

**WASHINGTON OILSEEDS COMMISSION
RESEARCH PROPOSAL FOR 2022-2023**

New Project Proposal: Yes **Proposed Duration:** 2 years

Project Title: Using multiple herbicide mode of actions in Roundup Ready spring canola for avoiding glyphosate resistance in Italian ryegrass.

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Cooperators: TBD

Year Initiated: 2022 **Current Year:** 2021 **Terminating Year:** 2023

Total Project Request: Year 1 \$10,355 **Year 2** \$10,638

Other Funding Sources: None

Agency Name: NA

Amount Requested/Awarded: NA

Notes: Equipment from WSU research farms and from individual WSU researchers will be available for use in this study.

Description

The objective of this research is to identify herbicides that can be used in addition to glyphosate (Roundup PowerMAX®) to control Italian ryegrass in Roundup Ready® (RR) spring canola and help avoid developing glyphosate-resistant Italian ryegrass. In other areas, Italian ryegrass has already developed resistance to glyphosate. In our region, one of the fastest ways for this to occur is using only glyphosate for weed control in RR canola (Lyon, 2019). There are only a limited number of herbicide options for control of Italian ryegrass in canola; however, using at least one other mode of action may significantly delay the onset of glyphosate resistance in Italian ryegrass. This research will evaluate herbicides with different modes of action with the goal of reducing selection pressure for glyphosate-resistant Italian ryegrass. We expect that applications with two modes of action will be more effective than glyphosate-only applications in overall Italian ryegrass control and in preventing escapes that could be glyphosate resistant.

Justification and Background

Italian ryegrass resistance to glyphosate is a concern for canola producers using RR cultivars specifically for control of Italian ryegrass. Resistance has occurred in southern U.S. states and California from repeated use of glyphosate on RR crops or in orchards (Jasieniuk, et al., 2008; Salas, 2012). To delay or avoid resistance, management that incorporates different control approaches, including multiple herbicide mode of actions, is highly recommended. Italian ryegrass is a cool-season annual to short-lived perennial grass weed that has developed a strong foothold in the Palouse region within the last 30 years. In this 30-year period, 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, Beyond®. Without these tools, Italian ryegrass is very competitive in both winter and spring crops, particularly when it emerges in dense stands before or shortly after crop emergence. Italian ryegrass is quick emerging and fast growing, and it competes successfully for moisture, nutrients, space, and light. Because of these factors, Italian ryegrass is a serious threat to crop production in the areas where it persists.

In this region, Italian ryegrass resistance to glyphosate is not yet present; therefore, RR canola remains an effective tool. For non-Truflex RR varieties, a single application cannot exceed 16 oz/A, and total application cannot exceed 22 oz/A up to the 6-leaf stage. Since these rates are lower than recommended for Italian ryegrass control in fallow, there is the chance for incomplete control, especially in dense stands or when applied to larger ryegrass plants. Low rates that result in incomplete control can lead to glyphosate resistance. In contrast, Roundup PowerMAX can be applied to RR Truflex™ canola at 44 oz/A for a single early application when the canola has up to 3 leaves, or at 22 oz/A in two split applications with the last application occurring up to the time of flower initiation. These higher rates are less likely to result in incomplete control of Italian ryegrass.

To reduce dependency on glyphosate for Italian ryegrass control, other strategies need to be incorporated; however, resistance has limited these options. For example, post-emergence applications of clethodim (e.g., Clethodim 2EC, Select® 2EC) are no longer effective in this region. Potential options include preemergence applications of trifluralin (Treflan®), which can control Italian ryegrass up to about 70% (Campbell and Thill, 2007), but require rainfall following application for activation. Pronamide (Kerb®), which is currently not labeled for use in canola, has the same mode of action as trifluralin and also needs rain for soil activation, but can be applied following planting either preemergence or postemergence without incorporation. Liberty Link® (LL) canola is resistant to glufosinate (Liberty®), which applied post-emergence can give about 90% control of Italian ryegrass, particularly if the ryegrass is in the 1-2 leaf stage (Grey et al., 2006). While Liberty is a non-systemic contact herbicide and can be less effective on grasses than glyphosate, using a LL canola and combining Liberty with a soil active herbicide

may be an important non-glyphosate option, especially if glyphosate resistance does become a reality.

2021 Trial

Applications were made in both tilled and non-tilled soil. Results from this year's trial were affected by regional drought conditions; however, several key pieces of information emerged. Overall, glyphosate applications were most effective at controlling Italian ryegrass. This is good news because resistance was not apparent. Control of Italian ryegrass was 100% at the final rating for the EPOST (early postemergence) or the EPOST plus LPOST (late postemergence) split applications of Gly Star 5 Extra (glyphosate) (Table 1). However, the single LPOST applications were slightly less effective and allowed a few Italian ryegrass plants to produce seed by harvest. The Liberty applications were not as effective in controlling Italian ryegrass compared with Gly Star 5 Extra; however, Italian ryegrass canopy cover (abundance) was similar to the Gly Star 5 Extra applications that resulted in less than 100% control. Treflan PPI followed by EPOST Liberty was visually better at the June 23 rating than the EPOST Liberty treatment without Treflan. Also, more Italian ryegrass plants produced seed by harvest following the LPOST Liberty treatment than the EPOST treatments. With adequate rainfall to activate the Treflan, Italian ryegrass emergence likely would have been delayed and less dense and may have been easier to control with either the EPOST or LPOST Liberty treatments. The lack of spring rains also kept the Kerb and Aatrex applications from controlling Italian ryegrass. The LPOST clethodim applications had no effect, confirming resistance to the group 1 herbicide.

Canola yield was reduced by at least 50% from the previous year because of the dry spring conditions, and it was observed that some of the Gly Star 5 Extra applications resulted in reduced yield compared with the EPOST Liberty treatments (Table 1). Furthermore, harvest for all canola treated with Gly Star 5 Extra was delayed three weeks compared with the Liberty treated canola. This was especially evident in the no-till plots. Furthermore, yield of the TT and NonGM canola were low compared with the highest yielding RR/LL plots.

Overall, the no-till planted canola was a little slower to emerge because the seed zone soil was about 5° F cooler at planting compared with the tilled soil, and this also delayed flowering by a few days; however, planting method was not statistically different for any of the measurements taken, therefore all data were combined for analysis. For control of Italian ryegrass, the early or split applications of Gly Star 5 Extra gave the best results and were more effective than the late application of Gly Star 5 Extra alone. However, the cost of 100% control came with a delay of harvest and some reduction in yield, compared with the same canola treated with Liberty. The TT and NonGM canola emerged and flowered a little faster than the RR/LL canola, but yield potential was less. Furthermore, the dry year was not conducive for the soil active herbicides, Treflan, Kerb, and Aatrex.

Table 1. Applications to three different canola cultivars for Italian ryegrass control with multiple modes of action.

Trt	Dates for each operation, and canola stage at each date or operation									
	04/23/21	04/21/21	04/23/21	05/26/21	06/01/21	06/08/21	6/23/21	Canola Harvest ⁷		
Canola Planted ¹	PPI ²	PRE ³	Canola 3-4 leaves EPOST ⁴	Canola 5-6 leaves LPOST ⁵	Canola Bolting LPOST ⁶	Italian Ryegrass Control	Italian Ryegrass Cover	Italian Ryegrass with Seed	Canola Yield	
						(% of check)	(%)	(%)	(lb/A)	
1	RR/LL	-	-	Gly Star 50	-	-	100 a	0 ef	0 c	1121 bcd
2	RR/LL	-	-	-	-	Gly Star 25	88 b	6 cd	0.4 c	1164 bc
3	RR/LL	-	-	Gly Star 25	-	Gly Star 25	100 a	2 def	0 c	1147 bcd
4	RR/LL	Treflan	-	Gly Star 50	-	-	100 a	0 f	0 c	1292 ab
5	RR/LL	Treflan	-	-	-	Gly Star 25	93 b	6 cd	0.4 c	1263 ab
6	RR/LL	-	-	Liberty	clethodim	None	67 c	5 cde	54 b	1488 a
7	RR/LL	Treflan	-	Liberty	-	none	84 b	4 cde	61 b	1484 a
8	RR/LL	Treflan	-	-	-	Liberty	59 c	12 bc	80 a	1303 ab
9	TT	-	Aatrex	clethodim	-	-	8 d	22 ab	84 a	942 d
10	TT	-	Aatrex	clethodim + Wetcit	-	-	10 d	27 a	85 a	1015 cd
11	TT	-	Kerb	Aatrex	-	-	11 d	25 a	85 a	1090 bcd
12	NonGM	Treflan	-	clethodim	-	-	15 d	17 ab	85 a	975 cd
13	NonGM	-	-	-	-	-	0	31 a	85 a	983 cd

¹RR/LL canola (InVigor LR344 PC) is resistant to both Gly Star 5 Extra (glyphosate) and Liberty (glufosinate) herbicides; TT canola (Rubisco RUBSCT20215) is tolerant of triazine herbicides, e.g., atrazine, simazine, metribuzin; NonGM (Photosyntech NCC1010s) is a non-GMO canola. All canola varieties were planted at 12 seeds/ft² with a no-till drill on 12 in. spacing.

²Treflan (trifluralin) was applied preplant incorporated (PPI) (2x harrow 180°) at 7.5 lb/A.

³Aatrex (atrazine) was applied PRE (post-plant preemergence) at 32 oz/A; Kerb was applied at 20 oz/A.

⁴EPOST (early postemergence) Gly Star was applied at 50 and 25 oz/A; Liberty was applied at 22 oz/A; clethodim was applied at 6 oz/A plus crop oil concentrate at 1% v/v; Aatrex was applied at 16 oz/A plus crop oil concentrate at 1% v/v; Wetcit surfactant was applied at 0.78% v/v.

⁵LPOST (late postemergence) clethodim was applied at 6 oz/A.

⁶LPOST Gly Star was applied at 25 oz/A; Liberty was applied at 22 oz/A. Glyphosate and Liberty applied with NH₄ SO₄ at 17 lb/100 gal.

⁷Italian ryegrass cover is percent of canopy covering the ground; Italian ryegrass with seed is percent of remaining plants that produced seed. Numbers followed by the same letter in each column are not statistically different (P≤0.05). Canola was harvested on 7/30/21 and 8/19/21.

Methodology for 2022

In 2022, we will continue to evaluate herbicide strategies using multiple mode of actions for Italian ryegrass control in spring canola (Table 2). However, we will focus our comparisons using only the RR/LL InVigor LR344 PC cultivar because it has good yield potential and allows for direct comparisons with the herbicides used in this trial. To build on the most effective treatments from 2021, we will focus on postemergence applications of either PowerMAX or Liberty combined with soil active herbicides Treflan or Kerb. Italian ryegrass resistance to group 1 and group 2 herbicides has taken several otherwise effective herbicide strategies off the table; therefore, we hope to show that adding Group 3 root growth inhibitors (Treflan or Kerb) with either a Group 9 aromatic amino acid inhibitor (PowerMAX), or a Group 10 glutamine synthesis inhibitor (Liberty), will increase control, thus reducing further development of resistance. Three glyphosate timings using PowerMAX will be repeated from 2021 as these were the most effective at controlling Italian ryegrass and likely are the most common application strategies used by growers. Applications will be made EPOST at 44 oz/A, LPOST at 22 oz/A, and split at 22 oz/A, each. PowerMAX is labeled for Truflex canola, and currently costs less than Gly Star 5 Extra. We will also be able to compare efficacy from the low and high PowerMAX rates following the EPOST applications. Liberty will be applied only EPOST because it is more effective on Italian ryegrass when the plants are still in the 1 to 3 leaf stage. Treflan will be applied PPI prior to each of the three PowerMAX timings and with one Liberty treatment. Kerb will be applied PRE prior to Liberty and has advantage over Treflan in that it doesn't require incorporation; however, it is reported to be more effective if soil temperatures are 50° F or below. Multiple mode of action treatments will be comparable to single applications of each herbicide, and with a nontreated check treatment, all using the same canola cultivar. We will also be able to see whether the PowerMAX applications will delay harvest and reduce yield compared with the Liberty applications, as was the case in 2021. The 2022 trial will be initiated with a minimum amount of tillage to loosen up the surface soil to facilitate incorporation of Treflan and fertilizer, and to emulate local grower practices. Liquid fertilizer will be broadcast-applied through StreamJet nozzles. The plot area will be seeded with a Great Plains no-till drill calibrated to plant 12 seeds/ft². Herbicide efficacy will be evaluated visually up until harvest, at which time, assessments will be made on the abundance of Italian ryegrass and plants that have produced seed. Plots will be harvested with a plot combine and the canola samples will be cleaned and weighed for yield and analyzed for oil content. Plots will measure 10 by 30 ft and each treatment will be replicated four times. This proposal refines what was most effective from the 2021 trial and provides more ability to make comparisons that will help determine efficacy of each treatment.

Table 2. Proposed 2022 herbicide applications for Italian ryegrass control in spring canola.

Trt	Canola ¹	Herbicide applications in relation to canola stage			
		PPI ²	PRE ³	1-3 leaves EPOST ⁴	6 leaves/first flower LPOST ⁵
1	RR/LL	-	-	PowerMAX 44	-
2	RR/LL	Treflan	-	PowerMAX 44	-
3	RR/LL	Treflan	-	-	-
4	RR/LL	-	-	-	PowerMAX 22
5	RR/LL	Treflan	-	-	PowerMAX 22
6	RR/LL	-	-	PowerMAX 22	PowerMAX 22
7	RR/LL	Treflan	-	PowerMAX 22	PowerMAX 22
8	RR/LL	-	-	Liberty	-
9	RR/LL	-	Kerb	Liberty	-
10	RR/LL	Treflan	-	Liberty	-
11	RR/LL	-	Kerb	-	-
12	RR/LL	-	-	-	-

¹ InVigor LR344 PC (RR/LL) Truflex canola will be planted at 12 seeds/ft².

²Pre-plant incorporated (PPI) Treflan applied at 7.5 lb/A.

³Postplant preemergence (PRE) Kerb applied at 20 oz/A.

⁴Early postemergence (EPOST) PowerMAX applied at 44 and 22 oz/A; Liberty applied at 22 oz/A. Both herbicide applications will include NH₄ SO₄ at 17 lb/100 gal.

⁵Late postemergence (LPOST) PowerMAX will be applied at 22 oz/A at first flowering.

Anticipated Benefits and Information Transfer

This research will demonstrate the efficacy and benefit of using additional herbicide modes of action along with, or instead of, glyphosate for Italian ryegrass control in spring canola. In addition, we will compare five different multiple mode of action herbicide systems that can be rotated into the canola phase of crop rotations, specifically for avoiding development of glyphosate resistance in Italian ryegrass. Information from this research will be available in extension publications and will be submitted to Weed Technology journal. In addition, on-farm presentations will be available to anyone interested in seeing results.

References

- Campbell J., and D. Thill. 2008. Italian ryegrass control with triallate in spring pea. 2008 Progress Reports, Western Society of Weed Science.
- D. Lyon. 2019. Canola and Italian ryegrass control. Wheat and Small Grains, CAHNRS and WSU Extension. <http://smallgrains.wsu.edu/canola-and-italian-ryegrass-control/>
- Jasieniuk M., R. Ahmad, A.M. Sherwood, J.L Firestone, A. Perez-Jones, W.T. Lanini, C. Mallory-Smith, and Z. Stednick. 2008. Glyphosate-resistant Italian ryegrass (*Lolium multiflorum*) in California: distribution, response to glyphosate, and molecular evidence for an altered target enzyme. *Weed Science* 56:496–502.
- R.A. Salas. 2012. Herbicide Resistance Mechanism(s) in Italian Ryegrass (*Lolium perenne* ssp. *multiflorum*) Populations in the Southern United States. Thesis, University of Arkansas, Fayetteville.
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Budget

Budget Item	2022	2023
Salaries ¹	\$ 6800	\$ 7072
Operations (seed, fertilizer, herbicides, fuel)	\$ 350	\$ 350
Other (land rent)	\$ 425	\$ 425
Benefits ²	\$ 2731	\$ 2840
Total	\$ 10,306	\$ 10,687

¹Associate in Research, 100% FTE.

²Regular employee benefits.