Response of Italian Ryegrass to Crop Rotation and Indaziflam in Eastern Washington

Lyman, K.C. and I.C. Burke

Italian ryegrass is becoming more prevalent and widespread within eastern Washington, with higher rates of resistance to numerous herbicide modes of action. Knowledge of the effects of management inputs on the seed bank of Italian ryegrass is critical component of an integrated management system. However, little is known of the impact of herbicide input or crop rotation on Italian ryegrass seedbank in Washington. The objectives of the study were to evaluate the effect of crop rotation and associated herbicide inputs on the Italian ryegrass seedbank, as well as evaluate the impact of indaziflam, very long lived soil residual herbicide, for management of Italian ryegrass. The preemergence herbicide indaziflam was used to prevent the germination of Italian ryegrass seedlings at the WSU Cook Agronomy farm, near Pullman WA. and near Almota, WA.

A study with two trials were established at the WSU Cook Agronomy farm near Pullman and the second trial near Almota, WA in the spring of 2020. The study was conducted as a randomized complete design with three main plot treatments and four replications. Plots were 30 ft wide by 35 ft long. Soil seedbank samples were collected from the trial site before planting and after harvest each year. A Wintersteiger or Kinkaid plot combine with a 5-ft header was used to harvest plots. All treatments were applied using a CO_2 powered backpack sprayer calibrated to 15 gallons per acre, at 3 mph. In year 1, indaziflam was applied postemergence to soft white spring wheat. For both trials, indaziflam treatments were applied with Axial Bold and NIS on May 8th of 2020 at the 2 to 3 tiller stage of the spring wheat (Table 1). Italian ryegrass had already emerged. Percent spring wheat injury assessments occurred 1 month after treatment and Italian ryegrass density was assessed for both trials 1 month after treatment and before harvest from 2 1-m² quadrats placed randomly in each plot (Tables 2 and 3). Harvest at the WSU Cook Agronomy study began on September 3, 2020 and harvest began on August 27, 2020 at Almota. For the second cropping year, dryland rotational small grain and broadleaf crops were planted to assess effects of crop rotation and the preemergence application of indaziflam applied the previous season. Each main plot was divided into 5 sub plots, measuring approximately 7 feet wide and 35 feet long. Soil seedbank samples were collected from the main plots before planting and from each sub-plot after harvest for analysis of the Italian ryegrass seedbank. Weekly assessments of percent crop injury for winter wheat, canola, barley, chickpea, or fallow were recorded for each site location (Table 2). Italian ryegrass density was assessed with 2 1-m² quadrats place randomly in each sub-plot at planting and before harvest (Table 3). For the third cropping year, winter wheat was planted at both locations to further access the effects from the preemergence application of indaziflam applied two seasons previously. Winter wheat was established across the main plots as in year 1, measuring approximately 35 feet wide by 30 feet long. The impact of indaziflam treatments applied in year 1 as well as the year 2 annual dryland rotational crops were assessed. Unfortunately, winter wheat failed to emerge in Pullman, and was replanted to spring wheat in the spring of 2022. At the Almota site, spring assessments of percent crop injury were recorded 23.5 months after indaziflam treatment during the critical growing stages for winter wheat (Table 2). At the Cook Agronomy site, spring visual assessments of percentage crop injury 25 months after indaziflam treatment (Table 2). At both site locations, Italian ryegrass density was recorded approximately 19 months after indaziflam treatment and

before year 3 harvest on a per-plot basis, using 2 1-m² quadrats placed randomly in each sub-plot. Density was averaged across quadrats prior to analysis (Table 3). At the Almota site, harvest occurred on August 30, 2022 for winter wheat. At the Cook Agronomy site, harvest occurred on September 13, 2022 for spring wheat. Final soil seedbank samples were collected post-harvest after the third and final harvest. Soil elutriation occurred after all seedbank samples were gathered and thawed (Table 5). Year 1, 2 and 3 data were analyzed separately using ANOVA with Proc GLIMMX and Proc mixed in SAS (SAS Institute 2022). The LS-means argument was added to the SAS code to generate estimates for means of treatments and to compare all treatments against each other with $\alpha \leq 0.05$.

Yields of the spring wheat crop in 2020 were not impacted by the application of indaziflam, indicating crop safety when applied postemergence in spring wheat. In 2021, yields were variable in Almota and very low in Pullman due to drought. Chickpea yield was not affected by treatment with indaziflam the previous season, but winter wheat, barley and canola yields were reduced. At both locations, Italian ryegrass density decreased with increasing rates of indaziflam, with canola and fallow achieving nearly complete control of Italian ryegrass seed production in year 2. Barley, chickpea, and winter wheat rotations showed increasing Italian ryegrass control with the increasing rates of indaziflam.

In 2022, a weakly significant response to indaziflam was observed in winter wheat that did not translate to significant impact to yield at Almota, likewise for the spring wheat yield at Pullman. The various crop rotations had no impact on year 3 winter wheat and spring wheat yield. Italian ryegrass control increased with increasing rates of indaziflam, though the impact on seed density was less pronounced. Final seed bank density in the indaziflam-treated plots were either the same or lower than the standard production practice treated plots but varied by location and the crop rotation from the previous year. In general, chickpea rotations combined with high rates of indaziflam appeared to have the largest impact on decreasing the seedbank density. Indaziflam appears a potential candidate for use as part of an integrated Italian ryegrass management system in dryland wheat production, particularly when rotations include chickpea.

Table 1. Crop rotations and crop management inputs as in year 1, 2 and 3 for trials located in Almota and Pullman, WA.

Year	Crop	Herbicide treatment	Rate – g ai ha^{-1}–	Date applied
1	Spring wheat	Axial XL (Pinoxaden) [Standard Production]	90	May 8th, 2020
		Esplanade (Indaziflam) Axial XL (Pinoxaden)	22 + 90	
		Esplanade (Indaziflam) Axial XL (Pinoxaden)	44 + 90	
		Huskie (Pyrasulfotole + Bromoxynil) MCPA Tilt (Propiconazole) Urea ammonium nitrate	284 + 780 + 95 + 750	May 28th, 2020 May 30th, 2020
2	Barley	Huskie (Pyrasulfotole + Bromoxynil) Axial XL (Pinoxaden) Urea ammonium nitrate	284 + 55 + 750	May 17th, 2021 May 22nd, 2021
	Canola	Roundup PowerMax® (Glyphosate) Urea ammonium nitrate	870 + 750	
	Chickpea	Select Max (Clethodim) Urea ammonium nitrate	105 + 750	
	Winter wheat	Urea ammonium nitrate	750	
	Fallow	Roundup PowerMax® (Glyphosate)	950	
3	Winter wheat/ Spring wheat	Anthem Flex (Pyroxasulfone + Carfentrazone-Ethyl) Sharpen (Saflufenacil) Roundup PowerMax® (Glyphosate)	96 + 50 + 950	Oct. 14th, 2021
		Talinor (Bicyclopyrone + Bromoxynil) Axial XL (Pinoxaden)	248 + 55	April 24th, 2022 July 3rd, 2022

[a] Initial broadcast application of pyroxasulfone applied at 1.20 g ai ha^{-1} and glyphosate applied at 950 g ai ha^{-1} prior to all fall planting events and for 2020, 2021 and 2022 trial years.
[b] Initial broadcast application of glyphosate applied at 950 g ai ha^{-1} prior to all spring planting events for 2020, 2021 and 2022 trial years.
[c] All Broadcast sprayer treatments were applied with Induce, nonionic surfactant at 0.25% on a volume product per volume mix basis.

[d] First and second listed dates within each trial year were applied in Almota and Pullman, respectively.

[e] Year 3 at Pullman, spring wheat consisted of a Goldsky application at 117 g ai ha^{-1} instead of Talinor and Axial XL.

Table 2. Crop injury for year 2020, 2021, and 2022 rotational crops following the indaziflam application applied to spring wheat the previous crop season, near Almota and Pullman, WA.

					Treatment		
					Standard Prod. 0 g ai ha^{-1}	Indaziflam 22 g ai ha^{-1}	Indaziflam 44 g ai ha^{-1}
Year	Crop	Site	Date	DAT[2]	%		
1	Spring wheat	Almota	*6/5/20*	*28*	0	1	7
		Pullman	*6/5/20*	*28*	0	2	2
2	Winter Wheat	Almota	*6/2/21*	*390*	34	13	20
		Pullman	*6/8/21*	*396*	66	81	92
	Canola	Almota	*6/2/21*	*390*	2	8	15
		Pullman	*6/8/21*	*396*	4	1	12
	Barley	Almota	*6/2/21*	*390*	2	5	11
		Pullman	*6/8/21*	*396*	1	7	11
	Chickpea	Almota	*6/2/21*	*390*	0	0	4
		Pullman	*6/8/21*	*396*	0	0	6
3	Winter wheat	Almota	*4/22/22*	*714*	0	10	14
	Spring wheat	Pullman	6/8/22	*760*	12	4	17

[a] DAT- days after preemergence application.

Table 3. Italian ryegrass (*Lolium multiflorum*) plant density for each yearly cropping rotation following the indaziflam application applied to spring wheat the previous crop season, near Almota and Pullman, WA.

				Treatment		
				Standard Prod.	Indaziflam 22 g ai ha^{-1}	Indaizflam 44 g ai ha^{-1}
Year	Cropping rotation	Site	DAT[2]	Plants m^{-2}		
Baseline	-	Almota	-	3	4	1
		Pullman	-	44	43	39
1	SW	Almota	*28*	2	4	1
		Pullman		41	40	39
2	SW - WW	Almota	*396*	14	4	2
		Pullman		41	13	5
	SW - C	Almota	*396*	0	1	0
		Pullman		2	1	0
	SW - B	Almota	*396*	7	2	1
		Pullman		21	12	3
	SW - G	Almota	*396*	6	3	1
		Pullman		36	11	3
	SW - F	Almota	*396*	0	0	0
		Pullman		0	0	0
3	SW - WW- WW	Almota	*730*	8	2	0
	SW - C - WW	Almota	*730*	3	0	0
	SW - B - WW	Almota	*730*	8	2	2
	SW - G - WW	Almota	*730*	10	3	1
	SW – F - WW	Almota	*730*	4	0	0
	SW - WW - SW	Pullman	*730*	30	16	3
	SW - C - SW	Pullman	*730*	18	6	1
	SW - B - SW	Pullman	*730*	31	20	2
	SW - G - SW	Pullman	*730*	28	18	2
	SW - F - SW	Pullman	*730*	26	11	2

[a] Barley is “B”, canola is “C”, chickpea is “G”, fallow is “F”, winter wheat is “WW” and spring wheat is “SW”.

[b] DAT- days after preemergence application.

Table 4. Crop yield for year 2020, 2021, and 2022 rotational crops following the indaziflam application applied to spring wheat the previous crop season, near Almota and Pullman, WA.

			Treatment		
			Standard Prod.	Indaziflam 22 g ai ha^{-1}	Indaziflam 44 g ai ha^{-1}
Year	Crop	Site	kg ha^{-1}		
1	Spring wheat	Almota	4150	4180	4020
		Pullman	2250	2460	2370
2	Winter wheat	Almota	1030	630	120
		Pullman	30	130	0
	Canola	Almota	160	80	80
		Pullman	70	90	90
	Barley	Almota	1140	700	810
		Pullman	230	340	560
	Chickpea	Almota	950	930	1640
		Pullman	100	120	200
3	Winter wheat	Almota	5480	6950	6890
	Spring wheat	Pullman	490	940	1170

Table 5. Italian ryegrass (*Lolium multiflorum*) seedbank density for each yearly cropping rotation following the indaziflam application applied to spring wheat the previous crop season, near Almota and Pullman, WA.

				Treatment		
				Standard Prod.	Indaziflam 22 g ai ha^{-1}	Indaizflam 44 g ai ha^{-1}
Year	Cropping rotation	Site	DAT[2]	Plants m^{-2}		
Baseline	-	Almota	-	0	0	0
		Pullman	-	11	34	12
1	SW	Almota	*146*	11	8	10
		Pullman		23	38	39
2	SW - WW	Almota	*490*	5	4	2
		Pullman		40	34	14
	SW - C	Almota	*490*	2	0	1
		Pullman		44	26	86
	SW - B	Almota	*490*	11	5	2
		Pullman		41	87	36
	SW - G	Almota	*490*	8	6	0
		Pullman		43	58	88
	SW - F	Almota	*490*	0	2	2
		Pullman		31	29	14
3	SW - WW- WW	Almota	*860*	17	9	9
	SW - C - WW	Almota	*860*	28	18	6
	SW - B - WW	Almota	*860*	24	7	3
	SW - G - WW	Almota	*860*	15	0	2
	SW – F - WW	Almota	*860*	9	4	3
	SW - WW - SW	Pullman	*860*	87	69	83
	SW - C - SW	Pullman	*860*	214	122	160
	SW - B - SW	Pullman	*860*	277	104	119
	SW - G - SW	Pullman	*860*	209	51	166
	SW - F - SW	Pullman	*860*	271	101	185

[a] Barley is “B”, canola is “C”, chickpea is “G”, fallow is “F”, winter wheat is “WW” and spring wheat is “SW”.

[b] DAT- days after preemergence application.

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.