

2024 WSU Weed Control Report

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Cover photo: 2024 WSU Weed Science Field Tour at the Palouse Conservation Field Station, Pullman, WA. Photo by Scott Weybright, WSU CAHNRS Communications.

Off-Label or Experimental-Use Disclaimer

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

Statistical Inference

Statistical inference is the process of drawing conclusions from experimental data that can be applied to a larger population or landscape. In our research, we replicate treatments in each trial to provide the variability needed to determine if differences are real or occur just by chance. While lack of statistical difference may indeed result from similar treatment effects or outcomes, e.g., a 100 lb/A fertilizer rate produced a similar yield to 101 lb/A, differences can also result from experimental or random error associated with the trial. We normally recognize statistical significance at the 95% probability level, which means there is a 95% probability that observed differences represent actual treatment effects and are not due to chance. This is indicated in our reports with the symbols $P \leq 0.05$ or $\alpha = 0.05$. We typically show statistical differences between treatments with the use of alphabetical letters. Treatment means that are statistically similar will be followed the same letter.

Germination periodicity of weedy amaranth (*Amaranthus* spp.) in PNW wheat systems

P. Weston Maughan, Marija Savic, Jessica E. R. Kalin, & Ian C. Burke

Introduction

In the summer of 2024, a multi-site study was initiated to investigate the environmental drivers of weed emergence within the wheat production systems in the Pacific Northwest (PNW). While a geographically small area, microclimates across the Palouse can vary greatly, leading different emergence patterns between different populations of the same species. The study seeks to determine climatic and management drivers of weed emergence across the PNW climate gradient, focusing on common amaranthus weeds tumble pigweed (*Amaranthus blitoides*) and redroot pigweed (*A. retroflexus*).

Methods

Three study sites were established in nontilled, fallow wheat fields in Pullman and Central Ferry, WA. Each research plot was 1.5 m by 2 m and arranged in parallel rows within each repetition. Treatments were applied to bring the research plots to bare ground in regular intervals to determine emergence patterns throughout the year. Treatments were arranged in randomized complete block design with two replications per site. Each round of treatments consisted of treating a pair of research plots with tillage in one and a chemical application in the other (Table 1). Chemical treatments consisted of an application of glyphosate as Gly Star 5 (by Agri Star) at 0.75 lbs acid equivalent acre⁻¹ of glyphosate using a CO₂-powered backpack sprayer. Population data for each plot was collected using two 0.25 m² frames per plot 6 weeks after treatment application. Onsite microclimate data was collected on 15 min intervals using a Meter Group ZL6 Data Logger, outfitted with an ATMOS 41 weather station and two Terros 21 soil matrix potential sensors installed at 5 and 20 cm depths.

A 2000 study found the base temperature for two amaranth species (*A. albus* and *A. palmeri*) to be 15.7 and 17 °C (Steinmaus, Prather, and Holt). For this study, we used 15.7 °C as the base temperature for calculating thermal time.

Results

While amaranth at the Central Ferry site germinated nearly a month earlier than at the Pullman site (Figure 1), peak emergence occurred at nearly the same thermal time (Figure 2). Germination density varied by site (Figure 3). Emergence in the tilled plots did trend towards continual emergence at higher accumulations of thermal time, though it did not appear to have an impact on when emergence started. We have not yet used soil moisture or temperature data as covariates for periods of increased emergence, but both factors likely also contribute to periodicity observed in Amaranths and other weed species.

Weed emergence variation across a landscape is strongly driven by climate cues, and particularly thermal time. Additional data on weedy amaranths, and other key weeds in the PNW, could allow a predictive model to be used to more accurately time inputs around anticipated or predicted emergence and growth.

Citations

Steinmaus SJ, Prather TS, Holt JS (2000) Estimation of base temperatures for nine weed species. *J Exp Bot.* 51(343): 275-286. DOI: 10.1093/jexbot/51.343.275.

Table 1. Treatment regimens from a 2024 study to determine the emergence timing of weedy species in the Pacific Northwest wheat systems. The study was conducted in Pullman, WA, and was conducted from April to August. The treatment date is when the research plot was rendered weed free through either tillage or chemical application. Glyphosate was applied at 0.75 lb ae/A.

Pullman, WA		Central Ferry, WA	
Treatment Date	Rating Date	Treatment Date	Rating Date
4/2	5/20	4/11	5/24
4/16	6/6	4/25	6/7
5/6	6/18	5/9	6/21
5/20	7/2	5/24	7/5
6/6	7/15	6/7	7/19
6/18	7/29	6/21	8/1
7/2	8/12	7/5	8/14

Figure 1. Amaranth (*Amaranthus* spp.) emergence densities from two 2024 studies from between April 2024 to August 2024. The studies were conducted at research farms in Central Ferry WA, and Pullman, WA. The dashed lines denote the standard errors for the measurements.

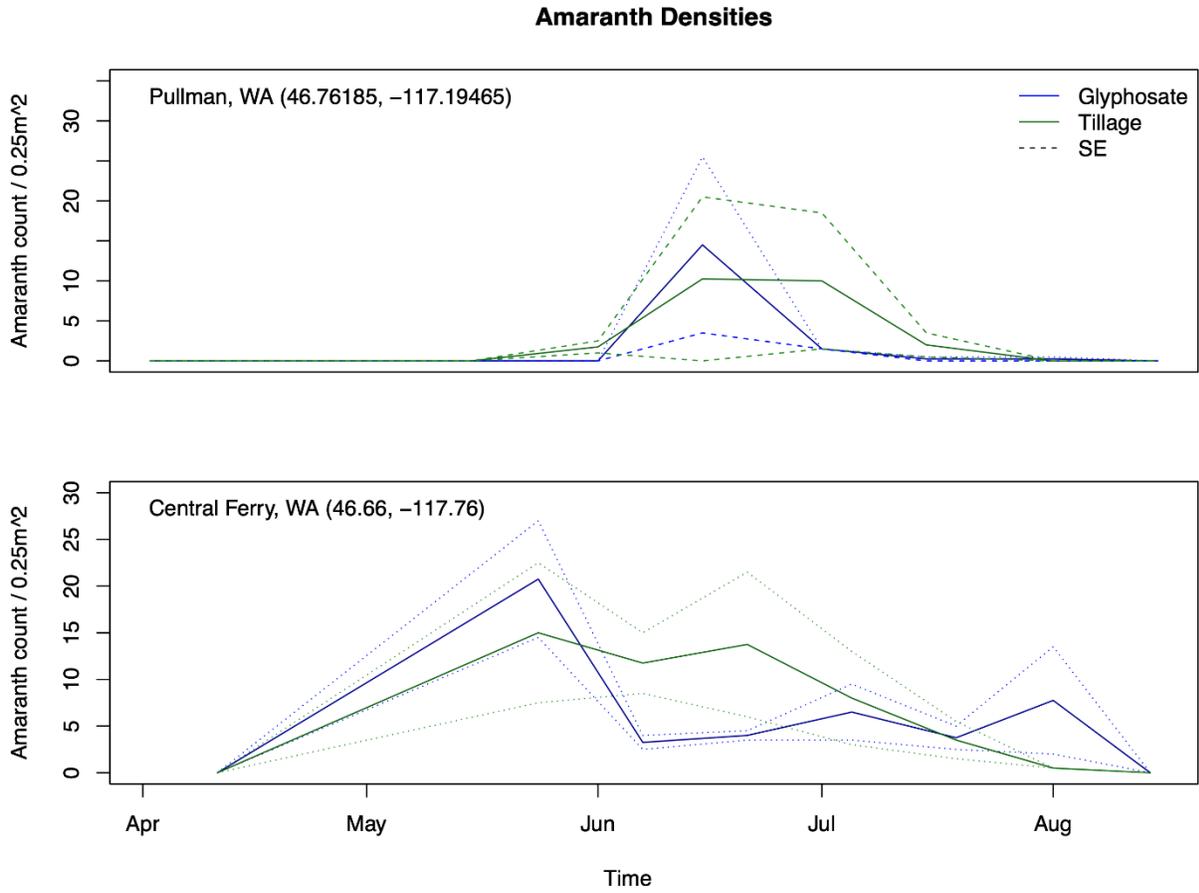


Figure 2. Amaranth (*Amaranthus* spp.) emergence densities from two 2024 studies based on the effects of thermal time. The studies ran from April 2024 to August 2024. The studies were conducted at research farms in Central Ferry WA, and Pullman, WA. The dashed lines denote the standard errors for the measurements.

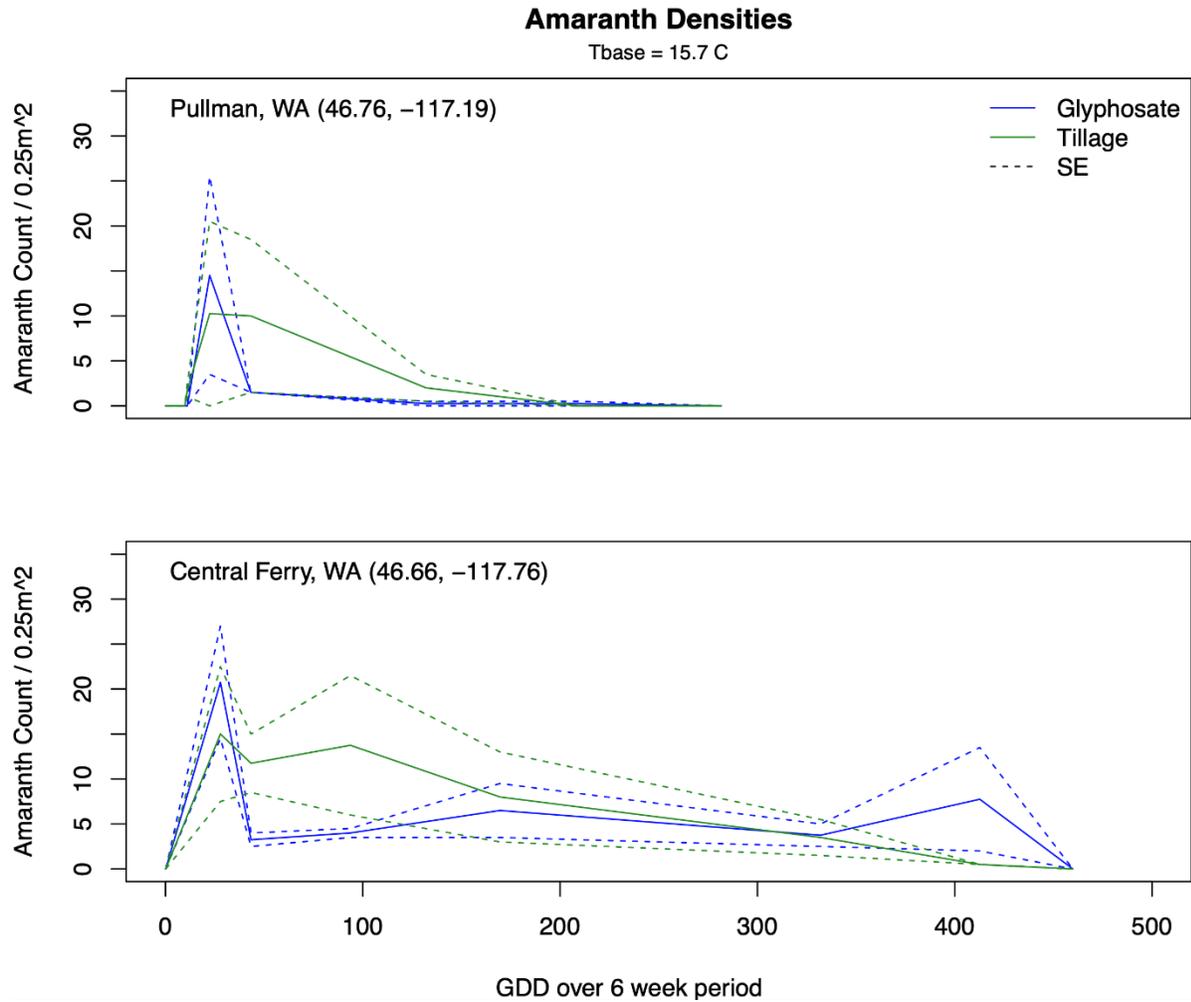
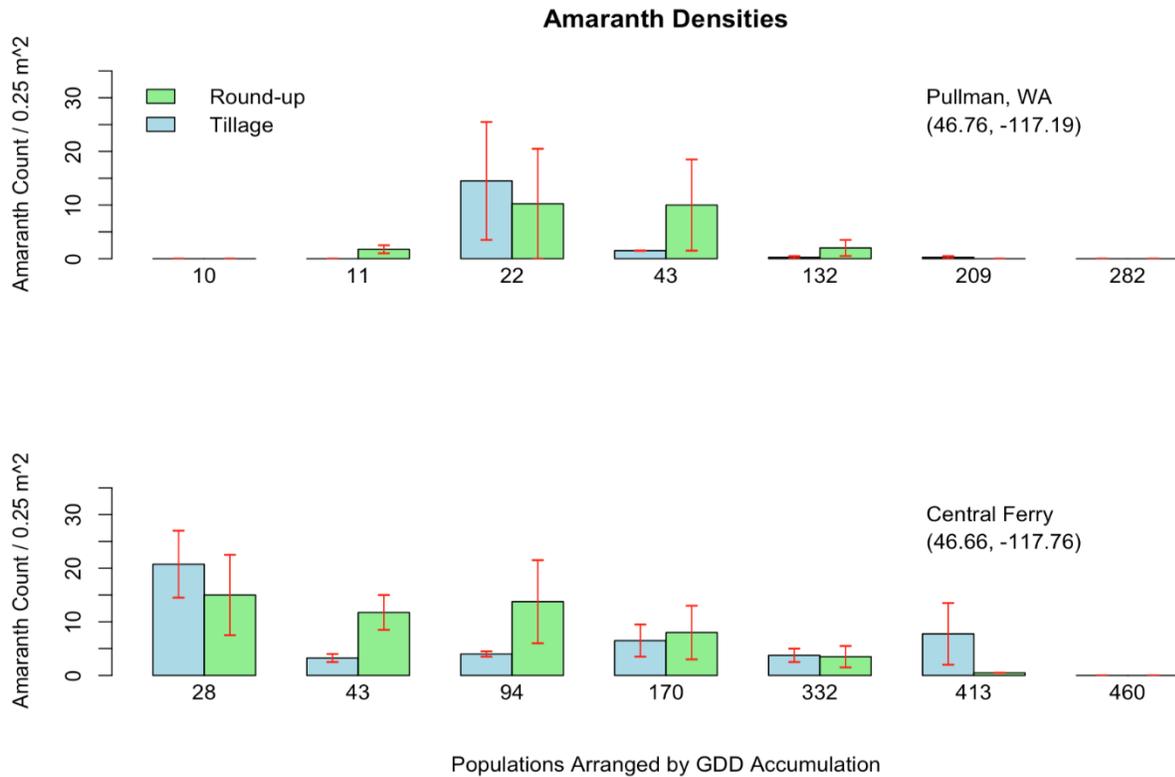


Figure 3. Amaranth (*Amaranthus* spp.) emergence densities from populations from two 2024 studies. The studies were conducted at research farms in Central Ferry WA, and Pullman, WA between April 2024 and August 2024. The numbers under each pair of bars indicate the number of growing degree-days accumulated by the population in the 6 weeks between rendering the plots weed free and measuring the emergent population. Error bars denote the standard error for the measurements.



Finesse® Cereal and Fallow Herbicide timing for smooth scouringrush control in wheat/fallow cropping systems

Mark Thorne, Marija Savic, and Drew Lyon

Finesse herbicide (chlorsulfuron + metsulfuron methyl) is effective for smooth scouringrush control when applied late spring in fallow; however, applications at other times may fit better in certain management strategies. If fall-applied treatments were effective, they would be useful if chemical fallow applications were delayed or following a crop harvest if stems are still present and green. Finesse is labeled for application anytime in fallow including just before fall seeding, and after one leaf but before the boot stage in wheat and barley. Smooth scouringrush stems usually begin emerging in May and persist until freezing temperatures in the fall. However, it is possible that smooth scouringrush may not be present or actively growing in late fall or early spring when Finesse would normally be applied and the efficacy of these timings is unclear. Glyphosate (e.g. PowerMax®, RT 3®) has been shown to be effective on smooth scouringrush, but at higher application rates than used in this study, and only with an organosilicone surfactant. PowerMax is included in this study as a comparison with a standard grower practice of applying glyphosate in chemical fallow for preplant weed control.



Figure 1. Spring wheat in 2024 near Steptoe, WA (left); smooth scouringrush growing under the spring wheat canopy (middle); Smooth scouringrush control two years after fall-applied Finesse on stems in fallow (right).

We began a study in 2022 at two farms comparing fall and spring applications of Finesse for control of smooth scouringrush. Finesse was applied in the fall to standing stems or bare soil before fall seeding. In the spring, treatments were applied before stem emergence when the winter wheat was tillering and then later when the smooth scouringrush stems were emerging but before the wheat was in the boot stage. Trials were initiated near Edwall on the Justin Camp farm and near Steptoe on the Mark Hall farm. Each site is in a no-till winter wheat/spring wheat/

fallow rotation. The Edwall site is in a gentle northwest-sloping draw bottom with good moisture and well-drained soil, which is classified as a Broadax silt loam. Soil organic matter and pH measured 2.9% and 5.0, respectively. The Steptoe site is on a gentle north-facing slope of soil classified as a Palouse-Thatuna silt loam. Soil organic matter and pH measured 2.7% and 5.0, respectively. Both sites average around 16 inches of precipitation per year.

At each site, plots measured 10 by 30 ft and were arranged in a randomized complete block design with four replications per treatment. All herbicide treatments were applied with a hand-held spray boom with six nozzles on 20-inch spacing and pressurized with a CO₂ backpack. Spray output was 15 gpa at 40 psi through TeeJet® AIXR110015 nozzles at 3 mph. Bare soil treatments were applied to plots where all vegetation had been mowed and removed by hand. Fall treatments were applied September 14 and 22, and early spring treatments were applied on May 8 and 11 at Steptoe and Edwall, respectively. Late spring treatments were applied May 18 at both locations; however, smooth scouringrush stems had not yet emerged at Steptoe. This was likely associated with hard dry soil and dry spring conditions observed in 2023. All treatments included either a nonionic surfactant (NIS) or an organosilicone surfactant (Syl-Coat®).

Final evaluations were made July 2024 by counting smooth scouringrush stems in two 1.2-yd² quadrats per plot in spring wheat crop ahead of harvest (Figure 1). Overall, treatment differences were less apparent at Edwall than at Steptoe as Edwall densities had increased substantially from 2023 (Refer to <https://smallgrains.wsu.edu/weed-resources/weed-publications/weed-control-reports/> for the 2023 report "Finesse® timing for Smooth Scouringrush Control in Wheat/Fallow Cropping Systems"). Smooth scouringrush plants at Edwall appeared visually more robust than at Steptoe and may have been more difficult to control. At Edwall, only the fall-applied tank mix of Finesse plus PowerMax with NIS applied to stems resulted in better control than applied to bare soil (Table 1). At Steptoe, all fall-applied Finesse treatments applied to standing stems reduced stem density compared with Finesse applied to bare soil.

At Steptoe, spring applications of Finesse to smooth scouringrush stems reduced stem density compared with the nontreated check but were less effective than if applied in the fall (Table 1). At Edwall, spring-applied Finesse did not reduce stem density compared with the nontreated check. Spring applications in the crop may be less effective as smooth scouringrush has either not emerged or has just emerged but is not yet translocating photosynthates into the roots. However, applications to stems would be more desirable than to soil. Finesse can be applied to wheat up to the boot stage, which may allow time for smooth scouringrush stem emergence.

Control of smooth scouringrush with fall applications of Finesse can be effective in some situations, but not all, and may depend on factors such as the physiological condition of the stems or population biotypes. Furthermore, applications during drought conditions or following frosts may be less favorable for herbicide uptake and efficacy. If fall applications are made, Finesse applied to standing green stems is more effective than to bare soil. Finesse is a soil active herbicide, but this study finds that soil uptake alone is not sufficient for control.

Table 1. Smooth scouringrush density in spring wheat crops two years after initial herbicide applications near Edwall and Steptoe, WA.

Treatments*	Timing	Target	Edwall	Steptoe
			-----stems/yard ² **-----	
Finesse + PowerMax + NIS	Fall	Standing stems	154 b	15 d
Finesse + PowerMax + Syl-Coat	Fall	Standing stems	196 ab	6 d
Finesse + PowerMax + NIS	Fall	Bare soil	272 a	114 b
PowerMax + NIS	Fall	Standing stems	293 a	98 bc
Finesse + NIS	Fall	Standing stems	265 a	28 d
PowerMax + NIS fb Finesse + NIS	Fall fb early Spring	Preemergence to stems in crop	198 ab	95 bc
PowerMax + NIS fb Finesse + NIS	Fall fb late Spring	Stems in crop	243 a	81 c
Nontreated check			250 a	162 a

*Finesse applied at 0.5 oz/A in fall in fallow and 0.4 oz/A in spring in crop; PowerMax was applied at 32 oz/A; NIS and Syl-Coat were applied at 0.5% v/v. All PowerMax applications included NH₄SO₄ at 17 lb/100 gal. fb=followed by.

**All stem densities for each site followed by the same letter are not different (P≤0.05).

Field horsetail control in the Palouse annual cropping region

Mark Thorne, Marija Savic, and Drew Lyon

Field horsetail (*Equisetum arvense*) is a member of a prehistoric group of plants in the genus *Equisetum*. Equisetums date back about 350 million years and were forage for dinosaurs and then became a major component of the vegetation that developed into coal during the Carboniferous period. Currently, three *Equisetum* species are common in the Pacific Northwest and include field horsetail, smooth scouringrush, and scouringrush. Field horsetail is a perennial rhizomatous species that produces fertile spore-bearing leafless stems early in the spring followed by vegetative stems that resemble Christmas trees that persist through the rest of the year up to freezing temperatures in the fall. Field horsetail can be found on flood plains and along roads where water collects in ditches and barrow pits.



Figure 1. Field horsetail in winter wheat (left) and chickpeas (right).

In the high-rainfall Palouse region of eastern Washington and northern Idaho, field horsetail is a problem weed because it is very persistent, hard to control with tillage or herbicides, and is competitive with all crops grown (Figure 1). Herbicides that could be effective do not fit well in the commonly used crop rotations because of long plant-back intervals that would injure sensitive crops like canola or pulses. Chlorsulfuron is an herbicide that is labeled on wheat and is

effective on other *Equisetum* species like smooth scouringrush but has up to a 36-month plant-back interval to crops other than wheat. Other herbicides that can control field horsetail, e.g., sulfometuron (Oust[®]) or dichlobenil (Casoron[®]), are also not labeled for use in field crops grown in this region because of long soil residual and potential crop injury.

In this region, crops are generally grown each year without a fallow year in between. Therefore, herbicides are applied either following crop harvest in the fall, preplant in the spring, or to a growing crop. Finesse[®] Cereal and Fallow Herbicide (chlorsulfuron + metsulfuron) is a Group 2 ALS inhibitor herbicide that has been effective on smooth scouringrush when applied during a fallow year, but it has not been well tested on field horsetail. Finesse has a 36-month plantback restriction to peas and a bioassay is recommended for chickpeas or canola. Express XP[®] (tribenuron) is another Group 2 herbicide that has a molecular structure very similar to sulfometuron but has not been tested for field horsetail control; however, Express XP has no plantback restrictions that would affect a crop after 2 months following application. Widematch[®] (clopyralid + fluroxypyr) is a Group 4 synthetic auxin herbicide that can be applied to wheat up to the flag leaf stage. It is not known if Widematch has any effect on field horsetail other than to burn down the current year's growth. The Widematch plantback interval to canola is 12 months or 18 months to any pulse crop.

Since field horsetail does not emerge early in the spring, foliar applications to field horsetail need to consider the labeled application window of the crop. Finesse, Express XP, and Widematch can all be applied to wheat when it is tillered up to the flag leaf stage, which is typically when field horsetail emerges in the spring. However, if these herbicides control field horsetail, crop rotations would have to be altered to avoid problems with plantback restrictions.

We initiated a field study September 2023 on the Jared Druffel farm near Pullman, WA for field horsetail control in the high-rainfall (>20" annual precipitation) annual cropping region of the Palouse. The study site is on a floodplain near a creek and is a Caldwell silt loam soil type with a pH of 5.4 and 3.2% organic matter. The experimental design is a randomized complete block with four replicates per treatment and 10- by 25-ft plots. The field produced a spring canola crop in 2023. The soil surface contained canola stubble and green field horsetail stems that were 6 to 12 inches in height. Fall treatments were applied on September 9, 2023. Early spring applications were applied on April 2, 2024, when the wheat was fully tillered, but field horsetail had not yet emerged. Late spring applications were on May 9, 2024, when the wheat had flag leaves, and the field horsetail had vegetative stems up to 6 inches high. All herbicide treatments were applied with a hand-held spray boom with six nozzles on 20-inch spacing and pressurized with a CO₂ backpack. Spray output was 15 gpa at 40 psi through TeeJet[®] AIXR110015 nozzles at 3 mph. All treatments included a nonionic surfactant (NIS) or an organosilicone surfactant (Syl-Coat[®]).

Treatment efficacy was evaluated visually May 9, 2024, and July 3, 2024, as a percent of the nontreated check treatment and included assessments of both field horsetail density and canopy volume. Visual ratings on May 9 showed that all fall- and early spring-applied Finesse treatments, including the application to bare soil, had resulted in 95-100% control of field horsetail as it was emerging in the spring (Table 1). In contrast, the early spring application of Express XP only resulted in 40% control. By the July 3 rating, only fall-applied Finesse to field

horsetail stems were effective. The late-spring application of Widematch did not add any benefit to the fall-applied Finesse treatment, but it might have controlled other broadleaf weeds if they were present. At the July 3 rating, field horsetail was no longer controlled by the fall-applied Finesse to bare soil treatment, which provided only 36% control and not different from any of the spring-applied Finesse treatments. Furthermore, Express XP was not effective in controlling field horsetail. In addition, there was no benefit of including Syl-Coat compared with NIS to either Finesse or Express XP applied in the spring.

Field horsetail is very difficult to control in crop production fields; however, fall applications of Finesse may be effective but only if they are applied to actively growing stems. Finesse applied to soil is not effective for long-term control as there appears to be minimal herbicide uptake through the rhizomes. Furthermore, applying Finesse to field horsetail in spring does not appear effective and this may be because plants have not yet begun to translocate photosynthates back into the rhizomes. Plantback intervals for sensitive crops should be observed following any Finesse application, and bioassays used if there is any doubt.

Table 1. Field horsetail control with herbicides and timing of application.

Herbicides*	Timing – wheat stage	Target	Field horsetail control**	
			5-9-2024	7-3-2024
			(percent of nontreated check)	
Finesse + NIS	Fall – preplant	Horsetail	100 a	91 a
Finesse + NIS fb Widematch	Fall – preplant fb flag leaf	Horsetail	100 a	91 a
Finesse + NIS	Fall – preplant	Soil	100 a	36 b
Finesse + NIS	Early spring –tillered	Soil	95 a	32 b
Express XP + NIS	Early spring –tillered	Soil	40 b	1 c
Express XP + NIS	Late spring –flag leaf	Horsetail	---	17 b
Express XP + Syl-Coat	Late spring –flag leaf	Horsetail	---	1 c
Finesse + NIS	Late spring –flag leaf	Horsetail	---	35 b
Finesse + Syl-Coat	Late spring –flag leaf	Horsetail	---	37 b
Nontreated check			0	0

*Applications rates: Express XP = 0.33 oz/A; Finesse in crop = 0.4 oz/A; Finesse in fallow/preplant = 0.5 oz/A; Widematch = 1.33 pt/A; NIS (nonionic surfactant) = 0.5% v/v; Syl-Coat (organosilicone surfactant) = 0.5% v/v.

**Means followed by the same letter in each column are not statistically different ($P \leq 0.05$).

Smooth Scouringrush control with Finesse[®] Cereal and Fallow Herbicide in winter wheat/spring wheat/no-till fallow cropping systems

Mark Thorne and Drew Lyon

Smooth scouringrush is a problem in no-till wheat/fallow rotations in the intermediate to low rainfall areas of eastern Washington (Figure 1). In spring wheat, smooth scouringrush has the potential to be more competitive than in winter wheat as the stems can emerge near the same time as the wheat; however, in winter wheat stem emergence often occurs as the wheat plants are jointing and may miss early herbicide applications. We are evaluating control following applications of Finesse (chlorsulfuron + metsulfuron) or Rhonox[®] (MCPA LV ester) during the no-till fallow phase, and Amber[®] (triasulfuron) or Rhonox during the crop phase. We have demonstrated that chlorsulfuron, one of the active ingredients in Finesse, is effective for controlling smooth scouringrush for at least two years after application. However, the question remains: is a second application in a subsequent fallow phase needed for continued long-term control? Furthermore, this study evaluates the application of Amber during the crop phases. Amber is molecularly similar to chlorsulfuron and is hypothesized to be a bridge application between the two fallow Finesse applications. Rhonox is a synthetic auxin herbicide (Group 4) that is used for broadleaf weed control in both fallow and grass crops and is effective for quick burndown of smooth scouringrush stems but long-term control is questionable.



Figure 1. Post-wheat harvest at Edwall, WA. Plot with no control of smooth scouringrush on left and control with Finesse on right.

Two trials were initiated in 2019, one near Edwall on the Camp farm, and a second near Steptoe on the Hall farm. Each site is in a no-till winter wheat/spring wheat/fallow rotation. The Edwall site is in a gentle-sloping northwest-facing draw with good moisture and well-drained soil, which is classified as a Broadax silt loam. Soil organic matter and pH measured 2.9% and 5.0, respectively. The Steptoe site is on a low-lying flat with inundated soil during winter and early spring. Soil at Steptoe is classified as a Caldwell silt loam. Soil organic matter and pH measured 3.4% and 7.2, respectively. Both sites average around 16 inches of precipitation per year.

At each site, plots measure 10 by 30 ft and are arranged in a randomized complete block design with four replications per treatment. All herbicide treatments were applied with a hand-held spray boom with six nozzles on 20-inch spacing and pressurized with a CO₂ backpack. Spray output in 2019-2021 was 15 gpa at 25 psi through TeeJet® XR11002 nozzles at 3 mph. In 2022-2024, spray output was 15 gpa at 40 psi through TeeJet AIXR10015 nozzles at 3 mph. Treatment sequences and herbicide rates are presented in Table 1.

Table 1. Herbicide sequences for long-term study for control of smooth scouringrush in winter wheat/spring wheat/fallow cropping systems trials at Edwall and Steptoe, WA.*

Seq	Fallow 2019	WW 2020	SW 2021	Fallow 2022	WW 2023	SW 2024	Fallow 2025
1	Finesse	Amber	Amber	Finesse	Amber	Amber	Final evaluations
2	Finesse	Amber	Rhonox	Finesse	Amber	Rhonox	
3	Finesse	Amber	Amber	Rhonox	Amber	Amber	
4	Finesse	Rhonox	Rhonox	Rhonox	Rhonox	Rhonox	
5	Finesse	Rhonox	Rhonox	Finesse	Rhonox	Rhonox	
6	Rhonox	Rhonox	Rhonox	Rhonox	Rhonox	Rhonox	

*Seq=sequence; WW=winter wheat; SW=spring wheat

Finesse (chlorsulfuron/metsulfuron) is applied at 0.5 oz/A.

Amber (triasulfuron) is applied at 0.56 oz/A.

Rhonox (MCPA) is applied at 34.6 oz/A in fallow and 24 oz/A in crop.

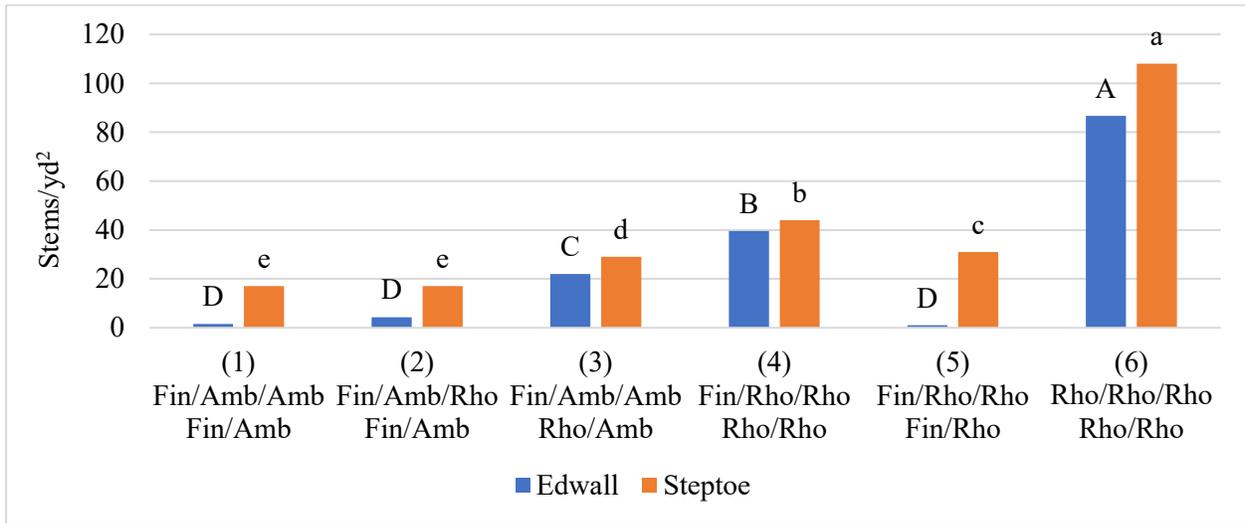
All treatments include NIS surfactant at 0.33% volume/volume concentration.

In June 2024, smooth scouringrush stem density was assessed in spring wheat before harvest at both locations. This assessment evaluates the cumulative efficacy of all applications from 2019 through 2023 (Table 1). Smooth scouringrush stems were counted in two 1.2-yd² quadrats per plot. Stem densities were greatest where Rhonox was applied each year (Table 1, seq 6), which further shows that Rhonox is not effective for long-term control (Figure 2). At the Edwall site, all treatments with Finesse applied in both fallow years had the lowest stem density in 2024. At the Steptoe site, the lowest stem densities were in treatments with Finesse applied in both fallow years and Amber applied in at least one of the crop years. At both sites, Finesse applied only in 2019 followed by Amber in each crop phase (Table 1, seq 3) was more effective than Finesse applied only in 2019 and followed only by Rhonox (Table 1, seq 4).

Spring wheat yields in 2024 differed by location. At Edwall, lowest yields corresponded with sequences where Rhonox was the only herbicide applied (Table 2, seq 6) or where Finesse was applied in 2019 and then followed only by Rhonox (Table 2, seq 4). Sequences 4 and 6 also corresponded with the least smooth scouringrush control (Figure 2). However, at Steptoe, no differences were found between yields. Smooth scouringrush can reduce crop yield if densities are high and crop competitiveness is low. Wheat yields at the Steptoe site tend to be higher than at Edwall likely because of greater soil moisture in the floodplain soil profile.

This research, thus far, indicates the need for Finesse applications in each fallow year of a three-year crop rotation that includes a fallow phase for long-term control of smooth scouringrush.

Figure 2. Smooth scouringrush stem density in 2024 spring wheat in a long-term herbicide rotation study that began in 2019 at Edwall and Steptoe, WA.*



*Herbicide sequences for each rotation are listed below each set of corresponding columns and coded as follows: Fin=Finesse; Amb=Amber; Rho=Rhonox. Means associated with each column are based on four replicates per treatment combined over two locations. Columns for each location with the same letter, case specific, are not significantly different ($P \leq 0.05$).

Table 2. Spring wheat yield in 2024 in relation to each herbicide sequence over six years at Edwall and Steptoe, WA.

Seq	Herbicides applied in each phase of the rotation*						Spring wheat yield**	
	2019 Fallow	2020 WW	2021 SW	2022 Fallow	2023 WW	2024 SW	Edwall	Steptoe
							--(bu/A)--	
1	Finesse	Amber	Amber	Finesse	Amber	Amber	46 a	59 a
2	Finesse	Amber	Rhonox	Finesse	Amber	Rhonox	42 ab	55 a
3	Finesse	Amber	Amber	Rhonox	Amber	Amber	45 a	55 a
4	Finesse	Rhonox	Rhonox	Rhonox	Rhonox	Rhonox	36 b	59 a
5	Finesse	Rhonox	Rhonox	Finesse	Rhonox	Rhonox	42 ab	60 a
6	Rhonox	Rhonox	Rhonox	Rhonox	Rhonox	Rhonox	37 b	62 a

*See Table 1 for herbicide and sequence information.

**Means followed by the same letter in each column are not statistically different ($P \leq 0.05$).

Control of smooth scouringrush with Finesse® Cereal and Fallow Herbicide and RT 3® three years after application - Reardan, WA

Mark Thorne, Marija Savic, and Drew Lyon

In 2021, we initiated a trial near Reardan, WA comparing applications of RT 3 and Finesse for control of smooth scouringrush in a wheat/fallow cropping system (Figure 1). Smooth scouringrush has been very difficult to control, especially in no-till cropping systems, as the routine herbicide applications for annual weed control in fallow have been ineffective. Previous research has shown that Finesse (chlorsulfuron + metsulfuron) can have activity on smooth scouringrush at least two years after application, and RT 3 (glyphosate) has been effective when applied at high rates and with an organosilicone surfactant. This study examines the effect of Finesse and RT 3 applied alone or in combination at different rates of RT 3 in the fallow phase of the grower's crop rotation for three years following application.



Figure 1. Smooth scouringrush control three years after treatment with 64 oz/A RT 3 plus Finesse (on left) and only 64 oz/A RT 3 (on right) near Reardan, WA.

The trial was initiated on July 9, 2021, in no-till fallow near Reardan, WA on the Carstens farm. The Reardan site is on a northwest-facing slope with an Athena silt loam soil and pH of 4.9 and 2.4% organic matter in the top 6 inches. All plots measure 10 by 30 ft and are arranged in a randomized complete block design with four replications per treatment. Treatments were applied

with a hand-held spray boom with six TeeJet® AIXR110015 nozzles on 20-inch spacing and pressurized with a CO₂ backpack at 3 mph. Spray output was 15 gpa at 40 psi. All treatments included an organosilicone surfactant (Silwet® L77). Initial smooth scouringrush density averaged 248 stems/yd² in July 2021. In 2022, the field was in winter wheat, and in 2023 it was in spring wheat.

Smooth scouringrush control was evaluated three years after application on July 1, 2024, by counting stems in two 1.2-yd² quadrats per plot. All treatments with Finesse were more effective than treatments with no Finesse; however, tank mixing 64 or 96 oz/A of RT 3 increased efficacy compared with Finesse alone or with 32 oz/A RT 3 (Figure 2). These results indicate a long-term benefit of adding RT 3 at higher rates to Finesse. If only using RT 3 for smooth scouringrush control, the 96 oz/A rate is needed for longer term control. The 32 and 64 oz/A rates of RT 3, alone, are not different than the nontreated check, which explains why lower rates of RT 3 have not controlled smooth scouringrush in no-till direct seed farming systems.

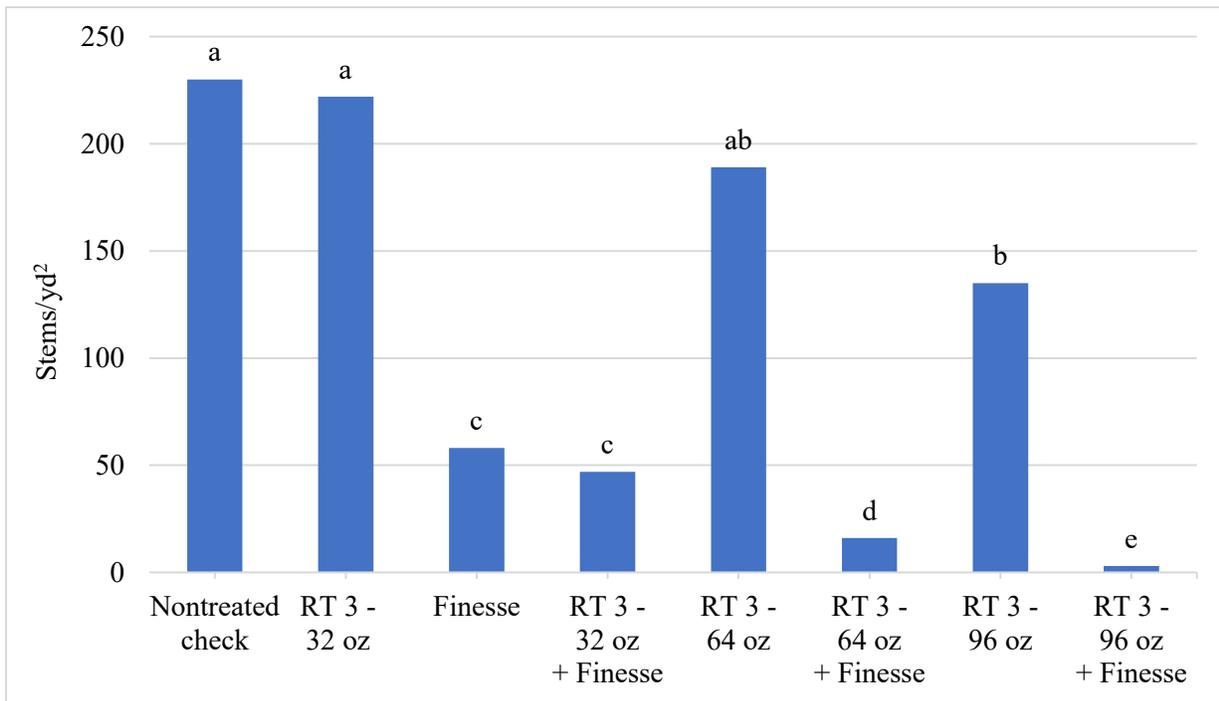


Figure 2. Smooth scouringrush stem density in 2024, three years after Finesse and RT 3 treatment were applied in chemical fallow near Reardan, WA. All herbicide treatments included Silwet L77 organosilicone surfactant at 0.5% v/v. Finesse was applied at 0.5 oz/A, and RT 3 rates are oz/A. Columns with the same letter are not significantly different ($P \leq 0.05$).

Diflufenican and metribuzin safety and efficacy in winter wheat

J.E.R. Kalin & I. C. Burke

Introduction

In fall of 2023, a field trial was established to evaluate the efficacy of diflufenican. Diflufenican is a selective pre- and postemergence herbicide widely used to control broadleaf weeds in cereals and other crops. It works by inhibiting carotenoid biosynthesis, which leads to bleaching and eventual death of the weeds. Known for its long residual activity, diflufenican is often applied in combination with other herbicides for broader spectrum weed control. Diflufenican is currently being evaluated for registration in wheat. The objective of the trial was to evaluate crop safety and efficacy on Mayweed chamomile, and in mixture with pyroxasulfone or metribuzin for broad spectrum control. Therefore, treatments included diflufenican and pyroxasulfone (as Zidua) herbicides, applied alone and in combination with metribuzin, for controlling key weeds in winter wheat

Methods

The study was established in a winter wheat field on the Plant Pathology Farm in Pullman, WA. The field selected was fallowed to minimize weed pressure. Preemergence treatments were applied with a CO₂ powered backpack sprayer and a 5 ft boom with 3 Teejet 11002VS nozzles with an effective spray pattern of 8 ft and calibrated to deliver 15 gallons per acre (Table 1). Diflufenican was applied at rates of 90 to 180 ga ai/ha, and in mixture with metribuzin, pyroxasulfone, or both. The study was conducted in a randomized complete block design with 4 replications. Plots were 10 ft wide by 30 ft long. Treatments were applied in fall 2023 and assessments for crop response and weed control were conducted in spring 2024. Plots were harvested with a Wintersteiger small plot combine with a 5-foot header. Data were subject to ANOVA using the Agricultural Research Manager software (Ver. 2024).

Table 1. Treatment application details.

Study Application	
Date	10/16/2023
Application volume (GPA)	15
Timing	Preemergence
Soil temperature (°F)	54
Air temperature (°F)	63
Wind velocity (mph, direction)	9, NW
Relative humidity (%)	49

Results

No visible injury (e.g., stunting, chlorosis) was observed across any treatments, demonstrating safety of diflufenican applied preemergence across multiple rates was very safe. Rainfall before and after planting was below normal, and typical annual weed germination was limited. No crop injury was observed, confirming the safety of these herbicides for winter wheat when applied preemergence. Rainfall before and after planting was below normal, and typical annual weed germination was limited. Control of mayweed chamomile was complete in the trial, although the population was relatively low.

Diflufenican and pyroxasulfone in combination with metribuzin control broadleaf and grass weeds in winter wheat fields. There was little rainfall before and after planting this trial. A total of 8/10 of an inch was accumulated two weeks prior to planting and 4/10 of an inch accumulated two weeks post-planting (AgWeatherNet). These results support the use of diflufenican and pyroxasulfone for integrated weed

management strategies, offering flexibility in rate selection for producers managing weed pressure. Additional experiments are needed to understand how best to incorporate diflufenican into herbicide

There was little rainfall before and after planting this trial. A total of 8/10 of an inch was accumulated two weeks prior to planting and 4/10 of an inch accumulated two weeks post-planting (AgWeatherNet). These results support the use of diflufenican and pyroxasulfone for integrated weed management strategies, offering flexibility in rate selection for producers managing weed pressure.



Figure 1. Nontreated plot (left) and diflufenican at 180 g ai/ha (right).

Winter wheat yield following Treflan[®] HFP applied the previous year in spring canola

Mark Thorne and Drew Lyon

Italian ryegrass is a cool-season annual to short-lived perennial grass that has become a major weed in the higher rainfall region of eastern Washington within the last 30 years. Italian ryegrass has developed resistance to all Group 1 (ACCase inhibitors) herbicides, e.g., clethodim, Hoelon[®], Poast[®], Assure[®], Axial[®], and Group 2 (ALS inhibitors) herbicides, e.g., Osprey[®], Outrider[®], Amber[®], PowerFlex[®], and Beyond[®]. Currently, growers have included glyphosate-resistant spring canola in their rotations so they can control Italian ryegrass in the canola crop with glyphosate. Resistance to glyphosate has occurred in other areas but is not yet widespread in eastern Washington. Concern over developing glyphosate resistance in Italian ryegrass has prompted research into using herbicides with sites of action different from glyphosate in spring canola.

Treflan HFP (trifluralin) is a Group 3 dinitroaniline herbicide used for preemergence control of grass and broadleaf weeds, including Italian ryegrass, in many crops. Its mode of action is to inhibit mitosis in the developing root tips by binding to tubulin, thus interfering with the formation of microtubules critical for cell division. Treflan HFP can be effective if applied and incorporated into the soil before weed seeds germinate. Following incorporation, adequate precipitation is needed to move Treflan HFP into the soil water where it can be taken up by seedling roots. Treflan HFP also has soil residual activity that can injure sensitive crops if they are planted too soon after application. Treflan HFP is labeled for preplant incorporated application in wheat, but only if the wheat is planted below the zone of herbicide incorporation. Planting winter wheat following a crop of spring canola where Treflan HFP was applied has raised concerns regarding residual carryover damage to the following wheat crop.

In 2023, we compared herbicides for Italian ryegrass control in spring canola at the WSU Cook Agronomy Farm near Pullman, WA. Treatments included Treflan HFP at 24 oz/A by itself and in combination with PowerMax[®] (glyphosate) and Liberty[®] 280 SL (glufosinate) in 10 by 30 ft plots with four replications per treatment. In the fall of 2023, winter wheat was planted over the study site with a Horsch direct-seed drill. In August 2024, we harvested winter wheat from all plots with a small plot harvester. Samples were cleaned and weighed for yield.

We found no statistically significant yield loss caused by Treflan HFP applied in the previous spring crop between individual treatments (data not shown) or between plots where Treflan HFP was applied and where no Treflan HFP was applied. (Table 1). This is congruent with a similar comparison in 2023 where winter wheat yield was not reduced by Treflan HFP applied the previous year (Refer to <https://smallgrains.wsu.edu/weed-resources/weed-publications/weed-control-reports/>). Treflan HFP applied at the labeled rate of 24 oz/A prior to planting a spring canola crop does not appear to cause yield loss in the following winter wheat crop.

Table 1. Winter wheat yield in 2024 following herbicides applied in 2023 for Italian ryegrass control in spring canola.

Applications in 2023 spring canola	Winter wheat yield in 2024*
	bu/A
Treflan applied	119 a
No Treflan applied	117 a

*Means followed by the same letter are not statistically different ($P \leq 0.05$).

Metribuzin tolerance in Rydrich MZ winter wheat

I.C. Burke and J.E.R. Kalin

Metribuzin is a critical component of an integrated herbicide management system for control of troublesome grass weeds in wheat. Over the decades since the registration of metribuzin, farmers in the region have recognized that certain wheat varieties were much less tolerant than others, and in the absence of data, modified their approach to metribuzin use by lowering rates regardless of variety. Lower rates make metribuzin much less effective for annual grass control. Once the Group 2 herbicides, particularly Outlook/Maverick were introduced, metribuzin use declined. To enable farmers to make informed decisions about rate of metribuzin to use, a screening protocol was developed that identified Rydrich MZ as having very high levels of tolerance, and Crecent as having substantially lower levels of tolerance. This study objective was to evaluate metribuzin tolerance in Rydrich MZ winter wheat in comparison to a known susceptible and genetically similar variety, Crescent, in different soil and climate conditions.

Three study sites were identified for these trials: WSU Research Farm near Central Ferry, WA, WSU Wilke Farm near Davenport, WA, and a farm near Ralston, WA. At each application timing (Tables 1 through 5), metribuzin was applied at 3, 5, 9, and 12 oz/A. Preemergence applications of metribuzin were applied prior to planting in the fall at planting – note this application timing is known to be injurious and not labeled. Postemergence applications of metribuzin were applied when wheat had 2 leaves in early spring and when wheat was 3-5 tillers in late spring. Treatments were applied with CO₂-powered backpack sprayer and a 5-foot boom with four Teejet 11002VS nozzles. The sprayer was calibrated to 15 gallons per acre. These studies were conducted in a randomized complete block design with four replications and plots were 8 ft wide by 30 ft long. Emergence of wheat in response increasing doses of metribuzin in the fall was assessed, and injury was also assessed in response to postemergence applications. Yield was assessed by harvesting each plot with a small plot combine.

There was a site by metribuzin rate by application timing interaction, so each site is presented by metribuzin rate and timing. Preemergence applications of metribuzin were the most injurious, but only in four of the five experiments. At Davenport, in 2022 (Figure 1), and Central Ferry in 2023 (Figure 4), yield was not affected by increasing rates of metribuzin applied preemergence, regardless of variety. However, at Davenport in 2024 (Figure 5), preemergence applications affected yield of the Rydrich MZ variety but not Crescent. In Ralston and Central Ferry, in 2022 (Figures 2 and 3), stand loss and thus yield decreased with increasing rates of metribuzin. The use of metribuzin preemergence is not labeled, and these data highlight the reason – there is risk for injury in the form of stand loss likely related to timing of activating rainfall in relationship to germination of wheat and would be very challenging to manage.

Yields in response to metribuzin applied early and late postemergence varied by site and year. At Davenport and Ralston, in 2022, there was no yield reduction in response to increasing doses of metribuzin applied postemergence. At Central Ferry, in 2022, there was no yield response for either variety when metribuzin was applied early postemergence, but Crescent yield declined with increasing metribuzin rate when applied late postemergence. Rydrich MZ yield loss occurred in two treatments (6 and 12 oz/A metribuzin), but yield was similar to the nontreated at 3 and 9 oz/A. At Central Ferry, in 2023, a similar trend was observed, where Crescent yields

declined with increasing rate of metribuzin at the last postemergence timing, while Rydrich MZ yields were similar to the nontreated, regardless of rate or timing. At Davenport, in 2024, Crescent yield did not decline with early or late postemergence applications, but Rydrich MZ yield loss occurred at 3 oz/A when applied at early postemergence timing.

Rydrich MZ tolerance to metribuzin over sites, years, metribuzin rate, and metribuzin application timing has been consistently similar to the nontreated. Yield loss did occur when applied at an off-label application timing, but tolerance was observed when applied postemergence at rates up to 12 oz/A. These trials support the use of the entire rate range of metribuzin on Rydrich MZ, when applied according to product labels for metribuzin.

Table 1. Application details for trial on Wilke Farm Davenport, WA.

	Study Application		
Date	8/31/2021	4/20/2022	5/10/2022
Application volume (GPA)	15	15	15
Timing	Preemergence	Postemergence	Postemergence
Crop Stage	-	2 leaf	3-5 tiller

Table 2. Application details for trial near Ralston, WA.

	Study Application		
Date	10/6/2021	4/13/2022	5/4/2022
Application volume (GPA)	15	15	15
Timing	Preemergence	Postemergence	Postemergence
Crop Stage	-	2 leaf	3-5 tiller

Table 3. Application details for trial near Central Ferry, WA, in 2022

	Study Application		
Date	9/28/2021	3/12/2022	5/4/2022
Application volume (GPA)	15	15	15
Timing	Preemergence	Postemergence	Postemergence
Crop Stage	-	2 leaf	3-5 tiller

Table 4. Application details for trial near Central Ferry, WA, in 2023.

	Study Application		
Date	10/17/2022	3/22/2023	4/28/2023
Application volume (GPA)	15	15	15
Timing	Preemergence	Postemergence	Postemergence
Crop Stage	-	2 leaf	3-5 tiller

Table 5. Application details for trial near Davenport, WA, in 2024.

	Study Application		
Date	9/19/2023	4/12/2024	5/9/2024
Application volume (GPA)	15	15	15
Timing	Preemergence	Postemergence	Postemergence
Crop Stage	-	2 leaf	3-5 tiller

Figure 1. Response of Crescent and Rydlich MZ to increasing doses of metribuzin applied preemergence (Timing A), early postemergence (Timing B), and late postemergence (Timing C) in Davenport, in 2022.

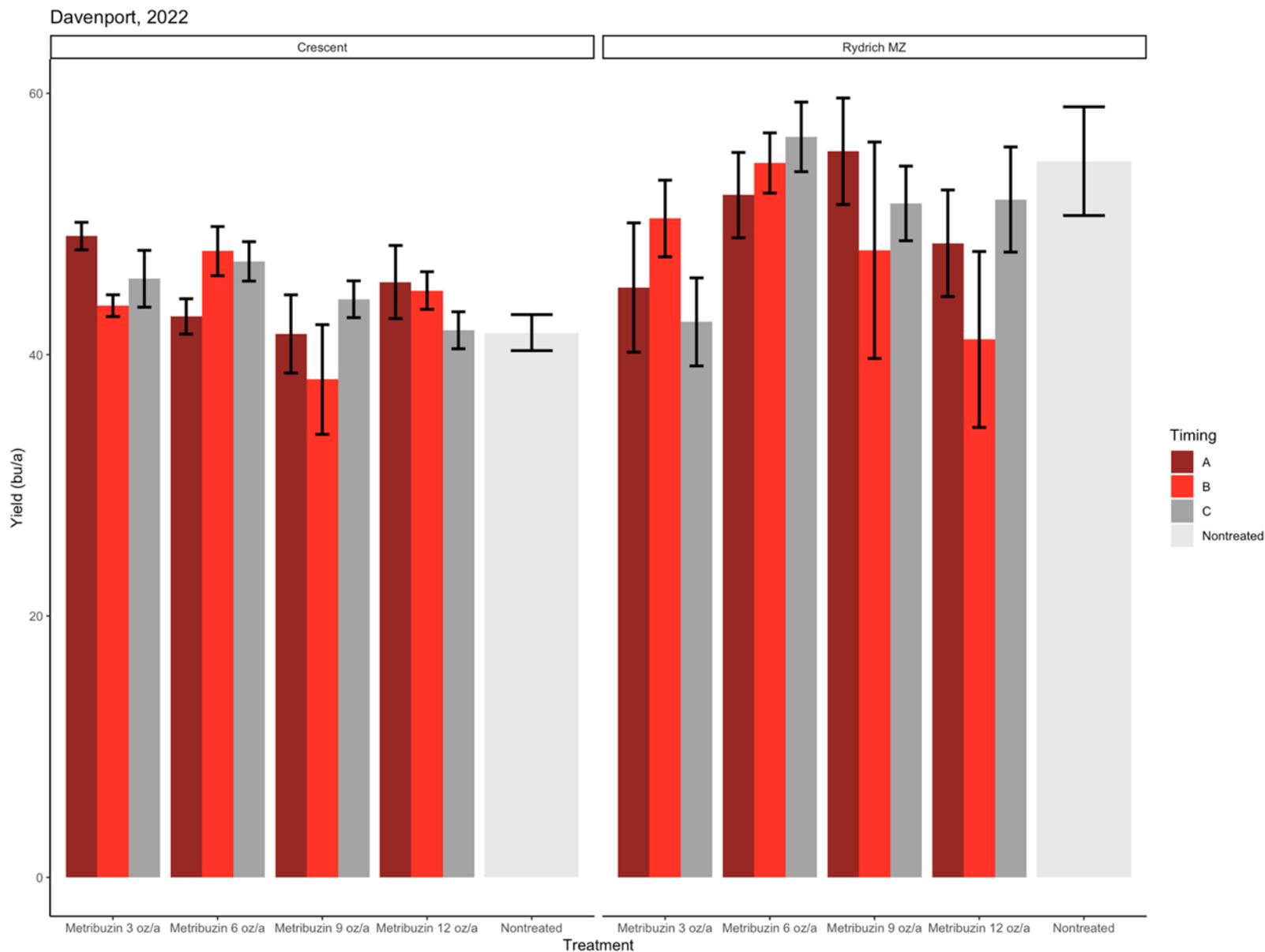


Figure 2. Response of Crescent and Rydlich MZ to increasing doses of metribuzin applied preemergence (Timing A), early postemergence (Timing B), and late postemergence (Timing C) in Ralston, in 2022.

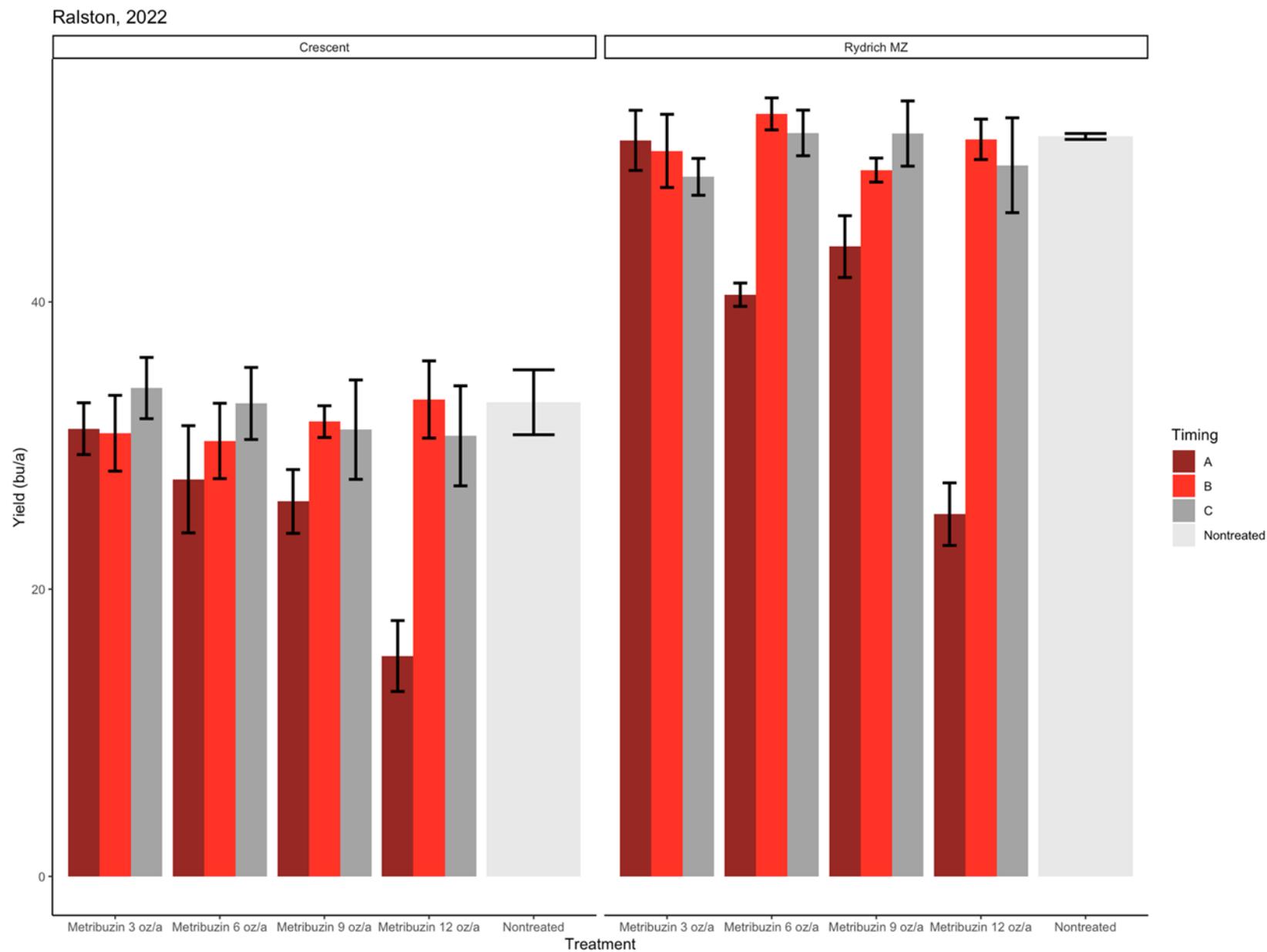


Figure 3. Response of Crescent and Rydlich MZ to increasing doses of metribuzin applied preemergence (Timing A), early postemergence (Timing B), and late postemergence (Timing C) in Central Ferry, in 2022.

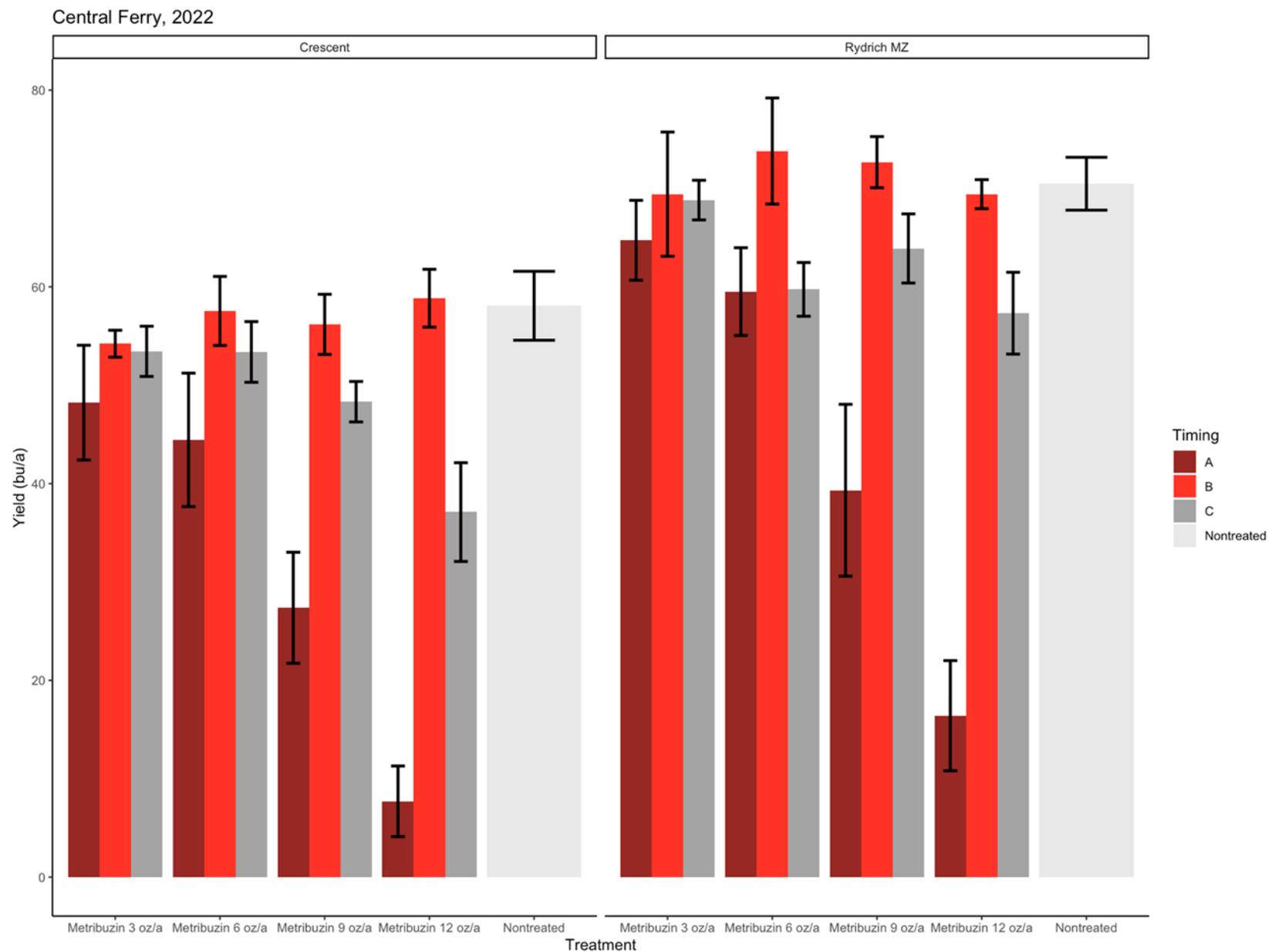


Figure 4. Response of Crescent and Rydlich MZ to increasing doses of metribuzin applied preemergence (Timing A), early postemergence (Timing B), and late postemergence (Timing C) in Central Ferry, in 2023.

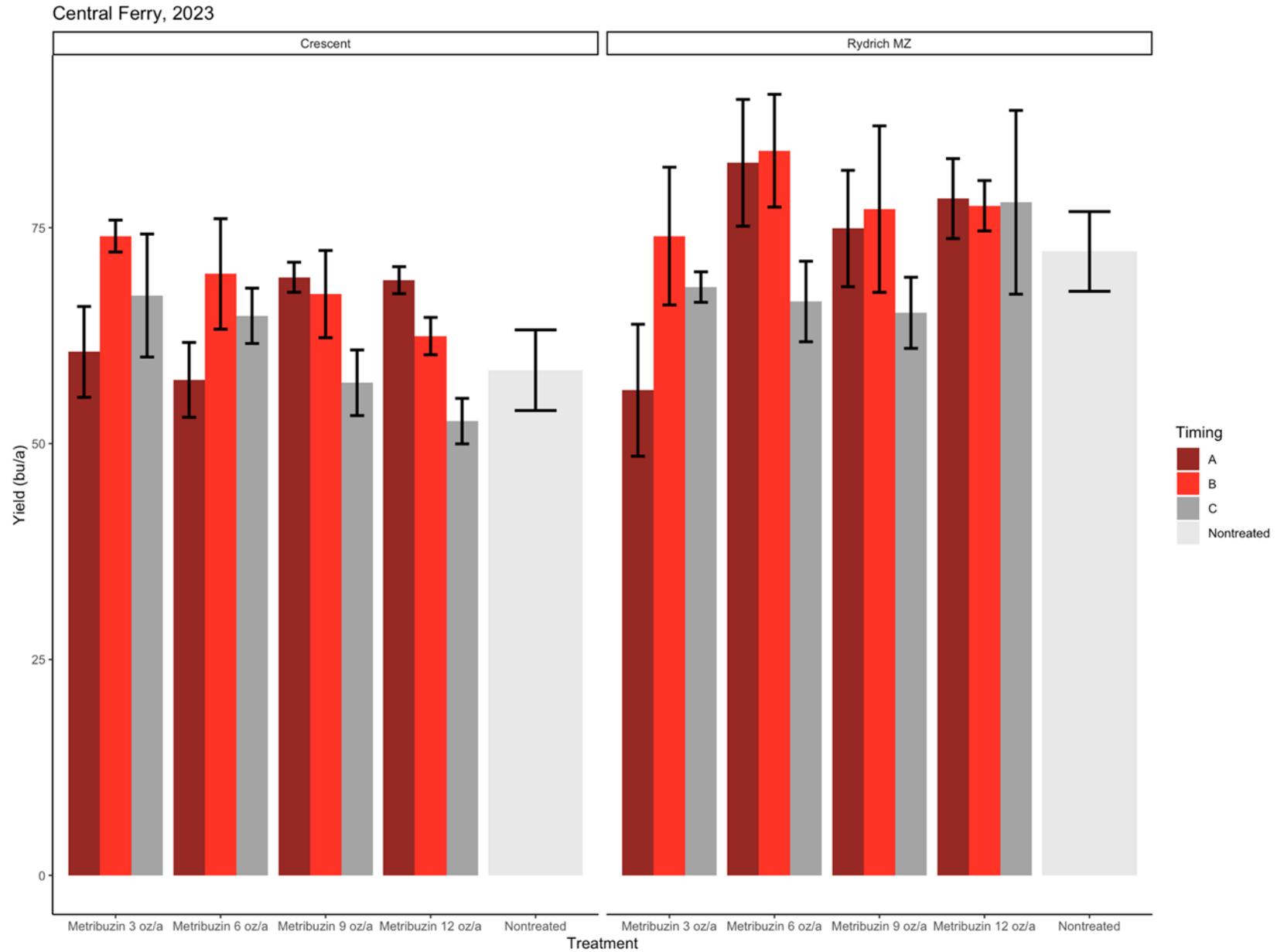
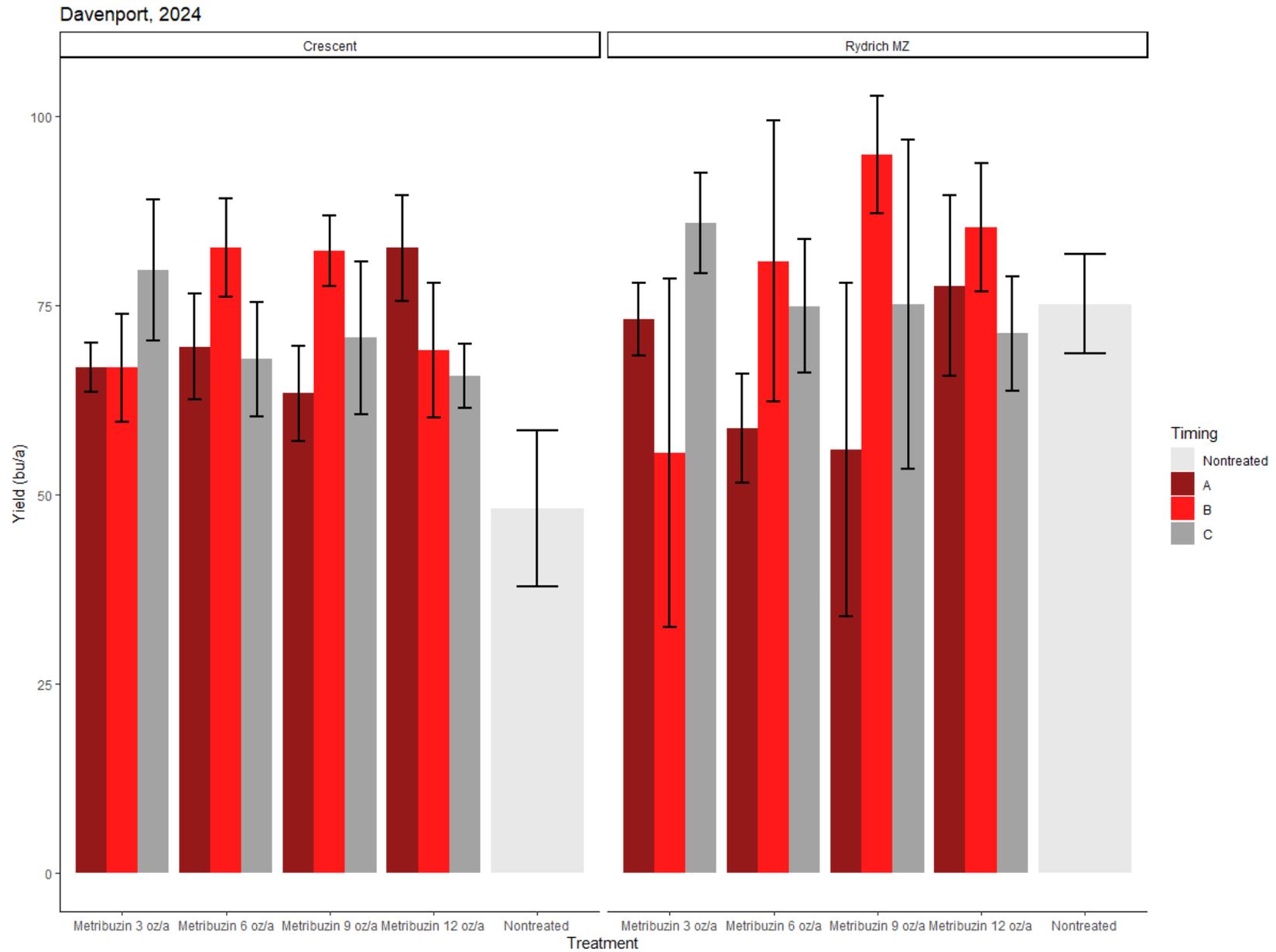


Figure 5. Response of Crescent and Rydrich MZ to increasing doses of metribuzin applied preemergence (Timing A), early postemergence (Timing B), and late postemergence (Timing C) in Davenport, in 2024.



Yellow rust control in winter wheat

J.E.R. Kalin & I. C. Burke

Introduction

In spring of 2024, a field trial was established to evaluate efficacy of three different fungicides to control yellow rust in winter wheat. Yellow rust is a significant disease that can reduce wheat yields and grain quality if not properly managed. The study focused on herbicides Osprey Xtra (mesosulfuron-methyl + iodofenoxifen-methyl-sodium), Huskie (pyrasulfotole + bromoxynil), and Brox-M (bromoxynil + MCPA), applied individually and in tank mixes with fungicides Prosaro Pro (tebuzonazole + prothioconazole + fluopyram), Tilt (propiconazole), Delaro (prothioconazole + trifloxystrobin), and Proline Gold (fluopyram + prothioconazole) – products containing fluopyram are not currently labeled for use in wheat in the United States.

The use of emulsifiable concentrates with high loads of petroleum distillates, like Brox-M, can reduce crop safety in complex mixtures. Furthermore, yellow rust prevalence varies from year to year but knowing if there is antagonism between the fungicides and business-as-usual herbicide tank mix is important for producers. Therefore, the objective of this study was to determine (1) crop injury, (2) yellow rust control, and (3) mayweed chamomile (*Anthemis cotula*) control using different fungicide tank mixes.

Methods

The study was established in winter wheat field near Pullman, WA. Treatments were applied when wheat was 3 to 5 tiller and actively growing (Table 1). Treatments were applied with a CO₂ powered backpack sprayer and a 5 ft boom with 3 Teejet 11002VS nozzles with an effective spray pattern of 8 ft and calibrated to deliver 15 gallons per acre (GPA). The study was conducted in a randomized complete block design with 4 replications. Plots were 12 ft wide by 20 ft long. Treatments were assessed for crop response, yellow rust control, and Mayweed chamomile control at 10, 25, and 40 days after treatment (DAA). Plots were harvested with a Wintersteiger small plot combine with a 5-foot header. Data were subject to ANOVA using the Agricultural Research Manager software (Ver. 2024).

Table 1. Treatment application details.

Study Application	
Date	5/3/2024
Application volume (GPA)	15
Timing	Postemergence
Crop Stage	3 to 5 Tiller
Air temperature (°F)	56
Wind velocity (mph, direction)	5, SSE
Relative humidity (%)	47

Results

The field that the trial was located did not have any detectable yellow rust in the 2024 growing season, so rust control ratings are not presented here. All treatments completely controlled mayweed chamomile when assessed at 25 and 40 DAA (data not shown). Some variability was observed at earlier stages (10 DAA), where control ranged from 17.5% to 80% depending on the treatment and the speed of the herbicide activity.

Phytotoxicity assessments indicated variable visible crop injury in treatments that included all three fungicides at the higher rates. Injury was primarily stunting and yellowing, with no significant impact on yield noted in any treatments. Yield data indicated that treatments did not significantly differ in bushel per acre (bu/A) outputs when compared to nontreated plots. Yields ranged from 210 bu/A (Osprey + Huskie + BROX + Delaro 7.8 oz/A) to 300 bu/A (Osprey + Huskie + BROX + Proline Gold 6.8 oz/A). Proline Gold, Prosaro, and Tilt contributed to the highest injury rates last year. We saw higher injury overall in 2023 compared to 2024.

The application of herbicides and fungicides in mixture is a common practice. Under adverse conditions such mixtures can result in significant injury. Ideally, applications of fungicides and herbicides should be separated. If a complex mixture is being considered, choosing the least injurious fungicide partner is advised to minimize potential yield loss.

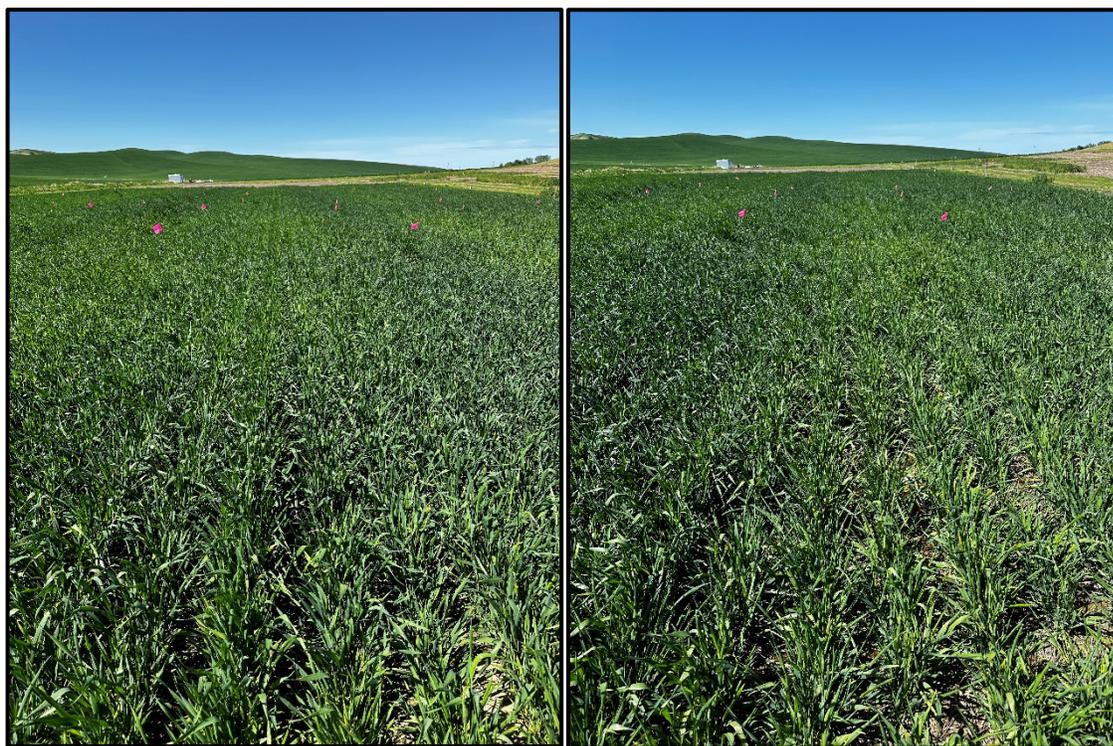


Figure 1. Nontreated plot (left) compared to treatment that included Osprey XTRA + Huskie + BROX-M + Prosaro Pro. There is slight stunting to the entire plot.

Table 2. Crop injury of winter wheat in response to fungicide tank mixes. Discoloration was not significantly different between treatments (alpha = 0.05).

Treatment ¹	Rate		Discoloration	Discoloration
			(%)	(%)
			5/13/2024	5/28/2023
Osprey XTRA	4.75	oz/A		
Huskie	13.5	oz/A	0	0
BROX-M	16	oz/A		
Osprey XTRA	4.75	oz/A		
Huskie	13.5	oz/A	15	5
BROX-M	16	oz/A		
Prosaro Pro	6.75	oz/A		
Osprey XTRA	4.75	oz/A		
Huskie	13.5	oz/A	5	0
BROX-M	16	oz/A		
Tilt	4	oz/A		
Osprey XTRA	4.75	oz/A		
Huskie	13.5	oz/A	15	5
BROX-M	16	oz/A		
Delaro	7.83	oz/A		
Osprey XTRA	4.75	oz/A		
Huskie	13.5	oz/A	10	0
BROX-M	16	oz/A		
Delaro	6.02	oz/A		
Osprey XTRA	4.75	oz/A		
Huskie	13.5	oz/A	5	0
BROX-M	16	oz/A		
Proline Gold	6.84	oz/A		
Osprey XTRA	4.75	oz/A		
Huskie	13.5	oz/A	0	0
BROX-M	16	oz/A		
Proline Gold	5.13	oz/A		

¹All treatments included NIS (0.25% v/v) and UAN (4 pt/A).

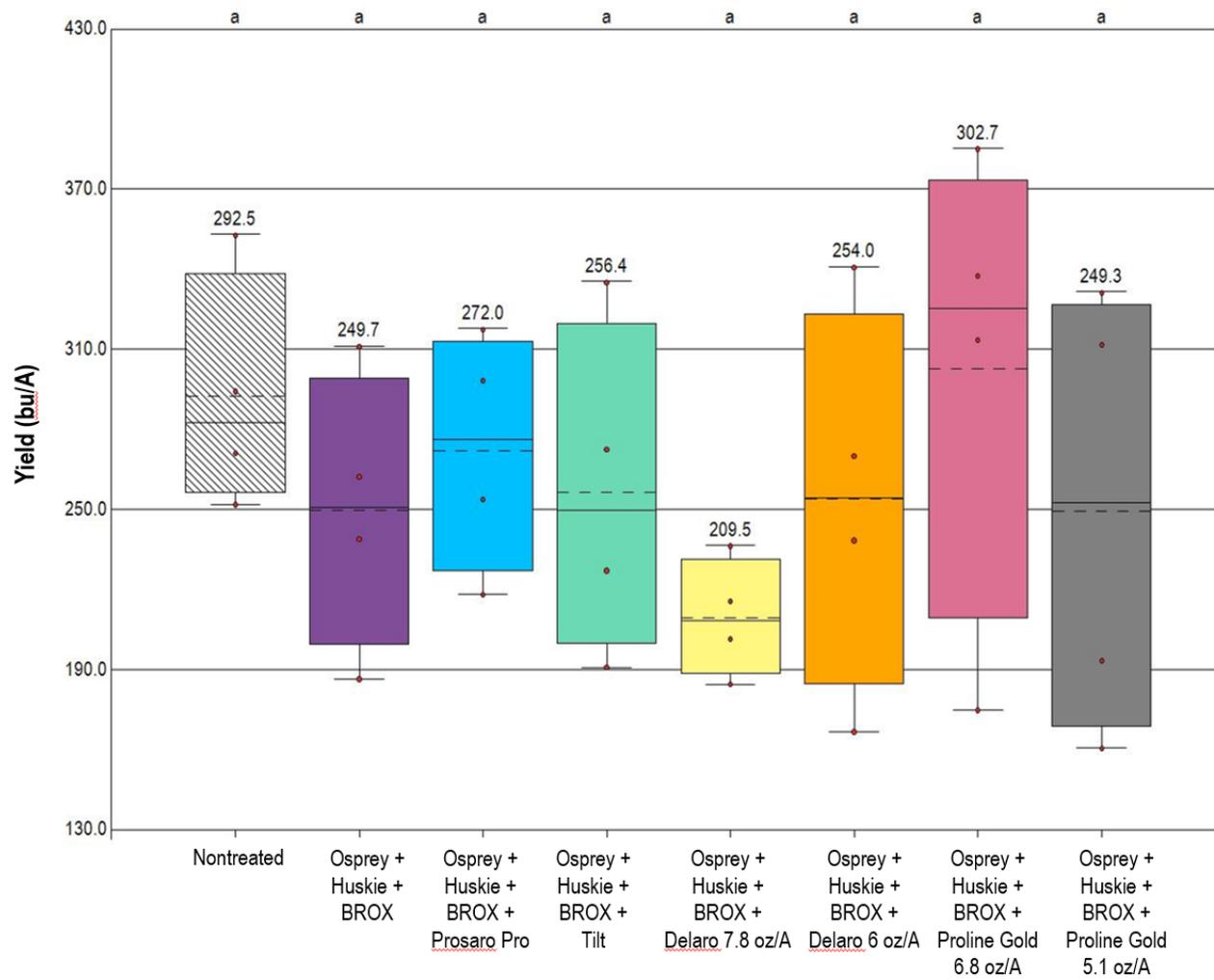


Figure 1. Yield of winter wheat in response to different fungicide tank mixes.

Tolvera[®] safety and efficacy in spring wheat

J.E.R. Kalin & I. C. Burke

Introduction

In 2024, a field trial was conducted to assess the performance of Tolvera in spring wheat. Tolvera, registered in Washington earlier this year, is specifically designed to target broadleaf weeds, making it a valuable tool for wheat growers seeking new modes of action for effective weed control. The goal of this trial was to evaluate the safety and efficacy of Tolvera at various application rates, both alone and in combination with other herbicides.

Methods

The study was established at the Palouse Conservation Field Station near Albion, WA in spring 2024. Treatments were applied when weeds were 2 to 4 inches and wheat was 2 to 4 tiller and both were actively growing (Table 1). Treatments were applied with a CO₂-powered backpack sprayer and a 5 ft boom with 3 Teejet 11002VS nozzles with an effective spray pattern of 8 ft and calibrated to deliver 15 gallons per acre (GPA). The study was conducted in a randomized complete block design with 4 replications. Plots were 10 ft wide by 30 ft long. Treatments were assessed for crop response and weed control 8, 15, and 26 days after treatment. Plots were harvested with a Wintersteiger small plot combine with a 5-foot header. Data were subject to ANOVA using the Agricultural Research Manager software (Ver. 2024).

Table 1. Treatment application details.

Study Application	
Date	6/6/2024
Application volume (GPA)	15
Timing	Postemergence
Crop Stage	3 to 5 Tiller
Air temperature (°F)	72-74
Soil temperature (°F)	70
Wind velocity (mph, direction)	2-3, SW
Relative humidity (%)	40

Results

All treatments were effective at controlling Mayweed chamomile (*Anthemis cotula*), with Tolvera + NIS having the lowest numerical control at 85% (Table 2). Control of common lambsquarters (*Chenopodium album*) varied but treatments were similar. Huskie and Talinor treatments completely controlled common lambsquarters. Prickly lettuce (*Lactuca seriola*) control was not different between treatments, with all herbicide treatments having 100% control (data not shown).

Minor crop injury, including chlorosis and stunting, was observed with certain treatments (Figure 1). Injury was most pronounced with combinations involving Tolvera + OpenSky, Tolvera + Axial Star, or Tolvera at 14 oz/A but did not significantly impact yields. Yield ranged from 45 bu/A (Tolvera + OpenSky, Tolvera + Axial Star) to 85 bu/A (Tolvera at 14 oz/A), with higher weed control generally correlating with greater yield. Both OpenSky and Axial Star have high loads of petroleum distillates, and combined with more aggressive surfactant packages may be injurious when used with Tolvera.

The trial demonstrated that Tolvera, especially at higher rates (14 oz/A), was effective in controlling problematic weed species in spring wheat. The importance of selecting the right herbicide combination as well as surfactant is underscored by the need to balance weed control efficacy with crop safety. Future work will focus on mixtures with other herbicides and surfactants to optimize activity and crop safety.



Figure 1. Nontreated plot (left) and Tolvera + OpenSky + Activator 90 (right).

Table 2. Crop injury and weed control in response to increasing rates of Tolvera alone and in tank mix. Means with the same letters are not significantly different from each other (alpha = 0.05).

Treatment	Rate		Chlorosis (%)		Injury (%)	Mayweed Control (%)	Lambsquarters Control (%)	Yield (bu/A)
			6/14/2024		6/21/2024	7/2/2024	7/2/2025	8/29/2024
Tolvera	11	oz/A	10	ab	5	95	90	72
MSO	0.5	%v/v						
Tolvera	14.7	oz/A	15	a	5	95	97	82
MSO	0.5	%v/v						
Tolvera	11	oz/A						
OpenSky	16	oz/A	15	a	5	90	97	44
Activator 90	0.5	%v/v						
Amsol	60	oz/A						
Tolvera	11	oz/A	10	ab	0	97	95	78
Axial Star	16.4	oz/A						
Tolvera	11	oz/A						
Harmony SG	0.3	oz/A	10	ab	0	92	97	84
Express 50 SG	0.3	oz/A						
MSO	0.5	%v/v						
Huskie	15	oz/A	5	b	0	100	100	80
NIS	0.5	%v/v						
Talinor	18.2	oz/A						
CoACT+	3.6	oz/A	5	b	0	95	100	69
NIS	0.5	%v/v						
Tolvera	14.7	oz/A	0	b	0	85	90	86
NIS	0.5	%v/v						

Italian ryegrass control and crop yield in winter peas

Mark Thorne and Drew Lyon

Winter pea (*Pisum sativum* L.) is a legume crop that can be grown in the Palouse region of Washington and Idaho as an alternative to a spring-planted legume crop. Winter peas are planted in the fall and overwinter in a vegetative stage (Figure 1) until spring when they produce extensive above-ground biomass that can overtake and suppress weed growth. Italian ryegrass (*Lolium perenne* L. ssp. *multiflorum*) is a problem weed in the Palouse, especially for spring-planted crops, because of resistance to Group 1 and Group 2 herbicides. Planting winter peas increases the potential for Italian ryegrass control by combining the use of effective fall-applied herbicides with the suppressive competitive winter pea growth in the spring.



Figure 1. Winter pea seedling in November 2023.

A study was initiated north of Pullman, WA in early October 2023 in a field that had produced a winter wheat crop in 2023. The field was prepared for fall-seeding with a chisel plow followed by a harrow. Herbicides were applied on October 7 and winter peas were seeded October 9 and were emerging by October 17. Herbicides were applied with a 10-ft hand-held spray boom with six TeeJet[®] AIXR110015 nozzles on 20-inch spacing and pressurized with a CO₂ backpack. Spray output was 15 gpa at 40 psi with a ground speed of 3 mph.

Herbicides with active ingredients potentially effective on Italian ryegrass included clomazone in Command[®] 3ME (Group 13) and pyroxasulfone in Authority Supreme[®] (Group 15); however, Authority Supreme also contains sulfentrazone (Group 14), which has little cool-season grass activity. Experimental product F9600 contains bixlazine (Group 13), which is being tested for Italian ryegrass control. Spartan Charge[®] (carfentrazone, Group 14; sulfentrazone, Group 14), Express[®] XP (tribenuron, Group 2), and WeatherMax[®] (glyphosate, Group 9) are included for control of weeds other than Italian ryegrass, if present. Currently, Command 3ME and Express XP are not label for use in winter or dry peas.

By November 2023, some bleaching was seen on <2% of winter pea plants in plots treated with Command 3ME (data not shown) (Figure 2); however, this did not persist into the spring as crop injury was not present at the May 14, 2024, visual rating (Table 1). Furthermore, no bleaching or injury was observed on winter peas treated with experimental F9600. Group 13 herbicides block

pigmentation; therefore, injury would present early with bleached or white colored leaves. Winter peas treated with Authority Supreme or Authority Supreme + Express XP had 20 and 22% injury, respectively, as stunted growth at the May 14 rating.

The greatest Italian ryegrass control was 96% with Authority Supreme and 95% with Authority Supreme + Express XP (Table 1). Control with Authority Supreme is likely a function of the pyroxasulfone inhibiting emergence. The 24 oz/A rate of Command 3ME was 60% effective in controlling Italian ryegrass but none of the other treatments resulted in acceptable control.



Figure 2. Bleaching on winter pea leaf in November from a clomazone treatment.

Italian ryegrass did not reduce yields in this study as the nontreated check had the highest yield at 1490 lb/A and was not different from all other treatments except the 24 oz/A rate of Command 3ME yielding 1170 lb/A or the WeatherMax treatment yielding 1170 lb/A. It is possible that the high rate of Command 3ME did cause some crop yield loss, but it is not clear why WeatherMax alone would have reduced yield as all other treatments except the nontreated check included WeatherMax to control weeds or volunteer prior to planting.

In this study, the dense winter pea canopy had smothered any Italian ryegrass or other weeds present; therefore, visual ratings or density counts were not possible after the May ratings or prior to crop harvest. Weed control from competition from the winter pea crop for light and space would likely explain why the nontreated check had a relatively high yield compared with the other treatments. Crop competition plus an effective pre-plant herbicide could be a very effective strategy for controlling Italian ryegrass in a legume crop.

Table 1. Italian ryegrass control with herbicides applied preplant in winter peas, and winter pea injury and yield.

Treatments*	Rates	Visual ratings May 14, 2024		Pea Yield**
		Winter pea injury**	Italian ryegrass control**	
	(oz/A)	-----(% of check)-----		(lb/A)
Nontreated check	---	0	0	1490 a
Command 3ME + Spartan Charge	4 + 8	0 c	15 de	1270 ab
Command 3ME + Spartan Charge	8 + 8	0 c	34 bcde	1290 ab
Command 3ME + Spartan Charge	16 + 8	0 c	23 cde	1490 a
Command 3ME + Spartan Charge	24 + 8	0 c	60 b	1170 b
Authority Supreme	15.4	20 b	96 a	1470 a
Authority Supreme + Express XP	15.4 + 0.5	22 a	95 a	1340 ab
F9600 + Spartan Charge	12.8 + 8	0 c	39 bcd	1210 ab
F9600 + Spartan Charge	25.6 + 8	0 c	49 bc	1300 ab
WeatherMax	32	0 c	11 e	1170 b

*All treatments except the nontreated check included WeatherMax at 32 oz/A at application.

**Means followed by the same letter in each column are not different ($P \leq 0.05$).

Fall-applied Eptam[®] 7-E herbicide for Italian ryegrass control in spring-planted crops

Mark Thorne and Drew Lyon

Controlling annual ryegrass (*Lolium perenne* L. ssp. *multiflorum*) in spring crops is a challenge in areas where Italian ryegrass has developed resistant to Group 1 (ACCase inhibitors) and Group 2 (ALS inhibitors). Alternate herbicide strategies include Group 3 (root growth inhibitors) like Sonalan[®] HFP or Treflan[®] HFP, or Group 15 herbicides like Far-Go[®] 4EC or Avedex[®] Microactiv that inhibit synthesis of very long chain fatty acids; however, these soil-active herbicides require incorporation and rainfall for soil activation and lack of rainfall after application can limit their efficacy when applied in the spring prior to crop planting. Fall application guarantees there will be sufficient moisture to activate soil-applied herbicides, but it is not clear if herbicides applied in the fall will still be active the following spring.

We applied Eptam 7-E (EPTC), a Group 15 herbicide like Far-Go 4EC, alone and in tank mixes with other soil-active herbicides (Table 1) on September 22, 2023, following rains that moistened the soil enough for cultivation and to absorb the herbicides. The field site that had been in winter wheat during 2023 and was prepared by flail mowing the winter wheat stubble and cultivating the ground to a depth of 4 inches to expose enough soil to intercept the herbicides. Following herbicide applications, the study site was roller packed to help seal the soil to keep the Eptam 7-E from volatilizing off the surface. Herbicides were applied with a 10-ft hand-held spray boom with six TeeJet[®] AIXR110015 nozzles on 20-inch spacing and pressurized with a CO₂ backpack. Spray output was 15 gpa at 40 psi with a ground speed of 3 mph.



Figure 1. Eptam 7-E field trial following preparation and herbicide applications in September 2023 (left); nontreated check plot July 2024 (middle) compared with Italian ryegrass control with fall-applied herbicides (right).

The Eptam 7-E label allows for fallow applications at a minimum of 45 days prior to planting of a crop not labeled for Eptam 7-E application; therefore, the application timing was within label requirements because it was in the fallow period between winter wheat harvest and spring planting; however, we included a 14 pt/A rate, which is twice the maximum labeled rate. Tank mixes included Eptam 7-E with Treflan HFP, Sonalan HFP, Far-Go 4EC, Zidua[®] SC (pyroxasulfone, Group 15), and Alion[®] (indaziflam, Group 29). Tank mixes with Far-Go 4EC (above allowable rate), Sonalan HFP (above allowable rate), and Alion (not labelled for this use) are experimental off-label applications.

Table 1. Italian ryegrass control following fall-applied soil-active herbicides.

Treatment	Rate	Italian ryegrass	Italian ryegrass control in spring crops*				
		Preplant	Chickpeas	Lentils	Peas	Wheat	Average
----- (percent of nontreated check)-----							
Nontreated check		0	0	0	0	0	0
Eptam 7-E	5 pt/A	74 d	52 bc	22 c	17 d	0 d	25 d
Eptam 7-E	7 pt/A	93 c	24 c	11 c	88 c	15 cd	40 d
Eptam 7-E	14 pt/A	94 bc	49 bc	41 bc	93 bc	74 ab	67 bc
Eptam 7-E + Treflan HFP	7 pt/A + 1.5 pt/A	95 bc	83 ab	38 bc	97 abc	37 bc	67 c
Eptam 7-E + Far-Go 4EC	7 pt/A + 4 qt/A	97 ab	89 a	78 a	100 a	77 ab	85 ab
Eptam 7-E + Zidua SC	5 pt/A + 2.5 oz/A	98 ab	88 a	68 ab	99 ab	67 ab	80 abc
Eptam 7-E + Zidua SC	7 pt/A + 6.5 oz/A	98 ab	93 a	86 a	100 a	96 a	93 a
Eptam 7-E + Sonalan HFP	7 pt/A + 4.5 pt/A	99 a	77 ab	78 a	99 ab	63 b	80 abc
Eptam 7-E + Alion	7 pt/a + 3.5 oz/A	99 a	91 a	85 a	99 ab	61 b	84 abc

*Means followed by the same letter in each column are not different ($P \leq 0.05$).

On April 2, 2024, prior to planting spring crops, PowerMax[®] (glyphosate) was applied at 24 oz/A to control volunteer crop and weeds that had germinated during the winter. On April 16, spring peas (163 lb/A), lentils (33 lb/A), and spring wheat (110 lb/A) were direct-seeded across each plot with a Great Plains[®] drill with double-disc openers on 10-inch spacing. On April 28, chickpeas (128 lb/A) were seeded when the soil temperature had warmed above 55°F.

Herbicide efficacy was evaluated visually as percent of the nontreated check plots on March 20, 2024, prior to the April 2 PowerMax application and again on July 5 when the Italian ryegrass could be easily identified in the crops (Table 1) and crop injury from the herbicides was evident. Crop injury was seen as stunting and/or decreased crop density.

Italian ryegrass control on March 20 was greater than 90% with all treatments except the 5 pt/A rate of Eptam 7-E. Treatments with the highest level of control were tank mixes of Eptam 7-E with either Far-Go 4EC, Zidua SC, Sonalan HFP, or Alion. On July 5, crop height was 16 inches for chickpeas, 12 inches for lentils, 30 inches for spring peas, and 32 inches for spring wheat. Italian ryegrass had flowered and was developing seeds in all crops; however, the dense spring pea canopy was very competitive and Italian ryegrass plants were stunted under the canopy. By July 5, Italian ryegrass control, on average, was still greatest with tank mixes of Eptam 7-E with Far-Go 4EC, Zidua SC, Sonalan HFP, and Alion; however, some differences in control could be seen in each crop. Italian ryegrass control in spring peas was high with all tank mixes and was aided by the dense crop canopy. In spring wheat, Eptam 7-E plus the 6.5 oz/A rate of Zidua SC had better control than Eptam 7-E with Sonalan HFP or Alion or the 7 oz/A rate of Eptam 7-E, alone. The wheat canopy was vertically dense but not horizontally dense, therefore light could get to the ground between the rows. Italian ryegrass control in chickpeas appeared greater than in lentils as ratings were 90% or greater with all treatments except the 5 oz/A rate of Eptam 7-E alone. In lentils, $\geq 90\%$ was only seen with the high rate of Zidua SC plus Eptam 7-E.

Crop injury observed as stunting and/or decreased density was only slightly evident on the pulse crops from the Eptam 7-E plus Alion tank mix with 7% for chickpeas and 4% for lentils (data not shown). Slight stunting to the spring peas was highly variable and not statistically different from zero. However, Eptam 7-E plus Alion caused 35% stunting and thinning of the spring wheat. Furthermore, Eptam 7-E plus Sonalan HFP injury to the spring wheat crop was 5%. No other herbicide treatments caused any visible injury; however, we did not harvest the crops for yield.

Eptam 7-E at 7 pt/A applied in the fall is a labeled fallow application providing it occurs at least 45 days before planting a crop that is otherwise not on the Eptam 7-E label. Fall-applied Eptam 7-E in our trial substantially reduced Italian ryegrass density into the following spring prior to planting; however, the 7 pt/A rate did not maintain good control during crop growth without the addition of a tank mix partner such as the above-label rate of Far-Go 4EC or with the maximum labeled rate of Zidua SC of 6.5 oz/A. On a cautionary note, applying Zidua SC in the fall following a wheat crop where it may have been also applied is not recommended. Zidua SC is one of the few herbicides still active on Italian ryegrass and applications two years in a row may promote resistance to the herbicide. Sonalan HFP at the above-label rate of 4 pt/A rate was more effective than the label rate of Treflan HFP in lentils, peas, and spring wheat.

Fall applied soil-active herbicides may be an option for reducing Italian ryegrass in spring crops, but more research is needed to identify effective herbicide treatments and labeled rates.

Italian ryegrass control with BAS 101005H glufosinate and Sonalan® HFP in spring canola

Mark Thorne and Drew Lyon

Glufosinate is a Group 10 herbicide and is an alternative to glyphosate, Group 9, for the control of Italian ryegrass in spring canola (Figure 1). Glyphosate is currently being used for Italian ryegrass control in glyphosate-resistant spring canola, and its extensive use increases the likelihood of developing Italian ryegrass resistant to glyphosate. Sonalan HFP (ethalfluralin) is a Group 3 herbicide that inhibits cell division in plant roots, and therefore, must be incorporated in the soil prior to seed germination to be effective. Glufosinate's mode of action differs from glyphosate's mode of action and works by inhibiting glutamine synthetase, an enzyme involved in the synthesis of the amino acid, glutamine. Inhibition of glutamine synthetase quickly results in a toxic buildup of ammonia in plant cells that destroys cell membranes. Glufosinate is commercially available in several products; however, all currently labeled glufosinate products contain two glufosinate molecular isomers, but only one isomer has herbicidal activity. BAS 101005H is a new glufosinate product being tested that consists of only the active isomer.



Figure 1. Italian ryegrass and common lambsquarters in spring canola in a nontreated control plot (left), spring canola in plot with preplant incorporated Sonalan HFP (middle), flowering spring canola in a nontreated control plot in the foreground and preplant incorporated Sonalan HFP in the background (right).

LibertyLink® spring canola is resistant to glufosinate because of a gene that codes for an enzyme that converts glufosinate to a non-toxic metabolite in the plant. Glufosinate-resistant canola was first developed in 1995. Glufosinate-resistant canola provides an herbicide option for Italian ryegrass control that can help delay the development of glyphosate-resistant Italian ryegrass.

We compared herbicide treatments for Italian ryegrass control in spring canola at the WSU Cook Agronomy Farm. In addition, common lambsquarters germinated in all plots as the canola was emerging and was included in the weed control assessments. The study site had produced chickpeas in 2023, and the residue was left in place through the winter. On March 22, 2024, liquid fertilizer, 100-10-0-20 N-P-K-S lb/A was stream-jet applied and then cultivated to incorporate the fertilizer. On April 2, Sonalan HFP, was applied at 24 and 32 oz/A preplant and incorporated (PPI) twice at 90° at a depth of 2-3 inches with a field cultivator and attached tine harrow. Spring canola cultivar ‘InVigor® LibertyLink/TruFlex® LR345PC, which has resistance genes to both glufosinate and glyphosate, was seeded on April 15 with a direct-seed drill with double-disc openers on 10-inch spacing. The seeding rate was 12 seeds per ft² at 0.75 to 1.0 inch deep. Early postemergence (EPOST) applications were applied on May 15 (see Table 1 for rates) when the canola had 3 leaves. The Italian ryegrass had 1-4 leaves and averaged 180 plants yd⁻² in the nontreated check plots. Common lambsquarters plants ranged from cotyledon stage to 2 inches in diameter and averaged 1800 plants yd⁻². Late postemergence (LPOST) treatments were applied on May 27 when the canola had 6 leaves. The Italian ryegrass plants were tillered and 4-12 inches high and the common lambsquarters ranged from 1-4 inches in diameter.

All herbicides were applied with a 10-ft hand-held spray boom with six TeeJet® AIXR110015 nozzles on 20-inch spacing and pressurized with a CO₂ backpack. Spray output was 15 gpa at 40 psi with a ground speed of 3 mph. All BAS 101005H and Surmise® 5 (glufosinate) applications included ammonium sulfate (AMS) at 3 lb dry granules/A, and all PowerMax® (glyphosate) applications included AMS at 2.6 lb dry granules/A. Italian ryegrass and common lambsquarters control were rated visually on May 15 (43 days after PPI application), and June 10 (14 days after LPOST applications) as a percent of the nontreated checks. Canola was harvested with a plot combine and samples were bagged, cleaned, and weighed to calculate plot yield.

Weed control from the PPI Sonalan HFP applications average ≥89% for Italian ryegrass and ≥83% for common lambsquarters by May 15 when the canola had three leaves and the EPOST treatments were applied (Table 1). Densities of both weed species were substantially reduced by the PPI treatments, which would have benefited the EPOST applications. Initial Italian ryegrass and common lambsquarters densities on May 15 averaged 180 and 1800 plants/yd², respectively. By June 10, two weeks after the LPOST applications, the most effective treatments for both Italian ryegrass and common lambsquarters were the tank mix of BAS 101005H + PowerMax at 22 oz/A EPOST, and split applications of PowerMax at 44 oz/A EPOST followed by (fb) BAS 101005H LPOST, and Sonalan HFP PPI at 24 oz/A fb PowerMax EPOST at 44 oz/A (Table 1). The single application of PowerMax at 44 oz/A EPOST was less effective at controlling Italian ryegrass than when followed by BAS 101005H LPOST. Control of Italian ryegrass (85%) and common lambsquarters (80%) with a split application of BAS 101005H was substantially more effective than the split application of Surmise 5, which was not effective on either species. Finally, there was no added benefit of applying Sonalan HFP at 32 oz/A compared with 24 oz/A for controlling either weed species.

In this trial, spring canola yield was exceptionally high with the highest yielding treatments averaging 3330 to 3580 lb/A (Table 1) with control of early flushes of Italian ryegrass and common lambsquarters with Sonalan HFP contributing to higher yields. For example, Sonalan

HFP fb PowerMax EPOST at 44 oz/A yielded 3500 lb/A compared with 3200 lb/A with only a single EPOST application of PowerMax at 44 oz/A. Furthermore, Sonalan HFP, alone, at 32 oz/A resulted in one of the highest yields of 3580 lb/A even though it did not give the highest level of weed control. The split application of BAS 101005H also resulted in a higher yield, 3330 lb/A, without giving the highest level of weed control. In contrast, the split application of Surmise 5 did not control either Italian ryegrass or common lambsquarters and resulted in the second lowest yield of 2300 lb/A and only greater than the nontreated check yielding 1760 lb/A.

Controlling Italian ryegrass with PPI treatments is an effective strategy for reducing the chances of developing resistance because of the reduced plant density to which the postemergence treatments will be applied. Additionally, canola yield was enhanced by the early season weed control provided by Sonalan HFP. BAS 101500H can be an effective alternative to glyphosate but would require a second application or be preceded by an effective PPI herbicide.

Table 1. Italian ryegrass and common lambsquarters control in spring canola.

Herbicide applications*			Visual control ratings**				Canola yield lb/A
			Italian ryegrass		Common lambsquarters		
PPI	EPOST	LPOST	15-May	10-Jun	15-May	10-Jun	
----- (fl oz/A)-----			-----(percent of nontreated check)----				
			0	0	0	0	1760 e
---	BAS(24)	BAS(24)	---	85 bc	---	80 b	3330 abc
---	SUR5(16)	SUR5(16)	---	0 e	---	7 c	2300 d
---	BAS(24) + PM(22)	---	---	89 abc	---	92 a	3380 abc
---	BAS(24) + PM(44)	---	---	82 cd	---	94 a	3230 bc
---	PM(44)	BAS(24)	---	93 ab	---	95 a	3170 c
---	PM(44)	---	---	84 c	---	95 a	3200 bc
---	BAS(24)	PM(22)	---	83 cd	---	93 a	3229 bc
SLN(24)	---	---	89 a	73 d	87 a	77 b	3330 abc
SLN(32)	---	---	91 a	84 cd	89 a	80 b	3580 a
SLN(24)	BAS(24)	---	90 a	73 d	83 b	72 b	3480 abc
SLN(24)	PM(44)	---	89 a	94 a	86 ab	95 a	3500 ab

*Application timings: PPI=preplant incorporated (April 2, 2024); EPOST=postemergence with canola at 3 leaves (May 15, 2024); LPOST=canola at 6 leaves (May 27, 2024). Herbicides: SLN=Sonalan HFP; BAS=BAS 101005H; SUR5=Surmise 5; PM=PowerMax. All glyphosate treatments included ammonium sulfate at 3 lb/A. All BAS 101005H treatments included ammonium sulfate at 2.6 lb/A.

**Means in each column followed by the same letter are not significantly different ($P \leq 0.05$).

Alion® crop safety and efficacy in Kentucky Bluegrass

J.E.R. Kalin & I. C. Burke

Introduction

In fall of 2023, an herbicide trial was conducted to evaluate the safety and efficacy of Alion (indaziflam) in Kentucky bluegrass grown for seed. Annual grass weeds, such as Italian ryegrass (*Lolium multiflorum*), are difficult to control in grass seed fields and infestations can reduce stand quality, longevity, and productivity. Alion controls annual grass weeds by inhibiting cellulose biosynthesis in newly germinated seedlings.

Methods

The study was established in a 2nd-year Kentucky bluegrass field near Rockford, WA. Treatments were applied when the Kentucky bluegrass was 3 to 5 tiller and actively growing in the fall of 2023. Treatments were applied with a CO₂ powered backpack sprayer and a 5 ft boom with 3 Teejet 11002VS nozzles with an effective spray pattern of 8 ft and calibrated to deliver 15 gallons per acre (GPA). The study was conducted in a randomized complete block design with 4 replications. Plots were 10 ft by 25 ft long. Treatments were assessed for crop response and weed control in the spring, 6 months after treatment. Two ½ m² subsamples were harvested from each plot to estimate yield. Data were subject to ANOVA using the Agricultural Research Manager software (Ver. 2024).

Table 1. Treatment application details.

Application Code	Study Application	
	A	B
Date	10/12/2023	4/17/2024
Application volume (GPA)	15	15
Timing	Postemergence	Postemergence
Crop Stage	3 to 5 tillers	3 to 5 tillers
Air temperature (°F)	55	40
Wind velocity (mph, direction)	4, NNE	2, N
Relative humidity (%)	66	62

Results

Weed control complete for all herbicide treatments across all evaluation dates (188, 203, and 217 days after first application). Alion, regardless of rate, and Callisto at 16 oz/a are effective for controlling Italian ryegrass.

No visible crop injury (0% phytotoxicity) was observed across all treatments during the evaluation period. Both Alion and Callisto were safe for use on Kentucky bluegrass at the rates tested in this trial. Plots were harvested on July 2, 2024. Yield was similar among treatments due to low weed pressure and absence of crop injury. Germination percentage was assessed using a subset of harvested seeds. Germination for all treatments ranged 70-78% and was not significantly different among treatments. Germination rates are reported as a percentage of viable seeds that germinated under controlled conditions.

The yield and germination data indicate that the split application of Alion (1.5 oz/a) slightly outperformed other treatments, achieving the highest yield and germination rates. While Alion at 3 oz/a resulted in lower yields, it maintained germination rates comparable to other treatments, suggesting that the higher

rate might impact yield due to other factors rather than seed quality. The herbicides in this trial effectively controlled Italian ryegrass with no adverse effects on Kentucky bluegrass. These findings support their use as effective weed management tools in grass seed production systems. Future studies could explore tank mixes and longer-term effects on crop performance.

Table 2. Yield (lb/A) and germination (%) of Kentucky bluegrass in response to increasing rates of Alion herbicide treatments. Means were not significantly different between treatments ($\alpha=0.5$).

Treatment	Rate		Timing	Yield (lb/A)		Germination (%)	
				7/2/2024	11/22/2024	7/2/2024	11/22/2024
Alion	2	oz/A	A	1208		70	
Alion	3	oz/A	A	912		74	
Alion	1.5	oz/A	A				
Alion	1.5	oz/A	B	1333		78	
Callisto	16	oz/A	A	1134		77	

Anthem® Flex crop safety and efficacy in Kentucky Bluegrass
J.E.R. Kalin & I. C. Burke

Introduction

Annual grass weeds are difficult to manage in grass seed fields due to similarities in physiology and lifecycles, and infestations can reduce stand longevity and productivity. Preemergence herbicides that control annual grasses selectively in Kentucky bluegrass are critical components of a weed management system. Pyroxasulfone, the active ingredient in Anthem Flex that has soil residual activity, is a new herbicide being considered for use in Kentucky bluegrass. The study objective was to evaluate Anthem Flex (pyroxasulfone + carfentrazone-ethyl) crop safety and efficacy in newly seeded Kentucky bluegrass.

Methods

The study was established in a 2nd-year Kentucky bluegrass field near Rockford, WA. Treatments were applied when the Kentucky bluegrass was 3 to 5 tiller and actively growing in the fall of 2023. Treatments were applied with a CO₂ powered backpack sprayer and a 5 ft boom with 3 Teejet 11002VS nozzles with an effective spray pattern of 8 ft and calibrated to deliver 15 gallons per acre (GPA). The study was conducted in a randomized complete block design with 4 replications. Plots were 10 ft by 25 ft long. Treatments were assessed for crop response and weed control in the spring, 6 months after treatment. Two ½ m² subsamples were harvested from each plot to estimate yield and determine germination rates. Data were subject to ANOVA using the Agricultural Research Manager software (Ver. 2024).

Table 1. Treatment application details.

Study Application		
Application Code	A	B
Date	10/12/2023	4/17/2024
Application volume (GPA)	15	15
Timing	Postemergence	Postemergence
Air temperature (°F)	55	40
Relative humidity (%)	66	62
Wind velocity (mph, direction)	4, NNE	2, N
Cloud Cover (%)	100	0

Results

Control of Italian ryegrass (*Lolium multiflorum*) was very good to excellent for all treatments. Outrider applied alone provided the lowest control at 92%. Treatments the included Anthem Flex consistently provided over 95% control.

Crop injury presented as stunted growth in plots where Anthem Flex was applied at rates over 2.75 oz/A, either alone in the fall or combined fall and spring applications (treatments 3-6, 8) (Table 2). Calculated yields were not different among treatments, though treatments that kept Anthem Flex rates around 3 oz/A yielded higher than other treatments (up to 2370 lb/A) (Table 3). Germination rates remained unaffected by herbicide application, ranging between 65-80% across treatments (Table 3).

In a similar trial in 2022, no injury was observed in any of the treatments, and we found similar rates of germination (65-85%). In another trial in 2023, high rates of Anthem Flex applied either alone in the fall or combined fall and spring applications caused similar injury seen in this trial (10-15%). We observed similar germination rates (62-80%) in the 2023 trial. We did find numerically lower yield in plots treated

with Anthem Flex applied at 2.75 oz/A in the fall and 1 oz/A in the spring (treatment 4), however it was not significantly lower than other treatments.

Anthem Flex appears to be a robust tool for Italian ryegrass management in Kentucky bluegrass grown for seed. While Prowl H2O and Outrider offered limited individual efficacy, their integration in tank mixes provided enhanced weed suppression. Crop safety is still a concern, especially at higher rates of Anthem Flex, though we did not find that the stunting affected yield or germination of the crop. Future studies could explore optimizing combinations and application timings for broader weed control.

Table 2. Crop injury and Italian ryegrass control for Kentucky bluegrass in response to increasing rates of Anthem Flex herbicide. Means with the same letter are not statistically different ($\alpha = 0.05$). Control was not statistically different.

	Treatment ¹	Timing	Rate	Stunting (%)		Control (%)	
				5/16/2024		5/16/2024	
1	Nontreated				0 b		0
2	Anthem Flex	A	2.75	oz/A	0 b		100
3	Anthem Flex	A	3	oz/A	10 ab		97
4	Anthem Flex	A	2.75	oz/A	5 ab		97
	Anthem Flex	B	1	oz/A			
5	Anthem Flex	A	6	oz/A	15 a		97
6	Anthem Flex	A	2.75	oz/A	10 ab		100
	Prowl H2O	B	64	oz/A			
7	Prowl H2O	A	64	oz/A	0 b		100
8	Anthem Flex	A	2.75	oz/A	10 ab		100
	Anthem Flex	B	2.75	oz/A			
9	Outrider	A	0.38	oz/A	0 b		92
10	Outrider	A	0.38	oz/A	0 b		97
	Anthem Flex	A	2.75	oz/A			

¹All treatments included NIS 0.05%V/V.

Table 3. Yield and germination for Kentucky bluegrass in response to increasing rates of Anthem Flex herbicide. Yield and germination were not statistically different.

	Treatment ¹	Timing	Rate	Yield (lb/A)		Germination (%)	
				7/2/2024	11/22/2024		
1	Nontreated			2010	81		
2	Anthem Flex	A	2.75 oz/A	1910	65		
3	Anthem Flex	A	3 oz/A	2370	80		
4	Anthem Flex	A	0.38 oz/A	1700	81		
	Anthem Flex	B	2.75 oz/A				
5	Anthem Flex	A	6 oz/A	1070	76		
6	Anthem Flex	A	2.75 oz/A	1390	74		
	Prowl H2O	B	64 oz/A				
7	Prowl H2O	A	64 oz/A	2620	66		
8	Anthem Flex	A	2.75 oz/A	2290	75		
	Anthem Flex	B	2.75 oz/A				
9	Outrider	A	0.38 oz/A	1950	79		
10	Outrider	A	0.38 oz/A	2310	71		
	Anthem Flex	A	2.75 oz/A				

¹All treatments included NIS 0.05%V/V.

Herbicide panel in Kentucky Bluegrass

J.E.R. Kalin & I. C. Burke

Introduction

In fall of 2023, an herbicide trial was conducted to evaluate the safety and efficacy of multiple herbicides for potential use in Kentucky bluegrass grown for seed. Annual grass weeds, such as Italian ryegrass (*Lolium multiflorum*), are difficult to control in grass seed fields and infestations can reduce stand quality, longevity, and productivity. The herbicides used in this trial included Axiom DF (flufenacet + metribuzin), Callisto (mesotrione), Metribuzin, Goal (Oxyfluorfen), Prowl H2O (pendimethalin), Dual II Magnum (metolachlor), and Sinbar (terbacil).

Methods

The study was established in a 2nd-year Kentucky bluegrass field near Rockford, WA. Treatments were applied when the Kentucky bluegrass was 3 to 5 tiller and actively growing in the fall of 2023. Treatments were applied with a CO₂ powered backpack sprayer and a 5 ft boom with 3 Teejet 11002VS nozzles with an effective spray pattern of 8 ft and calibrated to deliver 15 gallons per acre (GPA). The study was conducted in a randomized complete block design with 4 replications. Plots were 10 ft by 25 ft long. Treatments were assessed for crop response and weed control in the spring, 6 months after treatment. Two ½ m² subsamples were harvested from each plot to estimate yield. Data were subject to ANOVA using the Agricultural Research Manager software (Ver. 2024).

Table 1. Treatment application details.

Study Application	
Date	10/12/2023
Application volume (GPA)	15
Timing	Postemergence
Crop Stage	3 to 5 tillers
Air temperature (°F)	55
Wind velocity (mph, direction)	4, NNE
Relative humidity (%)	66

Results

Weed control ratings for Italian ryegrass were consistent across evaluation dates, with all treatments achieving complete control. There was also no noticeable phytotoxicity to any of the chemistries present. Yields were not significantly different between treatments (Table 2), though the highest numerical yield was observed in Metribuzin-treated plots (2,800 lbs/A). While not statistically significant, the comparatively low numerical yield in Sinbar-treated plots (1,300 lbs/A) indicates the need for further exploration of application timing or rate adjustments to enhance crop safety.

Table 2. Yield for Kentucky bluegrass in response to multiple herbicides. Means with the same letter are not statistically different ($\alpha = 0.05$).

	Treatment ¹	Yield (lb/A)		
		Rate		7/2/2024
1	Nontreated			1720
2	Axiom	6	oz/A	1520
3	Callisto	16	oz/A	1870
4	Metribuzin	3	oz/A	2810
5	Goal	8	oz/A	2260
6	Prowl H2O	64	oz/A	2260
7	Dual II Magnum	16	oz/A	1950
8	Sinbar	8	oz/A	1270

HPPD report

J.E.R. Kalin & I. C. Burke

Introduction

In the spring of 2024, a field trial was established to evaluate the efficacy of the BIR+BXN+PYR premix in controlling weeds under bare ground conditions at the Cook Research Farm near Pullman, Washington. Weed control in agricultural fields is critical for optimizing crop yields, and the BIR+BXN+PYR premix combines three herbicides aimed at improving efficacy across a variety of weed species. The objective of this study was to evaluate (1) the overall weed control efficacy of different herbicide treatments, and (2) the residual weed control at multiple assessment intervals.

Methods

Two study sites were identified for these trials: WSU Wilke Farm near Davenport, WA and the Palouse Conservation Field Station (PCFS) near Pullman, WA. Initial treatments were applied in the early spring across the whole plot. The plots were divided into three subplots: a) main treatment alone, b) main treatment with glyphosate applied 14 DAA, and c) main treatment with glyphosate applied 28 DAA (Tables 1 & 2). All herbicide treatments were applied with a CO₂ powered backpack sprayer and a 5 ft boom with 4 Teejet 11002VS nozzles. The sprayer was calibrated to deliver 15 gallons per acre. These studies were conducted in a randomized complete block design with 3 replications. Plots were 10 ft wide by 45 ft long, with the first 15 ft receiving the main herbicide application, the middle 15ft receiving the main herbicide treatment and a glyphosate treatment ~14 days after the main application, and the last 15ft receiving the main herbicide application and a glyphosate treatment ~28 days after the main application. Treatments were visually assessed for weed control at 17, 34, 49, and 60 DAT. Weed density and biomass was taken by species in each subplot at the end of the growing season using 2 ½ m² quadrats.

RStudio (R version 4.4.2) was used to analyze and visualize data. Fixed effects included treatment, subplot, species, and the interaction between treatment and subplot. Random effects included replication. A negative binomial distribution was applied to model density data.

Results

Weed communities were different at the trial locations so each site is presented by herbicide treatment and weed species. At Wilke Farm, Talinor was the only herbicide that significantly reduced common lambsquarters density compared to the nontreated (Figure 1). Timing of emergence was not affected, as most rainfall at the Wilke Farm occurred prior to trial initiation. Tolvera had little residual control on common lambsquarters, while Huskie Complete provided variable residual control of common lambsquarters. Trends in biomass were similar to trends in density (Figure 2), where Talinor reduced overall weed biomass at Wilke compared to nontreated – other treatments show reductions but are not significant. Given the limited rainfall that occurred after treatment for activation, common lambsquarters is either very sensitive to Talinor, or Talinor requires a relatively low amount of rainfall for activation.

At PCFS Farm, regular rainfall occurred after the application of the HPPD inhibitors (Figure 5). Each weed species germinated throughout the period of subplot treatments, although emergence did decline after 6/6/2024. Common lambsquarters density was reduced by Talinor and Huskie Complete, but a very late large rainfall event on 6/3/2024 stimulated germination after the second glyphosate treatment (which occurred 5/20/2024). Tolvera had no residual effect on common lambsquarters.

Tumble pigweed was present at low density in all treatments and subplots, indicating limited residual activity for the three HPPD inhibitors. Conversely, redroot pigweed germinated in large numbers after the first glyphosate treatment. Talinor completely controlled redroot pigweed after application, while the residual activity of Tolvera and Huskie Complete was variable. Finally, prickly lettuce was controlled by residual activity of all the HPPD inhibitors at PCFS.

Growers now have three HPPD herbicide options to manage broadleaf weeds in wheat. The data presented here indicates that Talinor may be best utilized early in the season for residual activity on common lambsquarters and prickly lettuce, while Tolvera and Huskie Complete should be utilized at the traditional postemergence timings for control of emerged weeds, as their residual activity appears to be shorter in duration and what residual activity there is appears to be more selective. More seasons are needed to determine the best timing of application, and for individual species management recommendations.

We continue to recommend the use of herbicide systems that utilize multiple effective modes of action on each weed every season, and do not advocate for the use of two different HPPD inhibitors in the same season.

Table 1. Treatment application details for the Wilke Farm near Davenport, WA.

Study Applications			
	Main Application	Glyphosate Spray Back 1	Glyphosate Spray Back 2
Date	4/23/2024	5/9/2024	5/23/2024
Application volume (GPA)	15	15	15
Timing	Preemergence	Preemergence	Preemergence
Air temperature (°F)	56	59	50
Soil temperature (°F)	53	49	53
Wind velocity (mph, direction)	5, ESE	9, NE	7, SSW
Relative humidity (%)	29	43	62

Table 2. Treatment application details for the PCFS Farm near Pullman, WA.

Study Applications			
	Main Application	Glyphosate Application 1	Glyphosate Application 2
Date	5/3/2024	5/20/2024	6/6/2024
Application volume (GPA)	15	15	15
Timing	Preemergence	Preemergence	Preemergence
Air temperature (°F)	49	51	72
Soil temperature (°F)	48	53	70
Wind velocity (mph, direction)	4, SSE	9, W	3, SW
Relative humidity (%)	54	56	40

Figure 1. Mean weed density per subplot at Wilke Farm near Davenport, WA. Glyphosate was applied to three different subplots on 4/23/24, 5/9/24, and 5/23/24, therefore any emergence that occurred in the subplot happened after those dates.

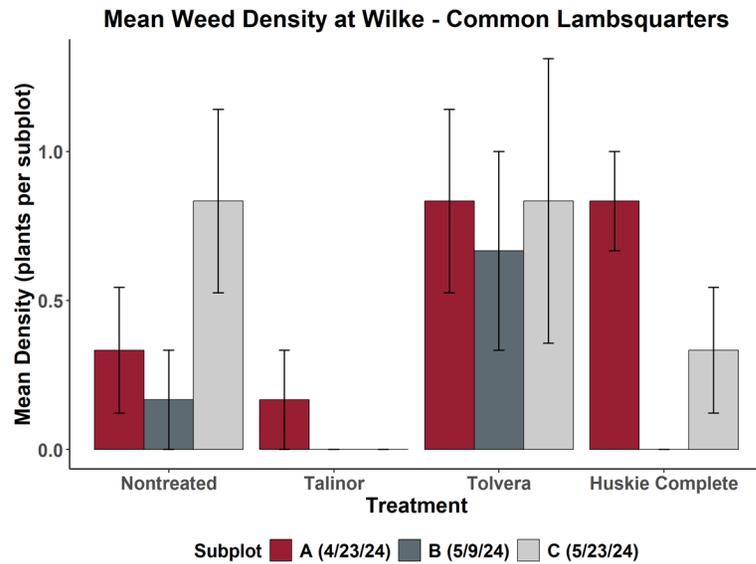


Figure 2. Mean weed biomass per subplot at Wilke Farm near Davenport, WA. Glyphosate was applied to three different subplots on 4/23/24, 5/9/24, and 5/23/24, therefore any emergence that occurred in the subplot happened after those dates.

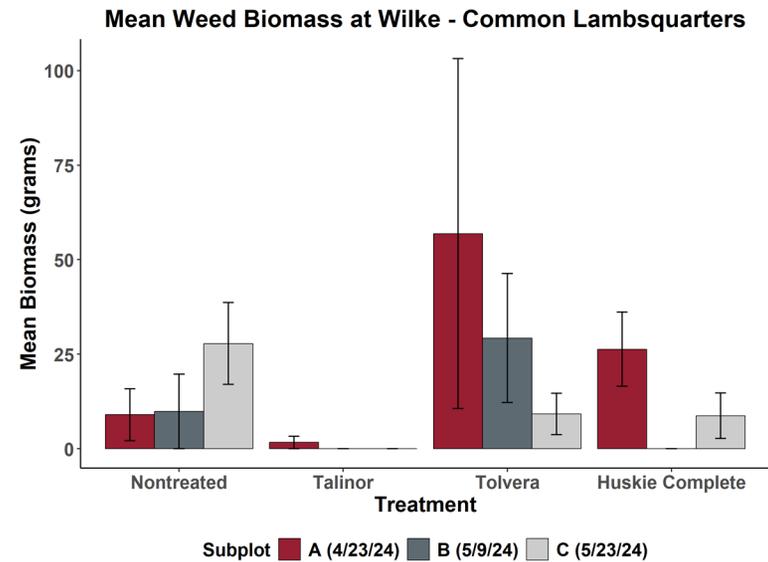


Figure 3. Mean weed density per subplot at the PCFS Farm near Pullman, WA. Glyphosate was applied to three different subplots on 5/3/24, 5/20/24, and 6/6/24, therefore any emergence that occurred in the subplot happened after those dates.

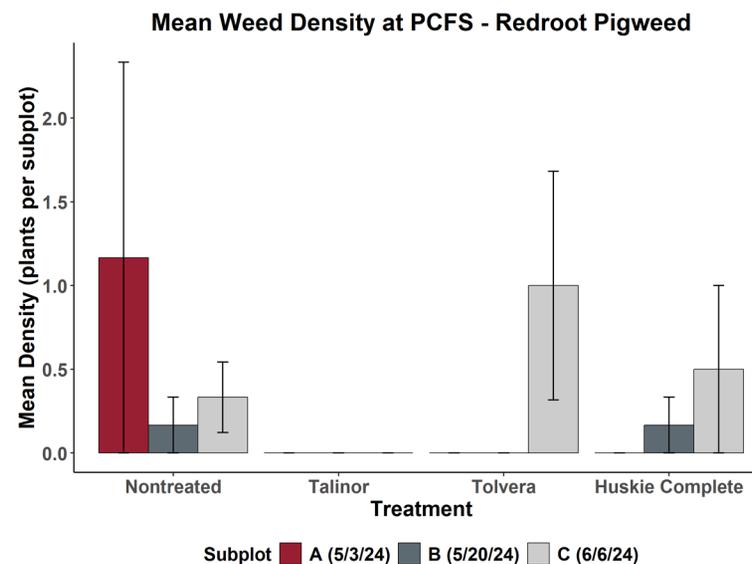
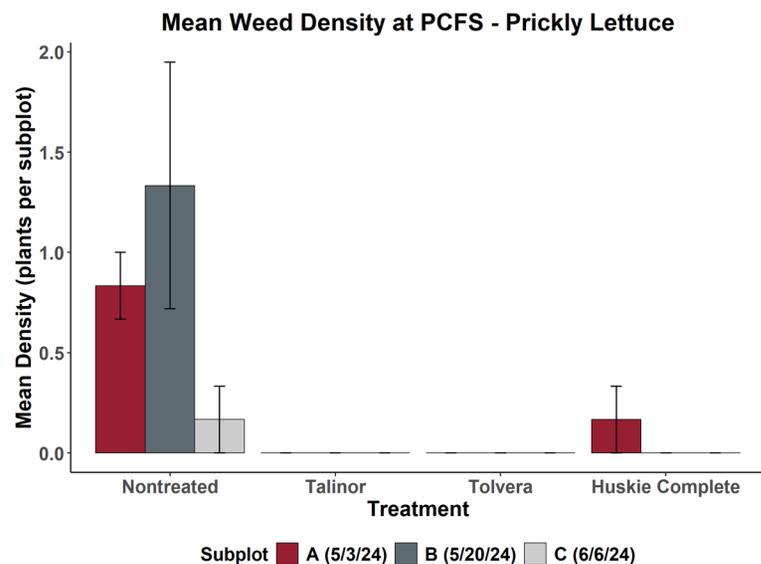
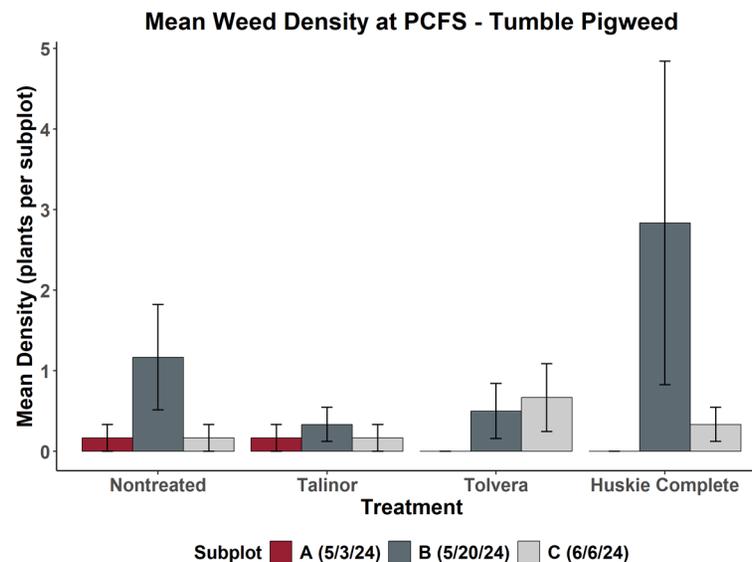
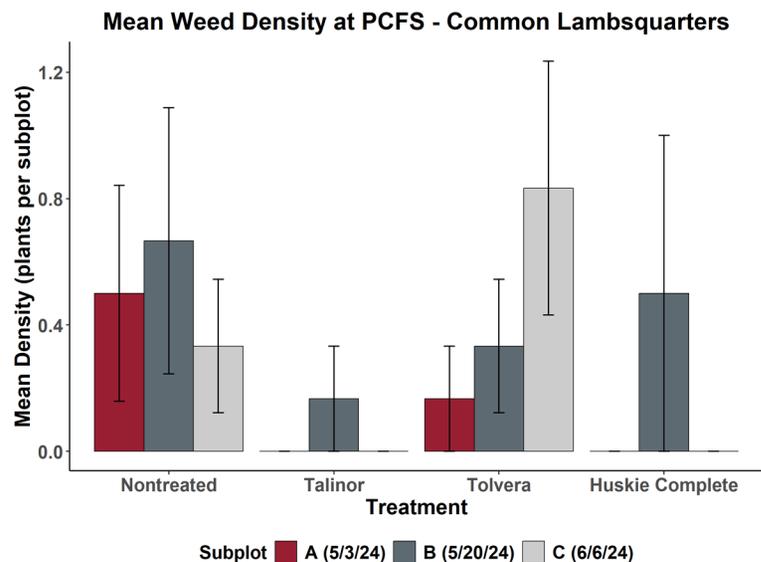


Figure 4. Mean weed biomass per subplot at the PCFS Farm near Pullman, WA.

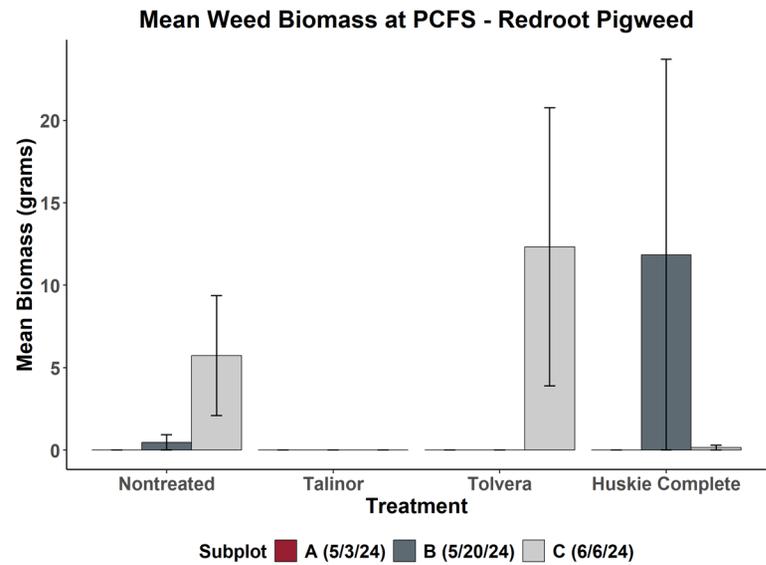
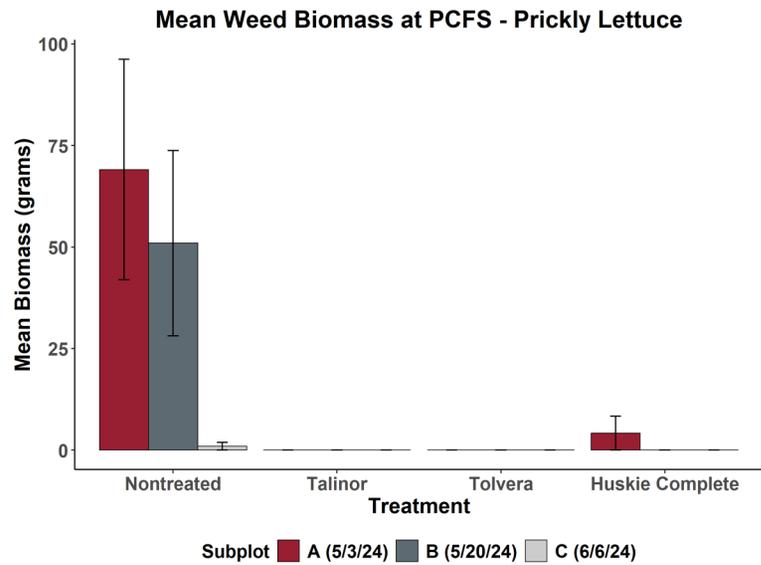
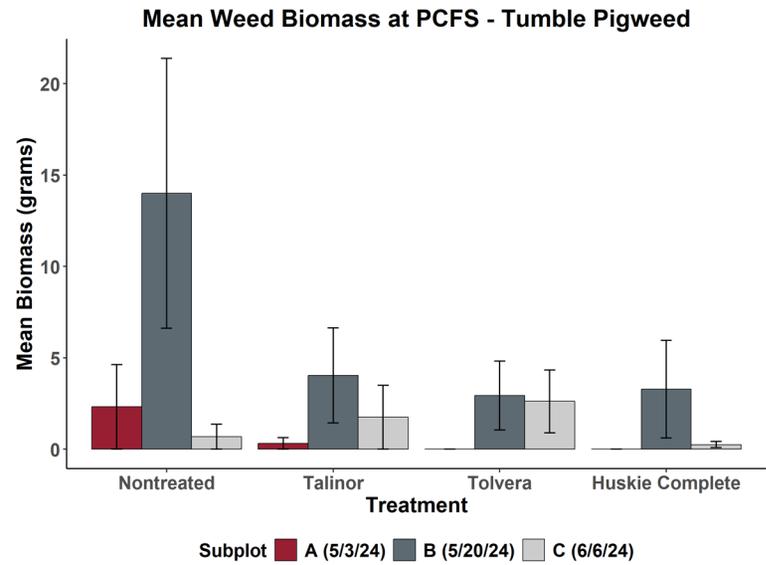
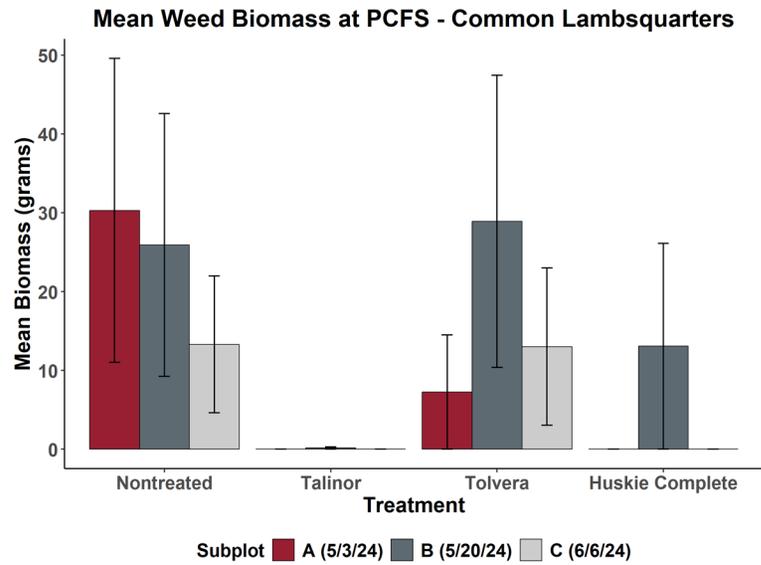
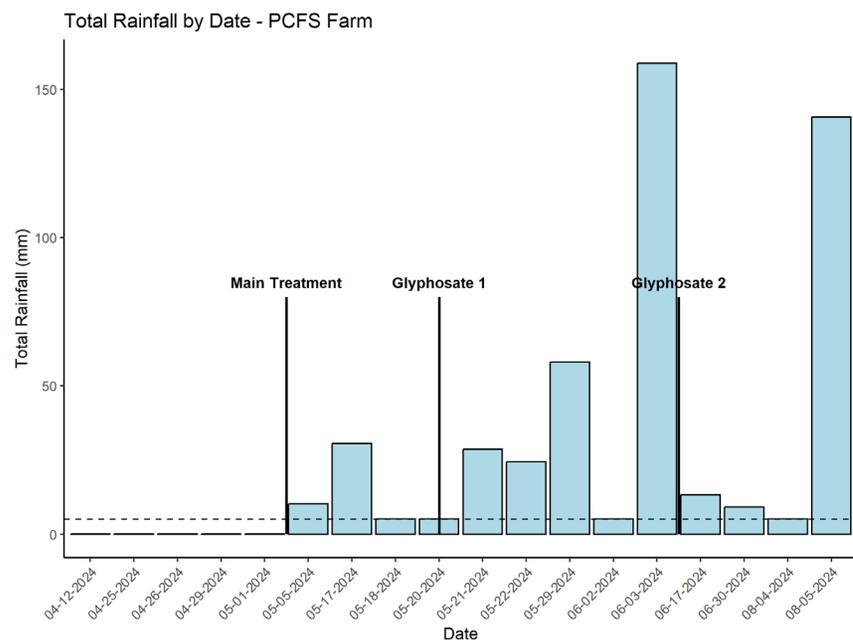
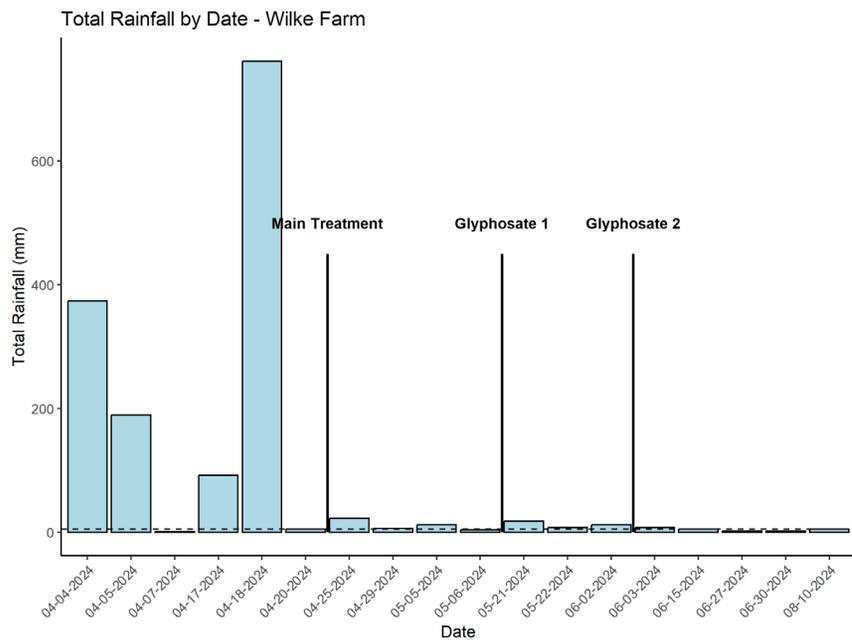


Figure 5. Total rainfall for Wilke Farm (left) and PCFS Farm (right) by date. Horizontal dashed line represents 5mm, or 2/10 of an inch.



Post-harvest Russian thistle control in spring wheat stubble with BAS 85101H

Mark Thorne and Drew Lyon

Post-harvest Russian thistle control in the low and mid-rainfall areas of eastern Washington is critical for preventing soil moisture loss, biomass accumulation, and seed production that will cause problems in future crops. Russian thistle is a warm season introduced annual forb and is a major weed problem in both winter and spring wheat and will flourish in wheat stubble following harvest if left uncontrolled (Figure 1). Previous research has found that post-harvest late-season Russian thistle root growth can remove as much as 26 gallons of water per plant and deplete most all the available soil moisture to a depth of at least 6 feet. Herbicides effective for post-harvest Russian thistle control are usually contact-type herbicides, e.g., paraquat, that must contact all surfaces of the plants to achieve complete control. Paraquat can be very effective but is also a very toxic chemical and can pose health risks to applicators. Glyphosate, a systemic herbicide, is also applied post-harvest for Russian thistle control but can be less effective if applied at too low of a rate for the size of the plants being treated or to plants that are glyphosate resistant. Group 14 protoporphyrinogen oxidase (PPO) inhibitor herbicides have burndown activity and can be tank mixed with glyphosate for increased efficacy.



Figure 1. Russian thistle in spring wheat stubble one week after harvest at the WSU Lind Dryland Research Station, Lind, WA.

We compared BAS 85101H, an experimental Group 14 PPO herbicide, with and without PowerMax[®] (glyphosate) for post-harvest Russian thistle control. We also compared tank mixes with Sharpen[®] (saflufenacil, Group 14), Distinct[®] (diflufenzopyr, Group 19; dicamba, Group 4), and Weedone[®] 638 (2,4-D, Group 4). See Table 1 for application rates.

Table 1. Herbicide treatments and rates.

Treatments*	Rates** (oz/A)
PowerMax	64
BAS 85101H	1.4
BAS 85101H + PowerMax	1.4 + 32
Sharpen + PowerMax	2.0 + 32
Distinct + Weedone 638 + PowerMax	2.5 + 22 + 32
Distinct + Sharpen + PowerMax	4.0 + 1.0 + 32

*All treatments included ammonium sulfate (AMS) at 17 lb/100 gal and methylated seed oil (MSO) at 1.0% v/v.

**Rates in fluid ounces except Distinct, which is a dry granular product.

The study location was on the WSU Lind Dryland Research Station near Lind, WA, and all treatments were applied on August 1, 2024, a week after the spring wheat had been harvested. The wheat stubble height was 10 inches at the time of application and the Russian thistle plant heights were up to 15 inches.

Treatments were applied with a CO₂-pressurized backpack sprayer and 10-ft hand-held spray boom with six TT110015 TeeJet[®] nozzles. Spray output was 15 gpa with 45 psi nozzle pressure and 3 mph ground speed. The experimental design was a randomized complete block with four replicates per treatment and 10- by 30-ft plots. All treatments included ammonium sulfate (AMS) at 17 lb/100 gal and methylated seed oil (MSO) at 1% v/v. Treatments were visually evaluated at 1, 2, and 4 weeks after treatment (WAT) and compared as a percentage of the nontreated check.

By 1 WAT, Russian thistle burndown and control with BAS 85101H and BAS 85101H + PowerMax was 100% and was greater than all other treatments. PowerMax by itself had only resulted in 12% control but then increased to 70% by 4 WAT (Figure 2). Some regrowth occurred after application and by 2 WAT, BAS 85101H control had declined to 93% and then 80% by 4 WAT; however, at 4 WAT BAS 85101H + PowerMax resulted in 87% control, which was the best control observed at 4 WAT. Control at 4 WAT averaged between 70-75% with all other treatments that did not include BAS 85101H. Control with Distinct + Weedone 638 + PowerMax did increase from 2 WAT to 4 WAT, which likely resulted from the slow activation time for Group 4 synthetic auxin herbicides. Control with treatments that included Sharpen declined from 1 WAT to 4 WAT.

BAS 85101H appears to be an effective post-harvest Russian thistle herbicide and a good alternative to other currently available options.

Post-harvest Russian thistle control

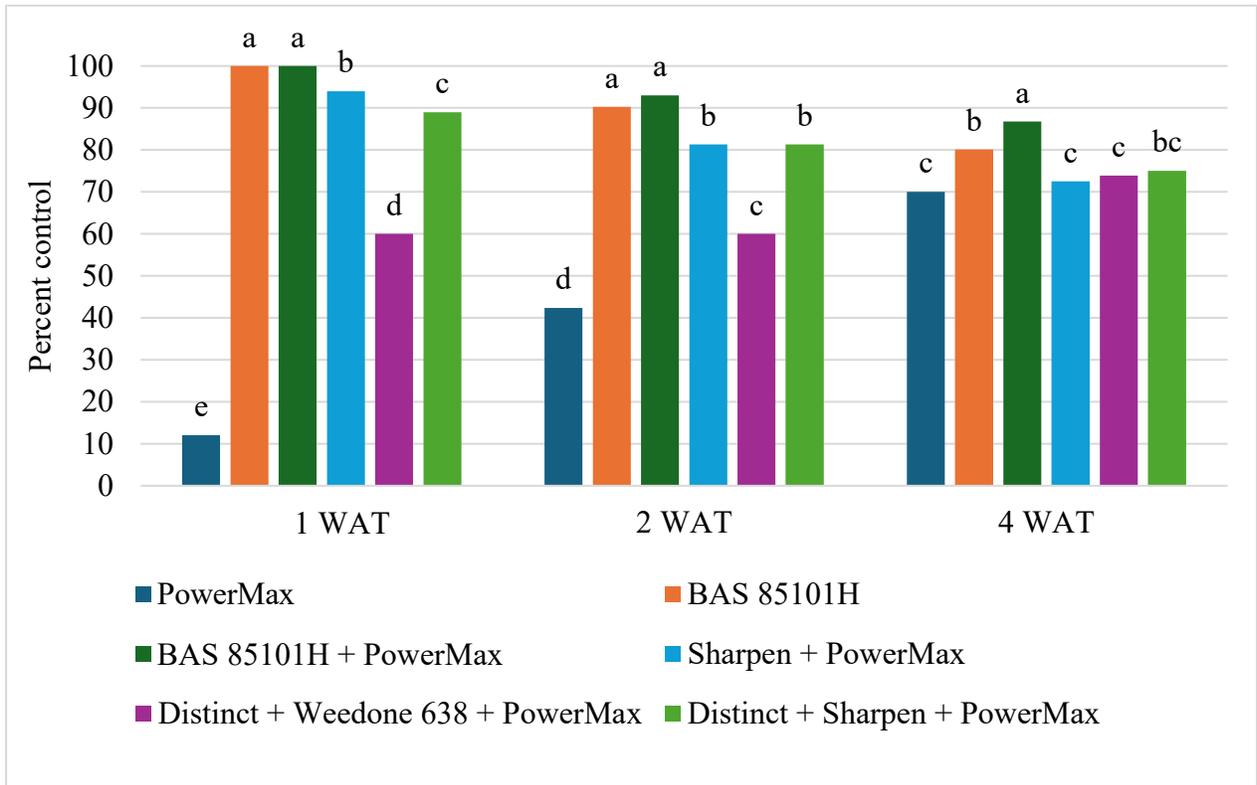


Figure 2. Post-harvest Russian thistle control assessed at 1 week after treatment (WAT), 2 WAT, and 4 WAT as a percentage of the nontreated check. See Table 1 for application rates. Columns followed by the same letter for each WAT are not statistically different ($P \leq 0.05$).

Russian thistle control in chemical fallow with fall- and late winter-applied soil-active herbicides

Mark Thorne and Drew Lyon

Controlling Russian thistle in chemical fallow in the winter wheat/fallow region of eastern Washington is critical for protecting soil moisture but often requires multiple herbicide applications throughout the fallow year (Figure 1). Herbicides such as glyphosate, paraquat, and 2,4-D can be effective, but have no soil activity, therefore, do not control subsequent flushes. Soil-active herbicides could provide a longer period of control but require precipitation to activate the herbicides in the soil prior to seed germination. Applications made too late in the spring risk not being effective if there is limited rainfall after application. Fall applications will likely be followed by adequate precipitation for soil activation but may be less effective the following year if degradation occurs.



Figure 1. Russian thistle in chemical fallow near Ralston, WA, on June 27, 2024. Nontreated check plot (left) and plot treated November 9, 2023, with Spartan Charge (right).

We evaluated Russian thistle control in chemical fallow with Spartan[®] Charge (carfentrazone + sulfentrazone, Group 14), Fierce[®] EZ (flumioxazin, Group 14, + pyroxasulfone, Group 15), Fierce[®] MTZ (flumioxazin + metribuzin, Group 5, + pyroxasulfone), and Authority[®] MTZ DF (sulfentrazone + metribuzin). All four herbicide products are labeled for weed control in fallow applications. Applications were made November 9, 2023, and March 18, 2024, at a field site near Ralston, WA, with a Ritzville silt loam soil with 5.6 pH and 1.5% organic matter. Precipitation near Washtucna, WA, from November 9, 2023, through March 18, 2024, totaled 4.7 inches. Precipitation between March 18 and June 27, 2024, totaled 1.1 inch. All applications were made with a CO₂-pressurized backpack sprayer and 10-ft hand-held spray boom with six AIXR110015 TeeJet[®] nozzles. The spray output was 15 gpa with 40 psi nozzle pressure and 3 mph ground speed. The experimental design at each timing was a randomized complete block with four replicates per treatment and 10- by 30-ft plots. At each timing, PowerMax[®] (glyphosate) at 24 oz/A and Downrigger[®] (acidifier, drift aid, surfactant) at 0.5% v/v was applied to control all presently emerged vegetation.

Russian thistle control was evaluated visually on June 13 and June 27, 2024, as a percent of the nontreated check treatment. Observable efficacy included both Russian thistle density and plant size. At the June 27 evaluation, all plants were counted in each plot. Plant density does not consider plant size or biomass; therefore, the visual ratings are also important to consider when evaluating control. Visual ratings on June 13 for all treatments averaged between 85 and 94% but differences between herbicides or timing were not found (data not shown). However, for the June 27 visual ratings, a significant statistical interaction between timing and herbicides found that the late-winter applications resulted in 92% Russian thistle control compared with 83% for the fall applications (Table 1). Differences between herbicide treatments were also found and Spartan Charge and Authority MTZ DF both resulted in the highest control with 94% for each herbicide. The least control averaged 74% with Fierce EZ and 85% with Fierce MTZ. Plant counts were consistent with the visual ratings as Fierce EZ and Fierce MTZ had the highest densities compared with Spartan Charge; however, Fierce MTZ was not statistically different from Authority MTZ DF.

In this trial, there was adequate precipitation following both application timings (> 0.5 inches) to activate the herbicides in the soil; therefore, we were able to see activity with all herbicides and timings. These results do suggest that sulfentrazone, as a component of both Spartan Charge and Authority MTZ DF, was providing the greatest Russian thistle control. It was also evident that metribuzin added some control as visual ratings for Fierce MTZ averaged slightly higher than Fierce EZ. Russian thistle control with flumioxazin + pyroxasulfone (Fierce EZ) averaged 74% and was not as effective as the products containing sulfentrazone. Furthermore, late winter applications were more effective than fall applications and were likely a result of adequate rainfall following applications to activate the herbicides. This research shows that applications of soil-active herbicides can be an effective tool in managing Russian thistle in chemical fallow.

Table 1. Russian thistle control and plant density in chemical fallow as affected by timing of herbicide applications and herbicides applied.

Factors	Rate (fl oz/A)	Evaluations 6/27/2024*	
		Control** (% of nontreated check)	Density*** (plants/plot)
Time			
Late winter		92 a	6 a
Fall		83 b	8 a
Herbicide			
Nontreated check		0	26 a
Spartan Charge	6	94 a	3 d
Fierce EZ	9	74 c	11 b
Fierce MTZ	20	85 b	8 bc
Authority MTZ DF	10	94 a	5 cd

*Means followed by the same letter for each factor in each column are not different ($P \leq 0.05$).

**Control ratings include assessment of plant density and size.

***Plots measured 300 ft², or 0.007 acres.

Russian thistle control in chemical fallow with sulfentrazone applied in fall and late winter

Mark Thorne and Drew Lyon

Russian thistle control in chemical fallow is critical to conserve moisture for fall planting in the wheat/fallow producing region of eastern Washington. Herbicide soil activity and application timing can play a role in the effectiveness of soil-applied herbicides. Fall-applied herbicides have the advantage of having fall and winter precipitation to activate the herbicides in the soil, however, late winter-applied herbicides would have less time to degrade in the soil prior to Russian thistle emergence in late spring and summer.



Figure 1. Russian thistle in nontreated check plot (left), and late winter-applied QY998-N001 plot on June 27, 2024.

We tested herbicide containing the active ingredient sulfentrazone for Russian thistle control in chemical fallow at a field site near Washtucna, WA that had produced a spring wheat crop in 2023 (Figure 1). Soil type is a Ritzville silt loam with pH of 6.5 and organic matter of 1.6%. Sulfentrazone is a Group 14 protoporphyrinogen oxidase (PPO) inhibitor herbicide that has soil activity on broadleaf weeds, including Russian thistle. Spartan[®] 4F (sulfentrazone) and Authority[®] Supreme (sulfentrazone; pyroxasulfone, Group 15) are currently labeled for preplant applications in certain crops but have a four-month rotational restriction for planting back to wheat. Furthermore, precipitation is important during the four-month rotational period for the herbicide to breakdown and not affect the wheat crop. QY998-N001 is an experimental product containing sulfentrazone being tested for fallow applications. Express[®] XP (tribenuron, Group 2) was included as a possible tank-mix partner for QY998-N001.

Treatments were applied on November 9, 2023, and on March 18, 2024, with a CO₂-pressurized backpack sprayer and 10-ft hand-held spray boom with six AIXR110015 TeeJet[®] nozzles. The

spray output was 15 gpa with 40 psi nozzle pressure and 3 mph ground speed. The experimental design at each timing was a randomized complete block with four replicates per treatment and 10- by 30-ft plots. All treatments included WeatherMax[®] (glyphosate) at 24 oz/A and Downrigger[®] (acidifier, drift aid, surfactant) at 0.5% v/v to control all emerged vegetation at the time of applications. Express XP treatments included a nonionic surfactant (NIS) at 0.25% v/v. Precipitation from November 9, 2023, through March 18, 2024, totaled 4.7 inches. Precipitation between March 18 and June 27, 2024, totaled 1.1 inch. Treatment efficacy was assessed on June 13 and 27, 2024, with visual control ratings as a percent of the nontreated check. Also, Russian thistle density was assessed in each plot on June 27, 2024.

Differences in efficacy were not found, individually, between the fall- and late winter applications of Spartan 4F, Authority Supreme, and QY998-N001 treatments at either the June 13 or 27 ratings (Table 1). By June 27, all herbicides containing sulfentrazone resulted in 100% Russian thistle control. Russian thistle control with Express XP by itself was only 32% by June 13 and 0% by June 27. Furthermore, Express XP plots averaged 1.5 plants/yd², which was 0.5 plants/yd² greater than the nontreated check. All other treatments averaged 0 plants/yd².

In this trial, treatments with sulfentrazone controlled Russian thistle through June of the fallow year whether the applications were made the previous fall or late winter of the fallow year. Effective chemical fallow weed control with sulfentrazone also includes controlling weeds that are present at the time of application with glyphosate or another effective herbicide. Also, precipitation is needed following sulfentrazone application for activation in the soil.

Table 1. Russian thistle control following fall and late-winter herbicide applications.

Treatment	Rate*	Timing**	Russian thistle***		
			Visual control ratings		Density
			6-13-24	6-27-24	6-27-24
Nontreated check			0	0	1.0 b
Authority Supreme	8	Fall	99 ab	100 a	0 c
Spartan 4F	8	Fall	100 a	100 a	0 c
QY998-R001	5.3	Fall	100 a	100 a	0 c
QY998-R001 + Express XP	2.7 + 0.5	Fall	100 ab	100 a	0 c
Express XP	0.5	Fall	32 c	0 b	1.5 a
Authority Supreme	8	Late winter	85 b	100 a	0 c
Spartan 4F	8	Late winter	100 a	100 a	0 c
QY998-R001	5.3	Late winter	100 ab	100 a	0 c

*Rates are fluid ounces per acre for all herbicides except QY998-R001 and Express XP, which are dry granule formulations.

**Fall treatments applied November 9, 2023; late winter treatments applied March 18, 2024.

***Means in each column followed by the same letter are not different ($P \leq 0.05$).

Russian thistle control in fallow with Talinor® herbicide

Mark Thorne and Drew Lyon

Russian thistle is a warm-season introduced annual forb and is a major weed problem in the low to mid-rainfall farming regions of eastern Washington. Russian thistle is particularly problematic during the fallow phase of wheat/fallow crop rotations (Figure 1) and if left uncontrolled, will significantly deplete soil moisture, and reduce yield of the following wheat crop. Chemical applications are used in reduced-tillage or no-till cropping systems to minimize soil moisture loss and to protect soil from erosion; however, control of ongoing flushes of Russian thistle through the summer requires repeat herbicide applications or tillage operations. Glyphosate is a common herbicide for weed control in fallow, but it has no soil residual, and repeat applications are often required. Glyphosate-

resistant Russian thistle is also now commonly found in eastern Washington. Herbicides with some soil residual could reduce the number of repeat applications, providing the herbicide is effective on Russian thistle. Talinor is currently not labeled for chemical fallow but does have soil activity and is being tested to determine if it can control flushes of Russian thistle following an initial application. Talinor

has a 1-month plant-back restriction for wheat and barley; therefore, applications would need to occur well in advance of fall planting.



Figure 1. Russian thistle nontreated (left) five weeks following Gramoxone + Talinor application (right) at Lind, WA

We compared tank mixes of Talinor plus PowerMax® or Gramoxone® SL 3 for Russian thistle control with other herbicides used for chemical fallow weed control including Sharpen®, Valor® SX, Reviton®, and Huskie®. Treatments were applied on June 6, 2024, in no-till fallow and July 5 in tilled fallow. Sharpen (saflufenacil), Valor (flumioxazin), and Reviton (tiafenacil) are Group 14 protoporphyrinogen oxidase (PPO) inhibitors that are primarily burndown herbicides with varying degrees of soil activity. Huskie is a product mix of pyrasulfotole and bromoxynil. Talinor is a product mix of bicyclopyrone and bromoxynil. Bicyclopyrone and pyrasulfotole are both Group 27 herbicides that inhibit carotenoid biosynthesis and have some soil activity. Bromoxynil is a Group 6 herbicide that inhibits photosynthesis but is only a contact herbicide with very little soil activity. PowerMax® (glyphosate, Group 9) and Gramoxone® SL 3 (paraquat, Group 22) were included to control Russian thistle already present at the time of application.

Treatments were applied with a CO₂-pressurized backpack sprayer and 10-ft hand-held spray boom with six AIXR110015 TeeJet® nozzles. The spray output was 15 gpa with 40 psi nozzle pressure and 3 mph ground speed. The experimental design at each timing was a randomized complete block with four replicates per treatment and 10- by 30-ft plots. All treatments included ammonium sulfate (AMS) at 15 lb/100 gal and modified seed oil (MSO) at 0.025% v/v.

Soil pH and organic matter at both sites were 5.7 and 1.0%, respectively. At the June application site, Russian thistle plants were 2-8 inches tall and averaged 2.2 plants/yd². The field was in no-till chemical fallow and had residual spring wheat stubble from the 2023 crop. Russian thistle at the July application site was 2-10 inches tall and averaged 0.8 plants/yd². The field was in tilled fallow with a 4-inch dust mulch surface layer. Treatment efficacy was evaluated visually at 1 week after treatment (WAT), 3 WAT, and 5 WAT as a percentage of nontreated plants.

June applications of PowerMax + Reviton, Huskie, and Talinor, and Gramoxone SL 3 + Talinor maintained ≥90% control of Russian thistle throughout the five-week trial; however, by 5 WAT, the greatest control was from Talinor with either PowerMax or Gramoxone SL 3 (Figure 2). PowerMax alone increased in control from 1 WAT to 5 WAT but PowerMax with either Sharpen or Valor SX decreased in control suggesting some form of antagonism or interference with PowerMax uptake and translocation. Similar results were seen from the July application as all treatments except PowerMax + Sharpen or Valor SX maintained good control throughout the five-week period. However, PowerMax alone only reached 60% control by 5 WAT but PowerMax + Talinor controlled Russian thistle nearly 100% and was slightly more effective than Gramoxone SL 3 + Talinor.

Overall, Talinor is an effective tank mix partner with either PowerMax or Gramoxone SL 3 for controlling Russian thistle in fallow; however, there were no new flushes observed so we could not assess whether Talinor was effectively controlling new emergence. Timing of application and soil activity of the herbicide are important factors in Russian thistle control in fallow. Early applications with herbicides with little or no soil activity will not control subsequent flushes. Later applications may have the potential to be effective if they include tank-mix partners that are effective on larger plants, but larger plants also have had time to deplete soil moisture.

Russian thistle control in fallow

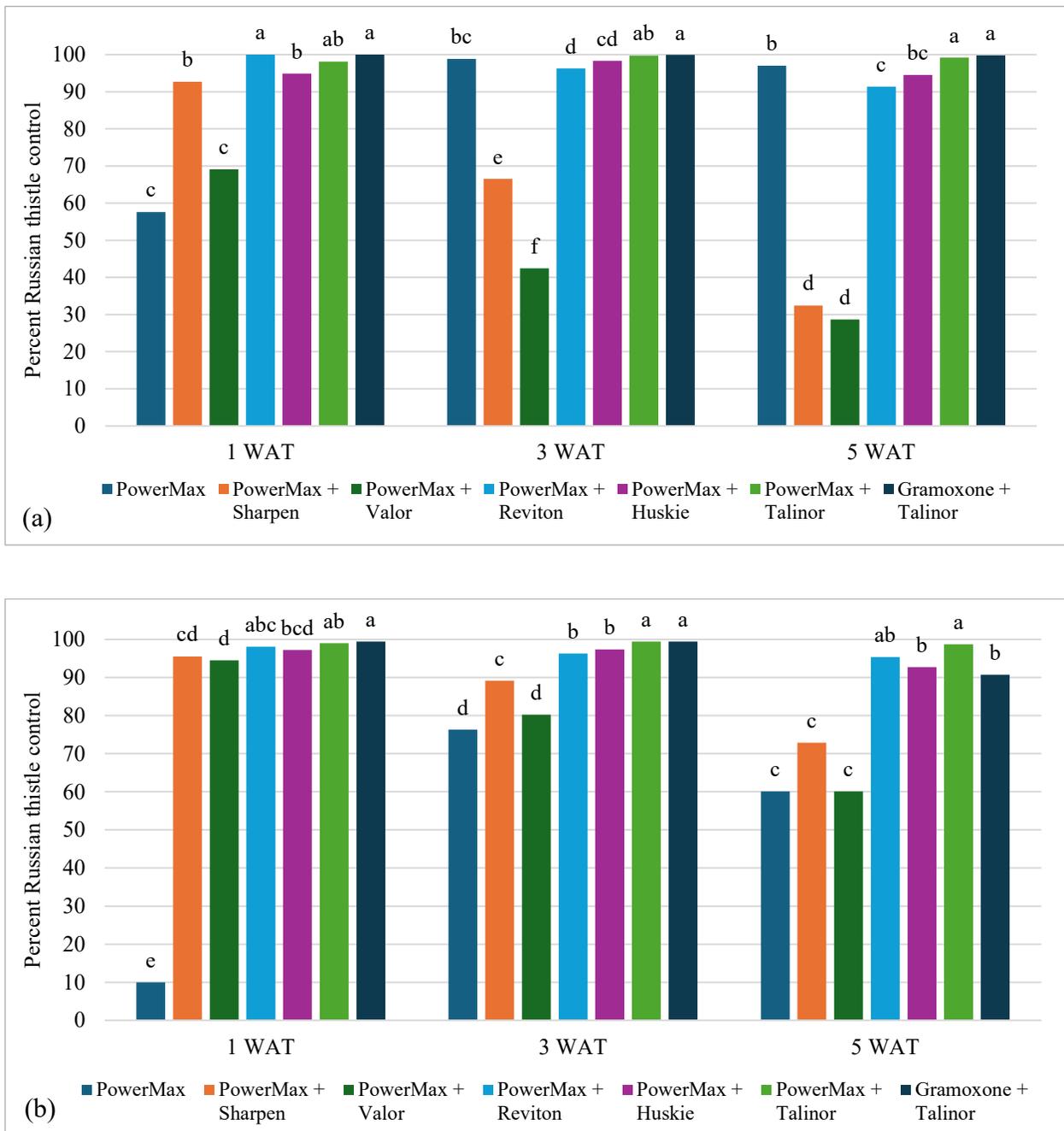


Figure 2. Russian thistle control in fallow as a percent of nontreated check visually rated 1 week after treatment (WAT), 3 WAT, and 5 WAT. Treatments were applied on (a) June 6 and (b) July 5 at Lind, WA. Columns within each rating time with the same letter are not significantly different from each other ($P \leq 0.05$).

Precipitation data for Pullman, WA - Palouse Conservation Field Station

Day	-----2023-----				-----2024-----							
	Sept	Oct	Nov	Dec	Jan	Feb	Mar	April	May	June	July	Aug
	-----precipitation in inches-----											
1	0	0.02	0	0.06	0	0	0.15	0	0.01	0	0	0
2	0	0	0.53	0.35	0	0.1	0.25	0	0	0	0	0
3	0.03	0.48	0.01	0.28	0	0	0.01	0	0	1.02	0	0
4	0	0	0.11	0.18	0.02	0.11	0.06	0.14	0	0.2	0	0
5	0	0	0.75	0.12	0.03	0.02	0	0.66	0.11	0.03	0	0.09
6	0	0	0.05	0.04	0	0.04	0	0.01	0.38	0	0	0.17
7	0	0	0.38	0.22	0.24	0	0	0	0.01	0	0	0
8	0.34	0	0.07	0	0.04	0.02	0	0	0	0	0	0
9	0	0	0	0	0.36	0.05	0	0.13	0	0	0	0
10	0	0	0	0.83	0.03	0.04	0.01	0	0	0	0	0
11	0	0.24	0.01	0.51	0.03	0.01	0.12	0	0	0	0	0
12	0	0.02	0.05	0.01	0.18	0.05	0.3	0.04	0	0	0	0
13	0	0	0	0	0	0.11	0.1	0	0	0	0	0
14	0	0	0	0	0	0	0	0	0	0	0	0.02
15	0	0	0.12	0	0	0.06	0	0	0	0	0	0
16	0	0	0.39	0	0	0.1	0	0	0	0.02	0	0.04
17	0	0.07	0	0	0.07	0.03	0	0	0.14	0	0	0
18	0	0	0	0	0.29	0	0	0	0	0.05	0	0
19	0	0	0.21	0.11	0.15	0.07	0	0	0.01	0	0	0
20	0	0	0	0	0	0.05	0	0	0	0	0	0
21	0.19	0	0	0.01	0.14	0.09	0	0	0.01	0	0	0.15
22	0.02	0	0	0	0.14	0.12	0.05	0	0.46	0	0	0
23	0	0	0	0.07	0.11	0	0.09	0	0.02	0	0	0
24	0	0	0.01	0	0.02	0	0.3	0	0	0	0	0.2
25	0.02	0.27	0	0	0.2	0	0.13	0	0	0	0	0
26	0.23	0.02	0	0.11	0	0.45	0.01	0.08	0	0	0	0
27	0.08	0.03	0	0	0.07	0.04	0.01	0	0	0	0	0
28	0.02	0	0	0	0.24	0.18	0.29	0.01	0	0	0	0
29	0	0	0	0	0.01	0.16	0.07	0	0.03	0	0	0
30	0.04	0	0	0	0		0	0.04	0.1	0.06	0.01	0
31		0		0.08	0		0		0		0	0
Total	0.97	1.15	2.69	2.98	2.37	1.9	1.95	1.11	1.28	1.38	0.01	0.67
Normal	2.67	1.94	2.05	1.96	1.81	1.22	0.44	0.48	0.65	1.8	2.62	2.77
Depart	-1.7	-0.79	0.64	1.02	0.56	0.68	1.51	0.63	0.63	-0.42	-2.61	-2.1

Sept 1, 2023 – Aug 31, 2024, total = 18.46 inches; Normal average = 20.41 inches.

Normal precipitation based on 1991-2020 data; Depart = departure from normal.

Precipitation data for Davenport, WA – Davenport Airport

Day	-----2023-----				-----2024-----							
	Sept	Oct	Nov	Dec	Jan	Feb	Mar	April	May	June	July	Aug
	-----precipitation in inches-----											
1	0.03	0	0	0.07	0	0.09	0.19	0	0	0	0.05	0
2	0	0	0.19	0.25	0	0.11	0.17	0	0	0	0	0
3	0	0	0.33	0	0	0	0	0	0	0.32	0	0
4	0	0	0.15	0	0	0.13	0.06	0	0	0.1	0	0
5	0.07	0	0.31	0.44	0.07	0.04	0	0.36	0	0	0	0
6	0	0	0.07	0.49	0	0.43	0	0.23	0.54	0	0	0
7	0	0	0.32	0.47	0.13	0	0	0	0	0	0	0
8	0	0	0	0.02	0	0	0	0	0	0	0	0
9	0	0	0	0	0.19	0	0	0	0	0	0	0
10	0	0	0	0.42	0	0	0.02	0	0	0	0	0
11	0	0.06	0	0	0	0	0.03	0	0	0	0	0
12	0	0.37	0	0	0	0.22	0.12	0	0	0	0	0
13	0	0	0.04	0	0	0.09	0	0	0	0	0	0
14	0	0	0	0	0	0	0	0	0	0	0	0
15	0	0	0	0	0	0	0	0	0	0	0	0
16	0	0	0	0	0	0.04	0	0	0	0.06	0	0
17	0	0.03	0	0	0.03	0	0	0	0	0	0	0
18	0	0	0	0.01	0.15	0	0	0	0	0	0	0
19	0	0	0.22	0.13	0.07	0.02	0	0.61	0	0	0	0
20	0	0	0	0.1	0	0.17	0	0	0	0	0	0
21	0	0	0	0	0.26	0.04	0	0	0	0	0	0
22	0	0	0	0	0.13	0	0	0	0.3	0	0	0
23	0	0	0	0.07	0.03	0	0	0	0	0	0	0
24	0	0	0	0	0	0	0	0	0	0	0	0.05
25	0	0.1	0	0	0.1	0	0	0	0	0	0	0
26	0.1	0.08	0	0.06	0	0	0	0.03	0	0	0	0
27	0.12	0.03	0	0	0.11	0	0	0	0	0	0	0
28	0.24	0	0	0.02	0.27	0	0.37	0	0	0	0	0
29	0.1	0	0	0	0	0	0	0	0	0	0	0
30	0	0	0	0	0		0	0	0	0	0	0
31		0		0	0		0		0		0	0
Total	0.66	0.67	1.63	2.55	1.54	1.38	0.96	1.23	0.84	0.48	0.05	0.05
Normal	1.73	0.99	1.53	1.11	1.37	1.15	0.42	0.3	0.49	1.26	1.72	1.9
Depart	-1.07	-0.32	0.1	1.44	0.17	0.23	0.54	0.93	0.35	-0.78	-1.67	-1.85

Sept 1, 2023 – Aug 31, 2024, total = 12.04 inches; Normal annual = 13.97 inches

Normal precipitation based on 1991-2020 data; Depart = departure from normal.

Precipitation data for Lind, WA – WSU Lind Dryland Research Station

Day	-----2023-----				-----2024-----							
	Sept	Oct	Nov	Dec	Jan	Feb	Mar	April	May	June	July	Aug
	-----precipitation in inches-----											
1	0	0	0	0.16	0	0.02	0	0	0.1	0	0	0
2	0	0	0.58	0.1	0	0	0.06	0	0	0.08	0	0
3	0	0.11	0.02	0.16	0.14	0	0	0	0	0.34	0	0
4	0	0	0.56	0.31	0	0	0	0.07	0	0	0	0.03
5	0	0	0	0.37	0.07	0.07	0	0.06	0.27	0	0	0
6	0	0	0.11	0.38	0.04	0.04	0	0.04	0.15	0	0	0
7	0	0	0.05	0.48	0	0	0	0	0	0	0	0
8	0	0	0	0.02	0	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0	0	0	0	0	0
10	0	0.02	0	0.48	0	0	0	0	0	0	0	0
11	0	0	0	0.04	0	0	0	0	0	0	0	0
12	0	0.17	0	0.02	0	0.03	0.04	0	0	0	0	0
13	0	0	0.07	0	0	0.01	0	0	0	0	0	0
14	0	0	0	0	0	0	0	0	0	0	0	0
15	0	0	0.15	0	0	0	0	0	0	0.11	0	0
16	0	0.02	0.02	0	0	0	0	0	0	0	0	0
17	0	0	0	0	0.22	0	0	0	0	0	0	0
18	0	0	0	0	0	0.01	0	0.02	0	0	0	0
19	0	0	0.04	0.24	0.07	0.05	0	0	0	0	0	0
20	0.16	0	0	0.02	0.02	0	0	0	0	0	0	0
21	0	0	0	0.02	0.13	0	0	0	0	0	0	0.02
22	0	0	0	0.15	0.05	0	0	0	0.15	0	0	0
23	0	0	0	0	0	0	0	0	0	0	0	0.05
24	0	0	0	0	0.05	0	0	0	0	0	0	0
25	0.01	0.29	0	0	0.02	0	0	0	0	0	0	0
26	0.04	0	0	0.09	0	0	0.06	0	0	0	0	0
27	0.06	0	0	0.03	0.41	0.05	0.19	0.01	0	0	0	0
28	0	0	0	0.07	0.03	0	0.08	0	0	0	0	0
29	0	0	0	0	0	0.2	0	0	0	0	0	0
30	0	0	0	0	0		0	0.04	0	0	0	0
31		0		0	0		0		0		0	0
Total	0.27	0.61	1.6	3.14	1.25	0.48	0.43	0.24	0.67	0.53	0	0.1
Normal	1.29	0.88	1.05	0.83	0.86	0.69	0.34	0.24	0.34	0.92	1.29	1.4
Depart	-1.02	-0.27	0.55	2.31	0.39	-0.21	0.09	0	0.33	-0.39	-1.29	-1.3

Sept 1, 2023 – Aug 31, 2024, total = 9.32 inches; Normal annual = 10.13 inches

Normal precipitation based on 1991-2020 data; Depart = departure from normal.