zero.

Spring applications on April 9, 2018 included a 24 oz/A application of RT 3 to all fall-applied treatments and the glyphosate check plots. This application was to control volunteer crop and winter annual weeds that had emerged through the winter. Spring-applied treatments of Stinger and Milestone were tank mixed with RT 3 at the 24 oz/A rate to combine the normal spring aid-to-tillage application with treatments for rush skeletonweed control during the fallow phase. Fallow tillage operations followed the spring herbicide applications during May and early June. The May/June tillage would have eliminated all above-ground plant material. Regrowth occurred in all plots, except those treated with Tordon, by the June 21 census; however, there were no differences between the fall-applied treatments except for fall-applied RT 3 + 2,4-D, which averaged 13 plants/plot and was not different from the glyphosate check, which averaged 23 plants/plot (Table 2). The greatest amount of regrowth occurred with spring-applied Stinger + RT 3, spring-applied Milestone + RT 3, fall- and spring-applied RT 3, and the glyphosate check.

On June 26, 2,4-D LV6 was applied to plots previously treated with Stinger, Milestone, and RT 3 (Table 2). This was intended as a rescue treatment for re-establishing rush skeletonweed beginning to bolt. At the mid-summer census on August 2, it was evident that the 2,4-D LV6 treatment only slightly checked an increasing density in the Milestone fall-treated plots, but it did not benefit fall-applied Stinger plots, which were already relatively low in density (Table 2). At the August 2 census, fall-applied Tordon was the most effective treatment averaging only 5 plants/plot.

A final census occurred on November 8, after the winter wheat had been seeded and had emerged. Fall treatments that were not different from the glyphosate check included Milestone, Curtail + Finesse, and fall-applied RT 3 + 2,4-D LV6 (Table 2). In previous research, Milestone applied at 1.2 oz/A controlled rush skeletonweed in the winter wheat crop; however, in this trial it had lost control by mid-summer. Milestone is not yet labeled for use in winter wheat or fallow, but the rate used in this trial may be too low for effective fallow control. In addition, the June application of 2,4-D LV6 had not reduced rush skeletonweed density in the Stinger or Milestone treatments where it was included as a rescue treatment (Table 2). Furthermore, spring-applied Stinger + RT 3 or Milestone + RT 3 were not different from the glyphosate check. The lack of rush skeletonweed control with these two treatments is not fully understood. It is not clear if there is potential antagonism between glyphosate and the two synthetic auxins, or if the lack of control is simply a timing issue. This is being researched further.

The best year-long control was with either Tordon or Curtail at the 64 oz/A rate. At the November census, plots with these treatments averaged 11 and 16 plants/plot, respectively (Table 2). A concern with Tordon is reduced yield in the following crop; however, no visible crop injury was observed at this census (data not shown). Yield will be evaluated at crop harvest in 2019. Control with Curtail at 64 oz/A was more effective than Curtail at 32 oz/A + Finesse at 0.4 oz/A, and more effective than the fall-applied Stinger at 10.7 oz/A + summer-applied 2,4-D LV6 (Table 2). The 64 oz/A Curtail treatment applied 0.19 lb ae/A clopyralid + 1.0 lb ae/A 2,4-D while the 10.7 oz/A Stinger treatment applied 0.25 lb ae/A. This would suggest there may be benefit or synergism from the combination of clopyralid and 2,4-D, both being synthetic auxin herbicides.

Glyphosate has been the standard fallow herbicide treatment in this region. In this trial, the aid-to-tillage application of 24 oz/A RT 3 in April controlled winter annual weeds and volunteer growth in the fall-treated plots and the glyphosate check plots. However, from grower communication it was reported that the aid-to-tillage rate does not reduce rush skeletonweed pressure in the fallow. By the August 2 census, density of rush skeletonweed in the glyphosate check plots was 50% greater than either the fall or spring glyphosate treatments of 64 oz/A (Table 2). By the November 8 census, the spring-applied 64 oz/A RT 3 plots still averaged 50% less rush skeletonweed than the glyphosate check. Density in the fall-applied RT 3 plots had increased and was not different from the glyphosate check, and averaged 1.6 times greater density than the spring-applied RT 3 treatment (Table 2). This would suggest that if glyphosate is the primary herbicide used for rush skeletonweed control, a spring high-rate application would give better control through the fallow phase than the fall application

From previous research, we have reported good control of rush skeletonweed with Stinger at 8 oz/A applied either in the fall or spring in the winter wheat crop. The 8 oz/A rate is above the maximum labeled rate of 5.3 oz/A for wheat, but is consistent with rates needed to control many perennial weeds. However, good control during the crop phase does not guarantee control through the following fallow year. This trial finds good, but not complete, control with either Tordon or Curtail, each applied at the maximum labeled rate for fallow. Long-term control will require use of effective herbicides in both the fallow and crop phases.

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

Trt	Herbicide[2]	Rate	Time[3]	Spring 3/29/18	Early Summer 6/21/18	Mid-Summer 8/2/18	Fall 11/8/18
		(oz/A)		------- plants per plot (6.5 by 28 ft)[4] -------			
1	Stinger	10.7	F	0 b	3 d	14 cd	28 cd
	RT 3	24	Sp				
2	Milestone	1.2	F	0 b	9 d	48 a	59 ab
	RT 3	24	Sp				
3	Stinger	10.7	F	0 b	5 d	14 cd	30 c
	RT 3	24	Sp				
	2,4-D	43	Su				
4	Milestone	1.2	F	0 b	7 d	30 b	46 abc
	RT 3	24	Sp				
	2,4-D	43	Su				
5	Curtail	64	F	0 b	5 d	13 d	16 de
	RT 3	24	Sp				
6	Curtail + Finesse	32 + 0.4	F	0.3 b	6 d	23 bc	41 bc
	RT 3	24	Sp				
7	Tordon	16	F	0 b	0 d	5 e	11 e
	RT 3	24	Sp				
8	RT 3 + 2,4-D	64 + 43	F	2.5 b	13 c	25 b	44 bc
	2,4-D	43	Su				
9	Stinger + RT 3	10.7 + 24	Sp	76 a	39 a	64 a	76 a
10	Milestone + RT 3	1.2 + 24	Sp	81 a	21 bc	49 a	69 ab
11	RT 3	64	Sp	75 a	13 bc	21 bcd	28 cd
	2,4-D	43	Su				
12	Glyphosate check[4]	24	Sp	75 a	23 b	54 a	57 ab

[1] Initial spring tillage and fertilization occurred in May/June 2018; Field was rod-weeded August 22, 2018; Field was seeded September 1, 2018

[2] Milestone and Curtail + Finesse treatments included non-ionic surfactant at 0.25% v/v; all RT 3 treatments included ammonium sulfate at 18 lb/gal. Glyphosate check plots were sprayed with an aid-to-tillage rate of glyphosate for control of winter annual weeds and volunteer crop.

[3] Time of application F = October 9, 2017, Sp = April 9, 2018, Su = June 26, 2018.

[4] Numbers in each column followed by the same letter are not statistically different (α=0.05)

Rope wick and broadcast herbicide applications for control of smooth scouringrush in winter wheat fallow

Mark Thorne, Dale Whaley, Derek Appel and Drew Lyon

Figure 1. Smooth scouringrush in no-till fallow.

We compared rope wick applications of RT 3® (glyphosate) with standard broadcast applications of RT 3 and Rhonox® (MCPA) for control of smooth scouringrush in no-till fallow (Figure 1). The advantage of a rope wick application is it places a higher concentration of RT 3 specifically on the target plant; however, broadcast applications have better overall coverage. Applications of glyphosate have not been successful in the past for controlling smooth scouringrush in fallow, but it is not known if the lack of control is because of herbicide concentration or timing of application. However, there is a need for control strategies that do not include long residual herbicides that could reduce yields in future crops.

Treatments were applied May 25, 2018 at a site near Omak, WA, and July 5, 2018 near Reardan, WA (Table 1). Both sites were in no-till fallow with a uniform density of smooth scouringrush stems. Plots measure 10 by 30 ft at Omak and 10 by 40 ft at Reardan. At both sites, plots were arranged in a randomized complete block design with four replications per treatment. Broadcast treatments were applied with a hand-held spray boom with six TeeJet® XR11002 nozzles on 20-inch spacing and pressurized with a CO_2 backpack at 3 mph. Spray output was 15 gpa at 25 psi. Rope wick treatments were applied with a 10-ft by 3-inch wick tube with braided polyester wicking ropes (Rodgers Sales Co. Inc., Lyon, MS) mounted on the front of a four wheeler ATV moving approximately 3 mph (Figure 2). The wick tube was supplied by a 3-gal CO_2 pressurized tank with just enough pressure to keep the ropes saturated and dripping.

Treatment were assessed 45 days after treatment (DAT) at Omak, and 33 DAT at Reardan. At the Omak site, stems were counted in two ¼ m^2 quadrat per plot on July 9, 2018. Stems were counted if green living tissue was visible. An accidental cattle grazing incident removed much of the biomass at this site, so biomass sampling would not have been meaningful. At the Reardan site, living portions of stems were collected in two ¼ m^2 quadrat/plot on August 7, 2018. Excessive branching on the lower portion of the stems made stem counts impractical.

Table 1. Application and soil data

Location	Omak, WA	Reardan, WA
Application date	May 25, 2018	July 5, 2018
Growth stage, smooth scouringrush	stems with strobili	stems, 6 to 20 inches
Crop phase	no-till fallow	no-till fallow
Air temperature	85	79
Relative humidity (%)	23	36
Wind (mph, direction)	4-6, S	3-7, NNE
Cloud cover (%)	60	0
Soil temperature at 6 inches (F)	80	68

At the Omak site, the broadcast RT 3 was the most effective treatment (Table 2). The broadcast RT 3 reduced stem density by 91% compared with the non-treated check and was 3.6 times lower than the rope wick application. However, the rope wick application reduced stem density 68% compared to the non-treated check. At the time of application, some smooth scouringrush stems were lying on the ground, therefore the rope wick did not make contact will all stems. The Rhonox treatment was not different than the non-treated check. This was partially due to a number of stems with incomplete herbicide control having both living and dead tissue but were counted as living stems; however, a number of stems had regrown since the herbicide application.

Figure 2. Rope wick application of RT 3 on smooth scouringrush.

At the Reardan site, a broadcast application of RT 3 + Silwet®, a nonionic organosilicone surfactant, was added to the trial. The RT 3 + Silwet treatment reduced living green biomass by 56% compared to the non-treated check, and was 54% lower in biomass than the RT 3 broadcast treatment without Silwet (Table 2). In contrast to the Omak site, there was no difference between the RT 3 broadcast without Silwet and the non-treated check. The rope wick application only reduced biomass 24% compared with the non-treated check and was not different than the RT 3 broadcast without Silwet. The Rhonox treatment was as effective as RT 3 + Silwet treatment and had reduced smooth scouringrush biomass by 51% (Table 2). Better reported performance by Rhonox at Reardan was likely due to collecting only green living tissue during biomass sampling.

Results from these trials indicate that rope wick applications of RT 3 can reduce smooth scouringrush abundance in fallow, but getting good coverage of RT 3 on all stems may be a limiting factor. At Omak, some of the stems were lying flat on the ground and did not contact the wicking ropes. At Reardan, a thick, dense stand may have limited contact with the ropes, as well. However, rope wicking may be a useful tool in reducing smooth scouringrush abundance where applying a high broadcast rate of RT 3 is not desirable.

The May broadcast application of RT 3 at Omak was more effective compared to the same application in July at Reardan. This may suggest that RT 3 uptake by smooth scouringrush diminishes as the stems mature. Smooth scouringrush stems contain a high amount of silica, which may limit absorption if stems accumulate more silica as they age; however, the addition of Silwet adjuvant at Reardan increased the efficacy of RT 3. Silwet contains an organosilicone compound that may be better suited to increasing RT 3 uptake into the silica-rich stems than the surfactants packaged with RT 3. Maximum yearly application of RT 3 is labeled at 170 oz/A (5.3 qt/A); therefore, a follow-up broadcast treatment of RT 3 could be applied as long as the total amount did not exceed the labeled rate. Both trials will be re-evaluated in 2019 to assess potential long-term efficacy.

Table 2. Smooth scouringrush control comparing rope wick with broadcast herbicide treatments 45 days after treatment (DAT) at Omak, and 33 DAT at Reardan.

		Smooth scouringrush abundance[2]	
Treatment[1]	Rate	Omak Stem density	Reardan Biomass
		(stems/m^2)	(g/m^2)
RT 3 – rope wick	75% v/v	61 b	57 b
RT 3 – broadcast	96 oz/A	17 c	72 ab
RT 3 + Silwet – broadcast	96 oz/A + 0.25%	--	33 c
Rhonox – broadcast	48 oz/A	170 a	38 c
Non-treated check	-	188 a	75 a

[1] Treatments applied May 25, 2018 at Omak and July 5, 2018 at Reardan.
[2] Values in each column followed by the same letter are not different (α=0.05). Omak treatments applied May 25, 2018; Reardan treatments applied July 5, 2018.

Evaluation of Sandea® as a post plant, preemergence herbicide for crop tolerance and weed control in 'Frontier' chickpeas

Henry Wetzel and Drew Lyon

Sandea (halosulfuron-methyl) is in the mechanism of action Group 2, which inhibits acetolactate synthase. Sandea has activity on numerous broadleaf weeds as well as members of the *Cyperus* specie, nutsedge. Sandea is not registered for use in chickpeas in WA. We evaluated Sandea for its safety and broadleaf weed control in chickpeas.

An area at the Cook Agronomy Farm, previously in spring wheat was sprayed with RT 3® (32 fl oz/A) and AMS (12 lb/100 gal) on April 24th. The trial area was prepared for planting with a one pass cultivator/harrow implement on May 18th. On May 20th, '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, preemergence herbicide applications were made on May 21st with a CO_2-powered backpack sprayer set to deliver 10 gpa at 52 psi at 2.3 mph. Winds out of the west at 8 mph, air temperature was 70°F and relative humidity was 48%. The first significant rainfall (0.51 in.) came nineteen days after treatments were applied. The soil at this site is a Thatuna silt loam with 4.0% organic matter and a pH of 5.1.

None of the treatments evaluated caused injury to chickpeas. Sandea was tested at 3 rates, 0.5, 0.75 and 1.0 oz/A. There was not a rate response when evaluating its effectiveness for common lambsquarters or mayweed chamomile control. Sandea did not provide commercially acceptable control of common lambsquarters, but demonstrated good control of mayweed chamomile. Crop yields were not negatively affected by any of the herbicide treatments.

Many mayweed chamomile biotypes have developed resistance to the Group 2 herbicides currently labeled in wheat. Sandea might provide a way to insert a Group 2 herbicide into the rotation for the control of mayweed chamomile, although history would suggest that resistance could develop quickly if Sandea was used too frequently.

		Crop injury	Common lambsquarters control		Mayweed chamomile control	
Treatment	Rate	6/1	7/6	7/20	7/20	Yield
	oz/A	0-100%	---------------0-100%----------------		0-100%	lb/A
Nontreated check	--	--	--	--	--	810 a
Hand-weeded check	--	--	--	--	--	1320 a
Sandea	0.5	0	43 a	30 c[1]	79 a	1000 a
Sandea	0.75	0	54 a	48 bc	89 a	1220 a
Sandea	1.0	0	45 a	35 c	79 a	1340 a
Sandea + TriCor® + Sharpen®	0.5 + 8.0 + 2.0 fl oz	0	85 a	75 ab	88 a	1630 a
Lorox® + TriCor + Sharpen	20.0 + 8.0 + 2.0 fl oz	0	94 a	91 a	93 a	1840 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.

Weed Control and Crop Tolerance to Paraquat Applied At-Cracking to Chickpeas

Zuger, R.J. & I.C. Burke

The objective of the study was to evaluate chickpea crop tolerance to paraquat in a field setting with the addition of a nonionic surfactant and weed efficacy by paraquat. This study was a repeat of previous studies conducted in 2016 and 2017.

The 2018 study was established at the Palouse Conservation Farm near Pullman, WA. Treatments were applied post emergence (POST) at several different timings starting at chickpea cracking, detailed in Table 1 and 2. Each study was conducted in a randomized complete block with 4 replications with 10' by 30' long plots. Studies were planted with chickpea variety 'Billy Bean' on May 2, 2018. Outlook at 21 fl oz A^{-1} and Lorox at 1.5 lb A^{-1} was applied preemergence (PRE) at planting. The entire study was blanket sprayed with RT3 (48 fl oz A^{-1}), NIS (0.25% v/v), and AMS Max (17 lb/100 gal) prior to harvest for burndown.

Crop injury was visually rated 9, 17, 28, and 37 days after crop emergence (DAE). Crop cover was assessed 28 and 37 DAE. Weed control of common lambsquarters was visually assessed 37 DAE. Crop heights were recorded 28 DAE by measuring 3 chickpea plants per plot. Plots were harvested using a plot combine on September 7, 2018. All data were subjected to an analysis of variance using the statistical package built into the Agricultural Research Manager software system (ARM 8.5.0, Gylling Data Management).

Visual crop injury was present after every treatment timing, however, the chickpea plants grow out of it and no crop injury was present 37 DAE (Table 2). At 28 DAE, there was no difference in crop cover. At 37 DAE, there was a reduction in crop cover for application timing B of 89 and 83% compared to 100% for the nontreated. Application B also had the most crop injury 9 DAE (41 & 49%) compared to the other timings, possibly a result of the high cloud cover (80%) at paraquat application (Table 2).

Treatment timing had no effect on plant heights or yield compared to the nontreated control. Although not significant, all treatments had numerically greater yields then the nontreated (Table 2).

Table 1. *Study treatment application details*

Study Application	**A**	**B**	**C**	**D**
Date	May 15, 2018	May 21, 2018	May 22, 2018	May 24, 2018
Timing	At-Cracking	6 DAC	7 DAC	9 DAC
Application volume (GPA)	15	15	15	15
Air temperature (˚F)	66	65	69	71
Soil temperature (˚F)	16	16.5	15	18
Wind velocity (mph, direction)	4, SW	5, NW	5, SE	6, SW
Cloud Cover (%)	73	80	0	50

Table 2. *Percent crop injury, crop cover, plant heights, weed control and yield following applications of paraquat with and without a nonionic surfactant at different application timings in chickpea. Pullman, WA, 2018. DAE = days after crop emergence. Means followed by the same letter are not statistically significantly different (α=0.05).*

Treatment	Application Code	Rate		May 24, 2018 (9 DAE)	June 1, 2018 (17 DAE)	June 12, 2018 (28 DAE)			June 21, 2018 (37 DAE)		July 10, 2018 (56 DAE)	September 20, 2016
				Crop Injury	Crop Injury	Cover	Crop Injury	Plant Ht.	Cover	Crop Injury	Weed Control	Yield
		field rate	lb ai/A	%	%	%	%	cm	%	%	%	lb/A
Nontreated	-	-	-	-	-	-	-	28	-	-	-	1860
Paraquat	A	8 fl oz/A	0.125	1 h	2 d	100	0 c	25	100 a	0	96	1920
Paraquat NIS	A A	8 fl oz/A 0.25 % v/v	0.125	5 fg	3 d	100	0 c	27	100 a	0	100	1990
Paraquat	B	8 fl oz/A	0.125	41 b	14 b	100	8 abc	22	89 b	0	99	2270
Paraquat NIS	B B	8 fl oz/A 0.25 % v/v	0.125	49 a	16 b	97	8 abc	22	83 b	0	96	2080
Paraquat	C	8 fl oz/A	0.125	19 d	6 cd	100	0 c	26	100 a	0	96	2150
Paraquat NIS	C C	8 fl oz/A 0.25 % v/v	0.125	24 c	9 c	100	5 bc	24	96 ab	0	98	2230
Paraquat	D	8 fl oz/A	0.125	0 h	28 a	100	14 a	23	89 b	0	100	2190
Paraquat NIS	D D	8 fl oz/A 0.25 % v/v	0.125	0 h	28 a	100	9 ab	23	97 ab	0	100	1970
Paraquat	A	16 fl oz/A	0.250	3 gh	1 d	99	0 c	26	99 a	0	91	2170
Paraquat NIS	A A	16 fl oz/A 0.25 % v/v	0.250	6 f	1 d	100	0 c	27	100 a	0	95	2030
Sharpen NIS	A A	2 fl oz/A 0.25 % v/v	0.045	10 e	1 d	98	0 c	26	95 ab	0	98	2140
			LSD	*2.92*	*4.29*	*NS*	*4.88*	*NS*	*9.97*	*NS*	*NS*	*NS*

Chickpea and Lentil Seeding Rate Study

Zuger, R.J. & I.C. Burke

Chickpea and lentil seeding rates were investigated for seeding rates that could increase crop stand establishment, time to canopy development and ultimately, weed competitiveness and productivity. Both studies were planted in the spring of 2018 near Pullman, WA, at the Cook Agronomy Farm. For the chickpea study variety 'Billy Bean' was planted May 15, 2018 and for the lentil study variety 'Pardina' as planted May 16, 2018 using a nine row Monosem NG4+ planter with openers spaced 10" and calibrated to deliver seeding rate treatments. Seeding rates are detailed in Table 2 and 3. Each study was conducted in a randomized complete block design with 3 replications, plots were 8' by 75' long. Stand counts were approximately 20 days after planting (DAP) within each plot. Leaf area index (LAI) were evaluated 45 DAP. Lentil plots were harvested on September 5, 2018 and Chickpea plot were harvested on September 7, 2018 using a plot combine. The chickpea study was treated with PRE herbicides (Outlook 21 fl oz A^{-1}, Spartan 4F 8 fl oz A^{-1}, GlyStar 28 fl oz A^{-1}, NIS 0.25% v/v, and AMS Max 10 lb A^{-1}) after seeding. The lentil study was also treated with PRE herbicides (Metribuzin 75DF 0.5 lb A^{-1}, Lorox DF 1.5 lb A^{-1}, Prowl H2O 2 pt A^{-1}, GlyStar 28 fl oz A^{-1}, NIS 0.25% v/v, and AMS Max 10 lb A^{-1}) after seeding. Both studies were blanket sprayed with Roundup PowerMax (48 fl oz A^{-1}), NIS (0.25% v/v), and AMS (l17

lb/100 gal) for preharvest burndown. All data were subjected to an analysis of variance using the statistical package built into the Agricultural Research Manager software system (ARM 8.5.0, Gylling Data Management).

Results

Chickpea

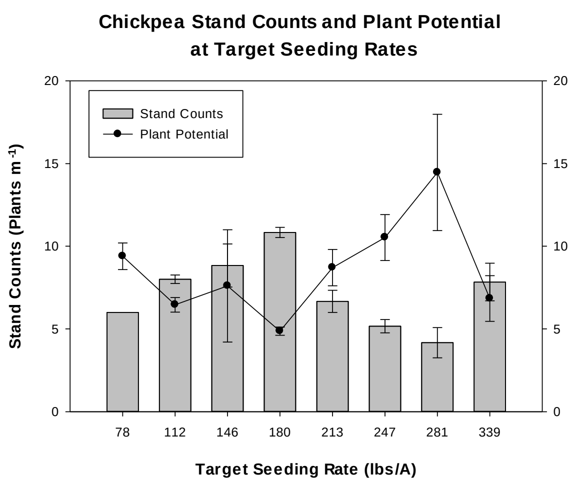
Stand counts increased as the seeding rate increased for treatments 1 through 4, with 20 plants m^{-1} at the 2.3 seed ft^{-1} treatment and 36 plants m^{-1} for the 5.3 seed ft^{-1} seeding rate. However, the higher seeding rates (treatment 5 – 8) were planted using pea plates. There was insufficient vacuum to hold the chickpea seed to the seed plat, causing lower seeding rate being planted then desired (Table 2). There were no differences in leaf area index (LAI) at 45 DAP and yield for any seeding rate (Table 2). Although there was no difference in yield, there was a reduction in yield as seeding rate increased. The lowest seeding rate of 2.3 seed ft^{-1} produced 2080 lb A^{-1} yield and the highest seeding rate produced 1680 lb A^{-1} yield (Table 2).

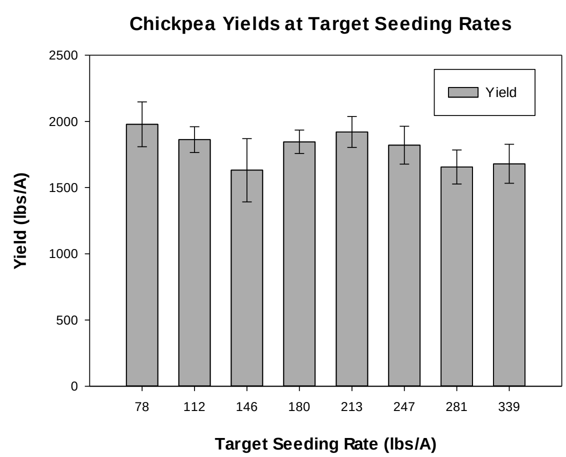
Figure 1. *Chickpeas 20 days after planting (DAP). Left: Lowest seeding rate of 78 lbs A^{-1}. Right: 180 lbs A^{-1} seeding rate.*

Table 2. Stand counts, leaf area index (LAI), and yield for the chickpea seeding rate study (Billy Bean). Pullman, WA, 2018. DAP = days after planting. Means followed by the same letter are not statistically significantly different (α=0.05).

Trt	Seeding Rate			June 4, 2018 (20 DAP) Stand Counts	June 29, 2018 (45 DAP) LAI	September 7, 2018 (115 DAP) Yield
	seed/m	seed/ft	lb/A	*plants/m*	*#*	*lb/A*
1	8	2.3	78	20 cd	1.3	2080
2	11	3.3	112	26 bc	1.1	1960
3	14	4.3	146	30 b	0.8	1720
4	17	5.3	180	36 a	1.3	1850
5	21	6.3	213	23 bcd	1.4	1920
6	24	7.3	247	16 d	1.4	1820
7	27	8.3	281	13 d	1.1	1660
9	33	10	339	26 bc	1.3	1680
			LSD	*6*	*1.12*	*438.50*

Figure 2. *Chickpea stand counts (plants m-1) and plant potential (g Yield plant-1) [left] and yields [right] at target seeding rates.*





Lentils

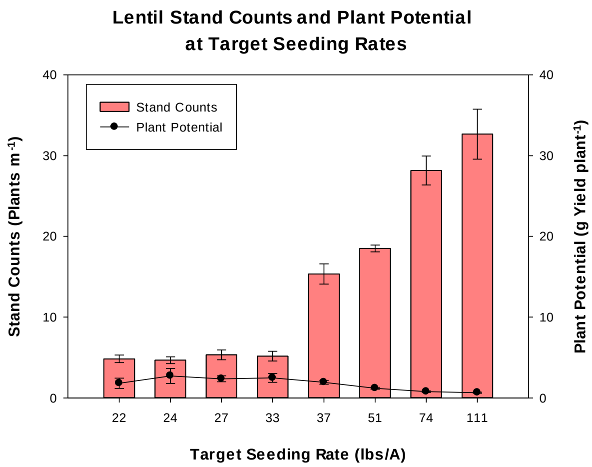
Stand counts at 20 DAP increased as the seeding rate increased. The lowest seeding rate of 4.8 seed ft^{-1} had 5 plant m^{-1}, and the highest seeding rate had 33 plants m^{-1} (Table 3). There were no differences in leaf area index (LAI) for any seeding rate (Table 3). Yield was the greatest for 26 plants m^{-1} seeding rate with 1020 lb A^{-1}. The second greatest yield was 790 lb A^{-1} at the 36 plants m^{-1}. The lowest seeding rate had the lowest yield of 260 lb A^{-1} (Table 3).

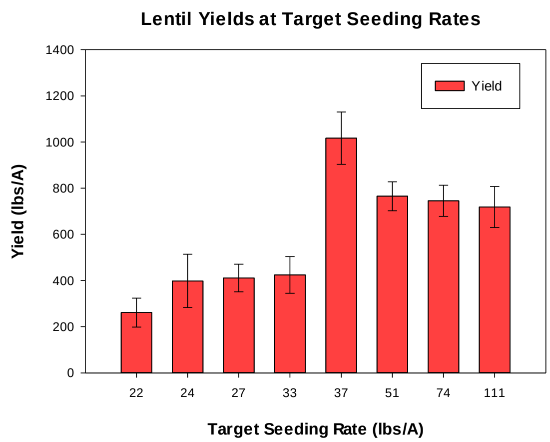
Figure 3. *Lentils 20 days after planting (DAP). Left: Lowest seeding rate of 22 lbs A^{-1}. Right: Highest seeding rate of 111 lbs A^{-1} seeding rate.*

Table 3. *Stand counts, leaf area index (LAI), and yield for the lentil seeding rate study (Pardina). Pullman, WA, 2018. DAP = days after planting. Means followed by the same letter are not statistically significant different (α=0.05).*

				June 4, 2018 (20 DAP)	*June 28, 2018 (45 DAP)*	*September 5, 2018 (112 DAP)*
Trt	**Seeding Rate**			**Stand Counts**	**LAI**	**Yield**
	seed/m	**seed/ft**	**~ lb/A**	***plants/m***	***#***	***lb/A***
1	16	4.8	22	5 a	1.0	260 c
2	17	5.2	24	5 a	1.3	400 bc
3	19	5.8	27	5 a	0.9	410 bc
4	24	7.2	33	5 a	0.9	420 bc
5	26	8.0	37	15 b	1.0	1020 a
6	36	11.1	51	19 b	0.8	790 ab
7	52	16.0	74	28 c	1.0	750 abc
9	79	24.0	111	33 c	0.6	720 abc
			LSD	*5.08*	*0.66*	*322.07*

Figure 4. *Lentil stand counts (plants m-1) and plant potential (g Yield plant-1) [left] and yields [right] at target seeding rates.*





Evaluation of sulfentrazone and pyroxasulfone for crop safety in dry peas

Henry Wetzel and Drew Lyon

Authority® Elite is a premixture of S-metolachlor and sulfentrazone. Anthem® Flex is a premixture of pyroxasulfone and carfentrazone. Anthem Flex is not labelled for use in dry shelled peas. Authority Supreme is a premixture of pyroxasulfone and sulfentrazone. Spartan® Charge is a premixture of carfentrazone and sulfentrazone.

An area at the Cook Agronomy Farm, previously in spring wheat, was sprayed with RT 3® (32 fl oz/A) and AMS (12 lb/100 gal) on April 24th. The trial area was prepared for planting with a one pass cultivator/harrow implement on May 11th. On May 12th, 'Banner' dry peas were planted at a rate of 154 lb/acre at a depth of 1.5 inches using a Monosem vacuum planter with a 10-inch row spacing. The herbicide treatments were applied on May 15th with a CO_2-powered backpack sprayer set to deliver 10 gpa at 46 psi at 2.3 mph. Winds were out of the east at 9 mph, air temperature was 64°F and relative humidity was 45%. Three days after the treatments were applied, the trial area received 0.46 inch of rainfall. The soil at this site is a Palouse silt loam with 3.2% organic matter and a pH of 5.1. The trial area was harvested with a Kincaid 8XP plot combine on August 14th.

Ten days after application, crop injury was minimal and only detected in plots treated with Authority Elite and Authority Supreme. Seventeen days after application, crop injury was not visible in any of the herbicide-treated plots. None of the herbicides affected yield when compared to the nontreated check treatment and the average yield was 1850 lb/A.

Treatment	Rate	Yield
	fl oz/A	lb/A
Nontreated Check	--	1880 a
Authority Supreme	5.8	1850 a
Authority Supreme	7.2	1700 a
Spartan Charge	3.75	1870 a
Authority Elite	25	1820 a
Sharpen®	2	1880 a
Anthem Flex	3.0	1890 a
Anthem Flex	4.5	1780 a
Anthem Flex	9.0	1970 a

Evaluation of Ultra Blazer® for the control of tumble mustard in 'Windham' fall-sown peas

Henry Wetzel and Drew Lyon

Fall-sown peas are emerging as a rotation crop in the intermediate and low rainfall regions of eastern WA. In addition to helping break pest cycles in winter wheat-fallow cropping systems, peas also require less nitrogen input than winter wheat. Although it is generally easier to control grass weeds in peas than in wheat, the control of broadleaf weeds in peas is more difficult. Previous work by Howard Nelson, with Highline Grain Growers Inc., had indicated that Ultra Blazer (acifluorfen), a protox inhibitor (Group 14), provided good postemergence control of tumble mustard in fall-sown peas with acceptable levels of crop injury. The objective of our study was to evaluate Ultra Blazer at two rates (12 and 16 fl oz of product/A) and with various tank mixes for the postemergence control of tumble mustard in fall-sown peas.

The Lind Dryland Research Station was the site chosen for this study and the field was previously in tilled fallow. The soil at this site is a Shano silt loam with 1.1% organic matter and a pH of 6.4. On September 1, 2017, 'Windham' fall-sown peas were seeded at 120 lb/A with a custom built deep furrow drill equipped with a Valmar seed box. Row openers were on a 17-inch spacing and seeds were placed 2 inches into moisture with a total soil cover of 5 to 7 inches. Postemergence treatments were applied on April 4, 2018 with a CO_2-powered backpack sprayer set to deliver 15 gpa at 46 psi at 2.3 mph. The applications were made with winds out of the south at 5 mph, air temperature of 45°F and relative humidity of 54%. At the time of application, the fall-sown peas had 10 to 11 pairs of leaves. Tumble mustard rosettes were 0.5 to 2.0 inches in diameter.

The addition of NIS (0.25% v/v) to Ultra Blazer at either the 12 fl oz or 16 fl oz/A rate caused more early crop injury than applying Ultra Blazer alone. Early crop injury was similar for all treatments containing Ultra Blazer plus NIS. Crop injury was short lived in this study and had disappeared before the plants began to flower. All treatments in this study, except Vulture + COC, provided excellent control of tumble mustard. Ultra Blazer provided similar control at the 12 fl oz and 16 fl oz rates. The addition of NIS to Ultra Blazer did not improve the control of tumble mustard, but did increase crop injury. Ultra Blazer is not currently labeled for use in fall-sown peas, but our results suggest that should the manufacturer decide to label the product, it could provide effective postemergence control of tumble mustard with little risk for crop injury if NIS is not added.

		Crop injury			Tumble mustard control	
Treatment	Rate	4/11	4/20		4/20	5/2
	fl oz/A	-----------------0-100%---------------			-----------------0-100%---------------	
Nontreated Check	--	--	--		--	--
Vulture™ + COC	4.0 + 1.0% v/v	0 a[1]	0 a		55 b	80 b
Rhomene® + Metribuzin 75DF + NIS	12 + 5.33 oz + 0.25% v/v	8 b	5 a		95 a	100 a
Ultra Blazer	12	3 a	0 a		89 a	100 a
Ultra Blazer + NIS	12 + 0.25% v/v	18 de	5 a		91 a	100 a
Ultra Blazer + Metribuzin 75DF + NIS	12 + 5.33 oz + 0.25% v/v	14 cd	3 a		95 a	100 a
Ultra Blazer + Rhomene + NIS	12 + 12 + 0.25% v/v	14 cd	8 a		91 a	100 a
Ultra Blazer	16	1 a	1 a		91 a	100 a
Ultra Blazer + NIS	16 + 0.25% v/v	18 de	8 a		95 a	100 a
Ultra Blazer + Metribuzin 75DF + NIS	16 + 5.33 oz + 0.25% v/v	11 bc	4 a		94 a	100 a
Ultra Blazer + Rhomene + NIS	16 + 12 + 0.25% v/v	19 e	8 a		93 a	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.

Downy brome and tumble mustard control in 'Windham' fall-sown peas

Henry Wetzel and Drew Lyon

Fall-sown peas are emerging as a rotation crop in the intermediate and low rainfall regions of eastern WA. In addition to helping break pest cycles in winter wheat-fallow cropping systems, peas also require less nitrogen input than winter wheat. Although it is generally easier to control grass weeds in peas than in wheat, the control of broadleaf weeds in peas is more difficult. We evaluated Volunteer™ (clethodim), an ACCase inhibitor (Group 1), for crop safety and the control of downy brome. We also evaluated the effect of adding Ultra Blazer® (acifluorfen), a protox inhibitor (Group 14), to Volunteer herbicide on the control of downy brome and tumble mustard, as well as on crop injury to fall-sown peas. Vulture™ (imazamox), an ALS inhibitor (Group 2), was also evaluated as it has activity on broadleaf and grassy weeds.

The Lind Dryland Research Station was the site chosen for this study and the field was previously in tilled fallow. The soil at this site is a Shano silt loam with 1.1% organic matter and a pH of 6.4. On September 1, 2017, 'Windham' fall-sown peas were seeded at 120 lb/A with a custom built deep furrow drill equipped with a Valmar seed box. Row openers were on a 17-inch spacing and seeds were placed 2 inches into moisture with a total soil cover of 5 to 7 inches. Postemergence treatments were applied on April 4, 2018 with a CO_2-powered backpack sprayer set to deliver 15 gpa at 46 psi at 2.3 mph. The applications were made with winds out of the south at 5 mph, air temperature of 50°F and relative humidity of 70%. At the time of application, the winter peas had 9 to 14 pairs of leaves. Tumble mustard rosettes were 0.75 to 2.25 inches in diameter.

The addition of Ultra Blazer to Volunteer resulted in early crop injury, whereas Volunteer applied alone caused little injury. Crop injury was short lived in this study and had mostly disappeared before the plants began to flower. Peas treated with Ultra Blazer + Volunteer appeared to be slightly delayed in their maturity compared to other treatments, but since yield was not taken, we do not know if the delay in their maturity affected yield. Volunteer provided effective control of downy brome and the tank mix with Ultra Blazer did not compromise control. Vulture provided fair to good control of downy brome but it was not as effective as Volunteer. Vulture provided fair to good control of tumble mustard but it was not as effective as the Ultra Blazer plus Volunteer tank mix. Increasing the rate of Ultra Blazer from 12 to 16 fl oz/A did not increase tumble mustard control.

				Downy brome	Tumble mustard
		Crop injury		control	control
Treatment	Rate	4/11	4/20	5/2	5/2
	fl oz/A	-----------------0-100%--------------		0-100%	0-100%
Nontreated Check		--	--	--	--
Volunteer + COC	8.0 + 1.0% v/v	0 a[1]	0 a	94 a	0 d
Vulture + COC	4.0 + 1.0% v/v	0 a	0 a	78 b	75 c
Vulture + Synurgize + COC	4.0 + 2.0 qts/100 gal + 1.0% v/v	0 a	0 a	80 b	81 b
Vulture + COC	5.0 + 1.0% v/v	1 a	0 a	84 b	80 b
Vulture + Synurgize + COC	5.0 + 2.0 qts/100 gal + 1.0% v/v	3 a	1 a	83 b	84 b
Vulture + Volunteer + COC	4.0 + 9.0 + 1.0% v/v	0 a	0 a	94 a	80 b
Ultra Blazer + Volunteer + COC	12.0 + 9.0 + 1.0% v/v	19 b	5 b	94 a	100 a
Ultra Blazer + Volunteer + COC	16.0 + 9.0 + 1.0% v/v	20 b	5 b	93 a	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.

Broadleaf Weed Control with Spartan Applied Preemergence in Winter Peas

Zuger, R.J., & I.C. Burke

The objective of the study was to look at Spartan (sulfentrazone) alone and in combination with other preemergence (PRE) and postemergence (POST) herbicides for effective long-term broadleaf weed control in winter peas. Due to limited POST options for broadleaf weed control in peas and to the long growing season, prolonged activity of soil active herbicides into the spring in winter peas is important for effective broadleaf weed control.

The study was seeded to winter peas, variety Windham, on November 2, 2017 using a Monosem NG4+ singulating planter at the PCFS farm outside Pullman, WA. Treatments were applied either preemergence (PRE) just after seeding or postemergence (POST) to the winter peas, detailed in Table 1 and Table 2. No weeds were present at the timing of the PRE-treatments. The study was arranged in a completely randomized design with 10’ by 35’ long plots. The entire study was blanket sprayed with clethodim 2EC (8 fl oz/A) with COC and UAN for grass weed control on May 16, 2018 (194 DAAT).

Crop emergence was visualy assessed 166 days after treatment of PREs (A) (DAAT). Crop necrosis and crop stunting was assessed at 207 DAAT (7 days after treatment of POSTs (B) (DABT)). Broadleaf weed control was rated at 170 DAAT and 207 DAAT (7 DABT). Peas heights were recorded by measuring the point of three pea plants in each plot at 214 DAAT (14 DABT). Plots were harvested using a plot combine with a 5.74 ft wide header on September 7, 2018. Due to non-normal data, crop emergence data and pest control data was acrsine square-rooted. Data was subjected to an analysis of variance using the statistical package built into the Agricultural Research Manager software system (ARM 8.5.0, Gylling Data Management).

Spartan, Karmex DF, and Dual Magnum + Prowl H2O + Metribuzin had no effect on crop emergence (> 97% 166 DAAT), while, Valor significantly reduced the crop emergence (< 35% 166 DAAT) (Table 2). At 207 DAAT (7 DABT), there was crop stunting present for Valor applied PRE (35 – 39%), Ultra Blazer applied POST (13 – 24 %), and MCPA ester (Rhomene) applied POST (15 – 24%) compared to the nontreated control and all other treatments (< 5% crop stunting) (Table 2). Ultra Blazer caused significant crop necrosis 7 DABT (11 & 19%). All other POST treatments did not cause significant crop necrosis compared to the nontreated (Table 2).

Plant heights were greatest for Spartan + Karmex DF, applied PRE, with 72 cm in height, Valor, applied PRE, had the worst with 49 cm (214 DAAT) (Table 2). There was no significant difference in yield between the nontreated control and all the treatment combination. However, Spartan applied PRE with metribuzin + NIS POST had the greatest yield of 1110 lb A^{-1} and Spartan + Valor had the lowest yield of 380 lb A^{-1}. The nontreated control had 810 lb A^{-1} (Table 2).

Fig 1. Winter peas 79 days after treatment A (DATA). From left to right: Nontreated, Spartan PRE, Spartan + Valor PRE, and Spartan PRE + Metribuzin + NIS POST.

Interestingly, certain plots had serious weed infestations, and the only treatments we were able to harvest all the plots with the plot combine were Spartan + Valor, Spartan + metribuzin + NIS, Spartan +

Ultra Blazer + metribuzin + NIS, and Spartan + Karmex DF (Table 2). These were all treatments with greater than 90% weed control 207 DAAT (7 DAAT) (Table 3). Tough + NIS alone with no PRE, did not provide effective weed control based on percent weed control (26 & 10%), plots harvested (25%), and yield (590 lb A^{-1})

Table 1. *Treatment application details*

Study Application	**A**	**B**	**C**
Date	11/3/2017	5/15/2018	5/22/2018
Application Timing	10:00 AM	2:30 PM	12:15 PM
Application volume (GPA)	15	15	15
Day air temperature (˚F)	37.5	55.7	70
Soil temperature (˚F)	42.8	62.4	61
Wind velocity (mph, direction)	0, SW	0.4, E	4, SE
Next rain occurred on	11/4/2017	5/16/2018	5/24/2018

Table 2. *Plant heights, percentage of plots harvested, and yield, as well as percent emergence, stunting, and leaf necrosis following fall preemergence (PRE) and spring postemergence (POST) applications. Pullman, WA, 2017-2018. DAAT = days after treatment of PRES (A). DABT = days after treatment of POSTS (B). Means followed by the same letter are not statistically significantly different (α=0.05).*

				4/18/18 ***166 DAAT***	***5/29/18*** ***207 DAAT (7 DABT)***		***6/5/2018*** ***214 DAAT***	***9/7/2018***	
Treatment	**Application Timing**	**Rate**		**Emergence**	**Stunting**	**Leaf Necrosis**	**Plant Hts**	**Plots Harvested**	**Yield**
		field rate	**lb ai/A**	**%**	**%**	**%**	**cm**	**%**	**lb/A**
Nontreated	A	-	-	-	-	-	67 abc	50	810 ab
Spartan	A	8 fl oz/A	0.250	97 a	5 c	0 c	63 abc	50	610 ab
Valor	A	2 oz/A	0.064	21 b	39 a	0 c	49 c	75	580 ab
Spartan Valor	A A	8 fl oz/A 2 oz/A	0.250 0.064	35 b	35 a	0 c	54 bc	100	380 b
Spartan Metribuzin NIS	A B B	8 fl oz/A 5 oz/A 0.25% v/v	0.250 0.234	97 a	3 c	3 c	65 abc	100	1110 a
Spartan Ultra Blazer NIS	A B B	8 fl oz/A 12 fl oz/A 0.25% v/v	0.250 0.188	99 a	24 ab	19 a	57 abc	75	560 ab
Spartan Ultra Blazer Metribuzin NIS	A B B B	8 fl oz/A 12 fl oz/A 5 oz/A 0.25% v/v	0.250 0.188 0.234	99 a	13 bc	11 b	57 abc	100	900 ab
Spartan Tough NIS	A B B	8 fl oz/A 8 fl oz/A 0.25% v/v	0.250 0.313	100 a	5 c	0 c	70 ab	75	750 ab
Spartan MCPA ester Metribuzin NIS	A B B B	8 fl oz/A 16 fl oz/A 5 oz/A 0.25% v/v	0.250 0.463 0.234	100 a	24 ab	0 c	53 bc	50	730 ab
MCPA ester Metribuzin NIS	B B B	16 fl oz/A 5 oz/A 0.25% v/v	0.463 0.234	99 a	15 bc	5 c	55 abc	75	630 ab
Spartan Karmex DF	A A	8 fl oz/A 3 lb/A	0.250 1.500	98 a	0 c	0 c	72 a	100	940 ab
Tough NIS	C C	8 fl oz/A 0.25% v/v	0.313	100 a	0 c	1 c	70 ab	25	590 ab
Dual Magnum Prowl H2O Metribuzin	A A A	1.33 pt/A 2.40 pt/A 5 oz/A	1.270 0.990 0.234	100 a	3 c	0 c	65 abc	50	910 ab
			LSD	*12*	*12*	*5*	*11*	*NS*	*350*

Table 3. *Percent broadleaf weed control following fall preemergence (PRE) and spring postemergence (POST) applications. Pullman, WA, 2017-2018. DAAT = days after treatment of PRES (A). DABT = days after treatment of POSTS (B). Means followed by the same letter are not statistically significantly different (α=0.05).*

Treatment	Application Timing	Rate		***May 1, 2018 179 DAAT*** Weed Control	***May 59, 2018 207 DAAT, 7 DAAT*** Weed Control
		field rate	**lb ai/A**	**%**	**%**
Nontreated	A	-	-	-	-
Spartan	A	8 fl oz/A	0.250	86 ab	61 ab
Valor	A	2 oz/A	0.064	96 a	85 a
Spartan Valor	A A	8 fl oz/A 2 oz/A	0.250 0.064	99 a	91 a
Spartan Metribuzin NIS	A B B	8 fl oz/A 5 oz/A 0.25% v/v	0.250 0.234	89 ab	90 a
Spartan Ultra Blazer NIS	A B B	8 fl oz/A 12 fl oz/A 0.25% v/v	0.250 0.188	69 ab	89 a
Spartan Ultra Blazer Metribuzin NIS	A B B B	8 fl oz/A 12 fl oz/A 5 oz/A 0.25% v/v	0.250 0.188 0.234	98 a	94 a
Spartan Tough NIS	A B B	8 fl oz/A 8 fl oz/A 0.25% v/v	0.250 0.313	67 ab	51 ab
Spartan MCPA ester Metribuzin NIS	A B B B	8 fl oz/A 16 fl oz/A 5 oz/A 0.25% v/v	0.250 0.463 0.234	70 ab	70 a
MCPA ester Metribuzin NIS	B B B	16 fl oz/A 5 oz/A 0.25% v/v	0.463 0.234	25 b	40 ab
Spartan Karmex DF	A A	8 fl oz/A 3 lb/A	0.250 1.500	99 a	96 a
Tough NIS	C C	8 fl oz/A 0.25% v/v	0.313	26 b	10 b
Dual Magnum Prowl H2O Metribuzin	A A A	1.33 pt/A 2.40 pt/A 5 oz/A	1.270 0.990 0.234	65 ab	39 ab
			LSD	*40*	*37*

Evaluation of soil incorporation methods for Sonalan® HFP and their effects on safety for use in lentils

Henry Wetzel and Drew Lyon

Sonalan HFP (ethalfluralin) is a Group 3 herbicide that inhibits microtubule formation in sensitive plants. The primary effect on sensitive grass and broadleaves is preemergence control. Sonalan HFP is not registered for use on lentils in WA. This study was to evaluate soil incorporation methods of Sonalan HFP to determine its effect on safety and yield in 'Pardina' lentils.

An area, previously in spring wheat, was selected at the Cook Agronomy Farm and was sprayed with RT 3® (32 fl oz/A) and AMS (12 lb/100 gal) on April 24th. The trial area was prepared for planting with a one pass cultivator/harrow implement on April 30th. Each of the four blocks contained two sets of four plots, nontreated check, hand-weeded check, Sonalan HFP (1.5 pts/A) and Sonalan HFP (2.0 pts/A). Plot size was 10 ft by 35 ft and each plot had a 2 ft border between them to minimize the spread of herbicide between treatments after mechanical incorporation. Within the block, immediately after herbicide application, four of the plots were harrowed (1- to 2- inch depth) and the other four were cultivated (3- to 4- inch depth) and harrowed in the same tillage pass. Sonalan HFP treatments were applied in 10 GPA of spray solution on May 1st. The applications were applied with a CO_2-powered backpack sprayer set to deliver 10 gpa at 51 psi at 2.3 mph. Winds were out of the north at 6 mph, air temperature was 52°F and relative humidity was 62%. Immediately after application, herbicide treatments were incorporated as described above. Soil incorporation occurred at a 45 degree angle to the treatment application. On May 4th, 'Pardina' lentils were planted at a rate of 40 lb/acre at a depth of 1.5 inches using a Monosem vacuum planter with a 10-inch row spacing. Eight days after the treatments were applied, the trial area received 0.33 inch of rainfall. The soil at this site is a Palouse silt loam with 3.1% organic matter and a pH of 5.5. The trial area was harvested with a Zurn plot combine on August 24th. Weed pressure was light and not uniformly distributed. Predominant species included volunteer wheat, Italian ryegrass, mayweed chamomile and common lambsquarters. The type of cultivation did not significantly influence crop injury or yield in 'Pardina' lentils. The initial crop injury, which consisted of reduced stand density and plant stunting, seemed substantial but the plants appeared to have mostly recovered by 6 weeks after application. Although there was not a significant difference between the two rates of Sonalan HFP, likely the result of variability within the plot area, the injury tended to look worst at the higher application rate. Sonalan applied at 2.0 pts/A significantly reduced lentil yield when compared to the nontreated and hand-weeded check treatments.

	Crop injury				
Treatment	5/17	5/25	6/1	6/8	Yield
	---------------------------------------0-100%---------------------------------------				lb/A
Nontreated check	--	--	--	--	1030 a[1]
Hand-weeded check	--	--	--	--	1020 a
Sonalan HFP @ 1.5 pts/A	49 a	11 a	6 a	4 a	920 ab
Sonalan HFP @ 2.0 pts/A	63 a	18 a	16 a	10 a	840 b

[1] Means, based on four replicates, within a column, followed by the same letter are not significantly different at P = 0.10 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 Anthem® Flex for crop tolerance and its effect on yield in 'Pardina' lentils

Henry Wetzel and Drew Lyon

Italian ryegrass is a difficult weed to control due to resistance to Group 1 & 2 herbicides. A preemergence control option would be welcome. In this study we evaluated Anthem Flex (pyroxasulfone + carfentrazone) for crop safety and its effect on yield in 'Pardina' lentils. Pyroxasulfone (Group 15) is the active ingredient in Anthem Flex that has good preemergence activity on Italian ryegrass. Anthem Flex is not labelled for use on lentils in WA.

An area, previously in spring wheat at the Cook Agronomy Farm, was sprayed with RT 3® (32 fl oz/A) and AMS (12 lb/100 gal) on April 24th. The trial area was prepared for planting with a one pass cultivator/harrow implement on April 30th. On May 4th, 'Pardina' lentils were planted at a rate of 40 lb/acre at a depth of 1.5 inches using a Monosem vacuum planter with a 10-inch row spacing. Treatments were applied on May 7th with a CO_2-powered backpack sprayer set to deliver 10 gpa at 52 psi at 2.3 mph. Conditions were calm, air temperature was 60°F and relative humidity was 60%. Two days after the treatments were applied, the trial area received 0.33 inch of rainfall. The soil at this site is a Palouse silt loam with 3.2% organic matter and a pH of 5.1. The trial area was harvested with a Zurn plot combine on August 24th.

Ten days after application, all herbicide treatments had caused some crop injury. Anthem Flex applied at 4.5 or 9.0 fl oz/A caused the most injury, which consisted of plant stunting and reduced plant denisty. Eighteen days after application, plants in those two treatments were still exhibiting the most crop injury. Twenty-five days after application, only plants treated with Anthem Flex applied at 9.0 fl oz/A were still exhibiting injury symptoms. Even though all herbicide treatments showed some initial crop injury, crop yields were not affected. The average yield among all treatments was 1945 lb/A.

		Crop injury				
Treatment	Rate	5/17	5/25	6/1	6/8	Yield
	fl oz/A	--------------------------0-100%--------------------------				lb/A
Nontreated Check	--	--	--	--	--	1960 a
Anthem Flex	2.5	10 a[1]	5 a	1 a	1 a	2050 a
Anthem Flex	4.5	21 b	9 b	1 a	3 a	1880 a
Anthem Flex	9.0	45 c	19 c	11 b	11 b	2020 a
Anthem Flex + TriCor®	3.5 + 7.0 oz	11 a	6 ab	1 a	1 a	1780 a
Dual Magnum® + Prowl® H_20	16 + 32	15 ab	8 ab	0 a	0 a	1980 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.

Precipitation data (September 1, 2017 to August 31, 2018) from AgWeatherNet station Pullman NE, Cook Agronomy Farm East

Date	Precipitation (in.)	Date	Precipitation (in.)	Date	Precipitation (in.)	Date	Precipitation (in.)
9/18/17	0.13	10/8	0.19	11/2	0.12	12/18	0.53
9/19	0.38	10/11	0.16	11/5	0.17	12/19	0.59
9/20	0.16	10/12	0.64	11/6	0.08	12/28	0.66
Total	0.68	10/13	0.25	11/10	0.14	12/29	1.98
Normal[1]	0.77	10/19	0.56	11/13	0.10	Total	3.84
Dep Norm	-0.09	10/20	0.17	11/16	0.21	Normal	2.56
		10/21	0.32	11/20	0.97	Dep Norm	1.28
		10/22	0.08	11/21	0.24		
		Total	2.07	11/22	0.09		
		Normal	1.58	11/23	0.17		
		Dep Norm	0.49	11/26	0.05		
				11/28	0.19		
				Total	2.62		
				Norm	2.91		
				Dep Norm	-0.29		

Date	Precipitation (in.)	Date	Precipitation (in.)	Date	Precipitation (in.)	Date	Precipitation (in.)
1/5/18	0.14	2/1	0.33	3/2	0.11	4/4	0.25
1/9	0.41	2/2	0.37	3/8	0.09	4/5	0.26
1/11	0.96	2/4	0.08	3/14	0.36	4/6	0.07
1/12	0.08	2/14	0.15	3/17	0.18	4/7	0.28
1/16	0.23	2/17	0.54	3/18	1.02	4/8	0.13
1/18	0.13	2/18	0.05	3/22	0.12	4/12	0.09
1/23	0.15	2/24	0.11	3/23	0.31	4/14	0.05
1/24	0.21	Total	1.69	Total	1.18	4/15	0.13
Total	2.4	Normal	1.81	Normal	2.05	4/16	0.21
Normal[1]	2.55	Dep Norm	-0.12	Dep Norm	-0.87	4/28	0.10
Dep Norm	-0.15					Total	1.68
						Normal	1.75
						Dep Norm	-0.07

[1]Normal precipitation values are based on the 1980 to 2010 record period, kept by the National Weather Service.

Precipitation data (September 1, 2017 to August 31, 2018) from AgWeatherNet station Pullman NE, Cook Agronomy Farm East, Con't

Date	Precipitation (in.)	Date	Precipitation (in.)	Date	Precipitation (in.)	Date	Precipitation (in.)
5/9	0.33	6/3	0.10	July	0.0	8/27	0.22
5/11	0.07	6/8	0.13	Total	0.0	Total	0.24
5/16	0.07	6/9	0.51	Normal	0.65	Normal	0.66
5/17	0.11	6/16	0.05	Dep Norm	-0.65	Dep Norm	-0.42
5/18	0.46	6/18	0.18				
5/20	0.08	6/21	0.31				
5/26	0.07	Total	1.33				
Total	1.30	Normal	1.49				
Normal[1]	1.77	Dep Norm	-0.16				
Dep Norm	-0.47						

[1]Normal precipitation values are based on the 1980 to 2010 record period, kept by the National Weather Service.

Precipitation data (September 1, 2017 to August 31, 2018) from AgWeatherNet station Davenport

Date	Precipitation (in.)	Date	Precipitation (in.)	Date	Precipitation (in.)	Date	Precipitation (in.)
9/18/17	0.10	10/12	0.06	11/2	0.05	12/2	0.06
9/19	0.15	10/13	0.13	11/6	0.07	12/17	0.09
9/21	0.19	10/18	0.16	11/9	0.18	12/18	0.16
Total	0.44	10/19	0.21	11/13	0.05	12/19	0.61
		10/20	0.05	11/15	0.34	12/30	0.38
		10/21	0.39	11/16	0.08	Total	1.34
		10/22	0.17	11/19	0.06		
		Total	1.17	11/20	0.39		
				11/21	0.41		
				11/23	0.26		
				11/26	0.11		
				11/29	0.07		
				Total	2.21		

Date	Precipitation (in.)	Date	Precipitation (in.)	Date	Precipitation (in.)	Date	Precipitation (in.)
1/5/18	0.06	2/2	0.29	3/1	0.35	4/4	0.08
1/7	0.10	2/14	0.21	3/2	0.17	4/5	0.41
1/9	0.17	2/15	0.12	3/8	0.15	4/7	0.47
1/12	0.24	2/17	0.12	3/14	0.44	4/10	0.10
1/16	0.09	Total	0.78	3/22	0.19	4/11	0.32
1/17	0.08			3/24	0.31	4/12	0.42
1/18	0.25			Total	1.70	4/15	0.29
1/23	0.24					Total	2.20
1/24	0.58						
1/29	0.18						
Total	2.14						

Date	Precipitation (in.)	Date	Precipitation (in.)	Date	Precipitation (in.)	Date	Precipitation (in.)
5/6	0.10	6/9	0.09	July	0.0	August	0.0
5/7	0.05	Total	0.14	Total	0.0	Total	0.0
5/17	0.12						
5/18	0.21						
5/23	0.25						
Total	0.78						