Italian Ryegrass Management in Oklahoma Winter Wheat

Grace K. Ogden, Misha R. Manuchehri

Two field and greenhouse studies were conducted to evaluate Italian ryegrass management in Oklahoma winter wheat. Herbicide treatments included flufenacet + metribuzin, metribuzin, pinoxaden, and pyroxasulfone applied very early postemergence and/or mid-postemergence. For the field experiment during the 2016-17 season in Perkins, OK, Italian ryegrass was controlled 97% or greater for all treatments containing pyroxasulfone. Control levels with treatments containing pyroxasulfone in the 2017-18 season were among the top performing treatments; however, limited herbicide to soil contact due to high levels of straw residue at the time of application and the absence of a timely rain after application decreased the overall level of Italian ryegrass control with pyroxasulfone compared to the 2016-17 season. Suspected pinoxaden resistant Italian ryegrass biotypes from the 2016-17 season were screened for resistance in the spring of 2018. Results suggest that biotypes from the Perkins field population have an increased tolerance to pinoxaden, but do not fit the description to be classified as pinoxaden resistant.

Nomenclature: Italian ryegrass, *Lolium perenne* L. spp. *multiflorum* (Lam.) Husnot; Flufanacent; Metribuzin; Pinoxaden; Pyroxasulfone; Wheat, *Triticum aestivum;*

Key words: Wheat, ACCase resistance, Zidua, Axial XL,

During the 2017-18 growing season, 4.5 million acres of winter wheat were sown in Oklahoma, making it the state's largest cash crop and ranking Oklahoma as fifth in the nation for winter wheat acres (USDA NASS 2017). Weed management is an important factor in producing a high quality wheat crop. Grassy weeds, such as Italian ryegrass, are problem weeds for Oklahoma winter wheat producers. Italian ryegrass is a winter annual weed with a life cycle and growing habit similar to wheat. Italian ryegrass densities of 158 plants m^{-2} has been found to reduce wheat grain yields in Oklahoma by 20% and wheat grain total price discounts by 26 cents/hectoliter (Fast et al. 2009).

The current management options for Italian ryegrass include tillage, PRE or POST herbicides, and crop rotation. Italian ryegrass was successfully and inexpensively controlled with acetolactate synthase (ALS) herbicides since their introduction in the 1980s. However, reliance on this mode of action resulted in the resistance of several grassy weeds including Italian ryegrass to ALS herbicides across the nation, Oklahoma included (Heap 2018). The widespread development of ALS resistance in economically important weeds to winter wheat systems pushed growers to use pinoxaden, an acetyl CoA carboxylase (ACCase) herbicide that will control ryegrass POST up until the emergence of its third tiller. The development of herbicide resistance to this chemistry has been less compared to ALS herbicides, but both modes of action are in the top three most susceptible chemistry groups in the United States (Heap 2018).

Oklahoma's neighbors to the north, Missouri, are already encountering serious resistance issues with Italian ryegrass as it is listed as one of the top ten most concerning resistant weeds in the state (Heap 2018). Texas and Arkansas are following close behind

(Kuk et al. 2008; Ellis et al. 2008). With many Oklahoma wheat producers using no-till systems, the use of herbicides is a critical tool to manage weed populations. In north central Oklahoma, there is speculation that Italian ryegrass biotypes exist that are resistant to pinoxaden; however, no studies have confirmed these suspicions. The goal of these experiments was to determine if pinoxaden resistance is present in a field at the Cimarron Valley Research Station in Perkins, OK and determine how to best manage them.

MATERIALS AND METHODS

Field studies were conducted over the 2016-17 and 2017-18 growing seasons at the Cimarron Valley Research Station in Perkins, Oklahoma. Trials were arranged in a randomized complete block design with four replications. Applications were made with a CO_2 pressurized backpack sprayer calibrated to 140 L ha^{-1}. Applications were made very early postemergence (VPOST), and/or mid-postemergence (MPOST). All treatments were applied at labeled rates (Table 1). One week after the VPOST application in 2016-17, Perkins received 6 cm of rain and several more rain events occurred over the following three months. The 2017-18 trial site did not receive any substantial precipitation until 37 days after the VPOST application.

Visual weed control was assessed 24 weeks after planting (WAP) and at harvest for the 2016-17 season and 24 WAP for the 2017-18 season. Data sets were analyzed using PROC MIXED with the pdmix 800 macro included (Saxton 1998). Means were separated using Fisher's Protected LSD at an alpha level of 0.05

All plots were harvested and bagged in 2017. Italian ryegrass seed was separated from wheat seed with a Clipper M2CB seed cleaner and weighed. From the weed control rating data, four plots with inconsistent weed control and one with adequate control were selected for seed stock for the greenhouse experiment. Italian ryegrass was planted in pots 10 cm wide by 9 cm deep, thinned to one plant, and grown until plants were between two to three tillers. The average plant height at time of application was 18 cm. Pinoxaden applications were made in a DeVries Generation III Research Sprayer. Four rates of pinoxaden plus a nontreated control were evaluated. Rates of pinoxaden used were 1X (0.60 kg ha^{-1} a), 2X, 3X, and 4X. The spray chamber was equipped with an 80001 EVS nozzle calibrated to deliver 140 L ha^{-1}. Each treatment was replicated 48 times. Visual ratings were recorded at 14 and 28 DAT. Plants were then cut at the soil surface at 35 DAT. Fresh weights were recorded and plants were placed in a dryer for 3 days. Dry weights were later recorded.

RESULTS AND DISCUSSION

The 2016-17 field season

Pyroxasulfone treatments provided consistent levels of weed control for the entire 2016-17 season. Twenty four WAP and at harvest, all treatments that included pyroxasulfone and flufenacet + metribuzin VPOST followed by pinoxaden at MPOST controlled Italian ryegrass 97 to 100% for the 2016-17 season (Table 2). Similar levels of efficacy has been observed observed by Walsh (2011) in rigid ryegrass in Australia and Hulting (2011) in Italian ryegrass in Oregon. Pinoxaden applied VPOST provided inconsistent control, which prompted the greenhouse experiment to evaluate suspected resistance. The greenhouse study indicated that the Italian ryegrass field biotype at the

Cimarron Valley Research Station in Perkins, OK has an increased tolerance to pinoxaden.

All pyroxasulfone treatments produced less than 37 kg ha^{-1} of Italian ryegrass seed compared to the nontreated control, which produced 329 kg ha^{-1} (Table 3). Pinoxaden + metribuzin applied VPOST produced 227 kg ha^{-1} of Italian ryegrass seed on average, the most of all the treatments by over 50 kg ha^{-1} (Table 3). Reduction in Italian ryegrass yield is an important factor to consider in assessing benefits of each treatment; minimizing the amount of Italian ryegrass seed returning to the seed bank is critical for future weed management.

The 2017-18 field season

Treatments with an MPOST application of pinoxaden provided the highest level of control for the 2017-18 season. Metribuzin and pyroxasulfone applied alone at the VPOST timing provided the least amount of control out of any treatment. This difference in control can be attributed to the absence of rain for the first thirty days after the VPOST application. Mueller (2011) also observed that pyroxasulfone efficacy is heavily dependent on rainfall patterns after application. In addition, products containing pyroxasulfone are recommended only for systems that utilize conventional tillage and the 2017-18 field trial was planted into no-till ground and no measure had been taken to evenly spread straw and chaff left over from the 2017 harvest. These conditions impacted herbicide-soil contact and thus, decreased Italian ryegrass control.

Overall, several, successful weed management systems were identified to control Italian ryegrass in the 2016-17 and 2017-2018 seasons. Wheat response to these products was minimal during both seasons and no wheat response was detected after spring green up. However, crop response, wheat in this instance, is highly influenced by planting depth, application timing, herbicide rate, soil type, and rainfall following application. Proper planting depth and timely rains aided in the success of treatments in 2016-17. Conversely, the lack of a timely rain during the 2017-18 season did hinder Italian ryegrass control.

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Table 1. Herbicides and application rates for the 2016-17 and 2017-18 field trials near Perkins, OK.

Herbicide common names	Brand names or designations	Application rates	Manufacturer
Flufenacet + metribuzin	Axoim	2.86 kg ai ha^{-1}	Bayer CropScience, Research Triangle Park, NC, https://www.cropscience.bayer.com
Metribuzin	Sencor	1.05 kg ae ha^{-1}	Bayer CropScience, Research Triangle Park, NC, https://www.cropscience.bayer.com
Pinoxaden	Axial XL	0.60 kg ai ha^{-1}	Syngenta Crop Protection, Greensboro, NC, https://www.syngenta.com
Pyroxasulfone	Zidua®	1.19 kg ai ha^{-1}	BASF Crop Protection Location https://www.basf.com

Table 2. Italian ryegrass control at harvest in the 2016-7 field trial near Perkins, OK.[a]

Weed control system		Italian ryegrass control	
Very Early POST[b]	Mid-POST	24 WAP	Harvest[c]
		---- % ----	
Pyroxasulfone		99 a	84 ab
Flufenacent +metribuzin		67 bcd	63 bc
Pyroxasulfone + pinoxaden		100 a	97 a
Pyroxasulfone + metribuzin		100 a	86 ab
Pyroxasulfone + pinoxaden +metribuzin		100 a	99 a
Pyroxasulfone + metribuzin	Pinoxaden	100 a	98 a
Pinoxaden		65 cd	40 cd
	Pinoxaden	91 abc	73 ab
Pinoxaden + metribuzin		38 d	28 de
Flufenacent + metribuzin	Pinoxaden	98 a	92 a

[a]Premixed flufenacent + metribuzin; metribuzin; pinoxaden, and pyroxasulfone were applied at 286, 105, 60, and 119 g ha^{-1}, respectively.

[b]Very early POST application made form spike to two leaf Italian ryegrass while mid-POST applications when ryegrass was four leaf to two tiller.

[c]Means within a column followed by the same letter are not significantly different according to Fisher's Protected LSD test at an alpha level of 0.05.

Table 3. Italian ryegrass seed yield for the 2016-17 field trial near Perkins, OK[a].

Weed control system		Italian ryegrass yield
Very Early POST[b]	Mid-POST	2017[c]
		---kg ha^{-1}---
Nontreated	Nontreated	329 a
Pyroxasulfone		37 cd
Flufenacent + metribuzin		130 bcd
Pyroxasulfone + pinoxaden		0 d
Pyroxasulfone + metribuzin		29 d
Pyroxasulfone + pinoxaden +metribuzin		0 d
Pyroxasulfone + metribuzin	Pinoxaden	0 d
Pinoxaden		179 abc
	Pinoxaden	90 bcd
Pinoxaden + metribuzin		228 ab
Flufenacent + metribuzin	Pinoxaden	12 d

[a]Premixed flufenacet + metribuzin; metribuzin; pinoxaden, and pyroxasulfone were applied at 286, 105, 60, and 119 g ha^{-1}, respectively.

[b]Very early POST application made form spike to two leaf Italian ryegrass while mid-POST applications when ryegrass was four leaf to two tiller.

[c]Means within a column followed by the same letter are not significantly different according to Fisher's Protected LSD test at an alpha level of 0.05.

Table 4. Italian ryegrass control at 24 WAP during the 2017-18 field trial near Perkins, OK[a].

Weed control system		Italian ryegrass control
Very Early POST[b]	Mid Post	2018[c]
		---- % ----
Pyroxasulfone		63 abc
Flufenacent + metribuzin		60 bc
Pyroxasulfone + pinoxaden		94 ab
Pyroxasulfone + metribuzin		78 ab
Pyroxasulfone + pinoxaden + metribuzin		64 abc
Pyroxasulfone + Metribuzin	Pinoxaden	97 a
Metribuzin		43 c
Pinoxaden		86 ab
	Pinoxaden	96 a
Metribuzin + Pinoxaden		70 abc
Flufenacet + metribuzin	Pinoxaden	97 a

[a]Premixed flufenacent + metribuzin; metribuzin; pinoxaden, and pyroxasulfone were applied at 286, 105, 60, and 119 g ha^{-1}, respectively.

[b]Very early POST application made form spike to two leaf Italian ryegrass while mid-POST applications when ryegrass was four leaf to two tiller.

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