Italian Ryegrass Herbicide Resistance Survey and Harvest Weed Seed Control Evaluation

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Introduction

Italian ryegrass (annual ryegrass) continues to be problematic in Kentucky wheat acres and has shown rapid increases in infestations over the past two growing seasons. This weed species has proved to be the most problematic weed for Kentucky wheat growers with our previous research identifying at least one population of glyphosate-resistant and one population of pinoxaden (Axial XL) resistant annual ryegrass in Kentucky wheat fields.

Since the identification of the single population of pinoxaden resistant ryegrass from Simpson County in 2017, we have observed numerous fields through the state with late season ryegrass escapes.

Herbicide resistance in ryegrass is inevitable and Kentucky wheat acres are on the brink of widespread herbicide resistance. The lack of potential postemergence herbicides and limits of currently effective preemergence herbicides call for additional control tactics such as seed destruction at harvest. Rigid ryegrass seed destruction at harvest has been implemented by Australian farmers for over a decade with much success. The investigation of the potential of this technology in Kentucky wheat acres is warranted at this time as Kentucky wheat farmer continue to struggle with annul ryegrass and herbicide resistance.

The objectives of this research were:

1. Survey annual ryegrass populations from across Kentucky for herbicide resistance to pinoxaden and fenoxaprop.
2. Investigate ryegrass seed rain and combine dispersal to further understand the utility of harvest weed seed control

Materials and Methods

Objective 1

Italian ryegrass seed heads were collected in May and June of 2020 from Kentucky fields in which populations had escaped control of postemergence wheat herbicides. Seed heads were thrashed, seed cleaned, and labeled by county and number in order of collection.

Seed from each population was planted along with a known susceptible ryegrass population in the greenhouse facility at the University of Kentucky Research and Education Center in Princeton, KY. Following emergence, induvial ryegrass plants were transplanted into 10 in^3 greenhouse cone-tainers. At the one to two tiller growth stage, ten plants from each population were sprayed with 1 fold and 2 fold rate of Axial XL (Pinoxaden) and Axial Bold (Pinoxaden plus fenoxaprop).

Four weeks after application plants were evaluated for visual control, fresh biomass weight, and dry biomass weight. Only visual control will be presented in this report for brevity.

Objective 2

Commercial grower wheat fields with ryegrass escapes were evaluated for annual ryegrass seed rain June of 2020 prior to wheat harvest. A $1m^2$ area was evaluated for every 0.5 acre of infestation within each field evaluated. Within the 1 m^2 area all ryegrass seed heads were collected and all debris on the soil surface immediately within the $1m^2$ area was collected using a vacuum. Ryegrass seed was then separated and cleaned of all other debris within the samples. Ryegrass seed samples were weighed and counted to achieve a distribution of seed retained on the seed head and seed that had "rained" to the soil surface just prior to wheat harvest.

A field located at the University of Kentucky Research and Education Center was further evaluated for distribution of ryegrass during wheat harvest. Samples were collected from below the combine header, from the chaff behind the combine, and from the combine grain tank. Four samples per 1 acre of infestation were collected during harvest. Ryegrass seed was separated from all other debris, grain, and chaff within the collected samples. Ryegrass seed samples were weighed and counted to achieve a distribution of ryegrass seed that shattered at the combine header, seed contained within the chaff, and seed contained within the grain tank.

Results

Objective 1

The susceptible population was evaluated as having 85 to 96 percent control to Axial XL and 75 to 80 percent control to Axial Bold four weeks after application. When directly compared to the susceptible population, eight populations showed significantly lower control at both the one-fold and two-fold rate of Axial XL (Table 1). Within those eight populations, seven also had significantly lower visual control as compared to the susceptible population at the 15 fl oz/a rate of Axial Bold. Although only one of the eight populations was significantly lower than the susceptible at the two fold rate of Axial Bold (Table 1).

Objective 2

Seed retention and rain collections were analyzed for two locations collected in 2020: Young Road and UKREC. At both locations seed retention and rain collections were conduction within three days prior to the wheat field harvest operation. At both locations, the majority of seed was retained within the ryegrass seed head prior to harvest. Ryegrass seed heads retained 10,000 and 11,000 ryegrass seeds per m^2 at both locations as compared to 2,500 to 3,500 seeds per m^2 that had rained onto the ground prior to harvest.

Ryegrass seed dispersal at harvest was only evaluated at the UKREC location in 2020. The majority of ryegrass seed collected at harvested was found either in the combine chaff or grain tank. The highest proportion of ryegrass seed was found in the chaff portion at approximately 7000 seeds/m^2 of harvested area. This is in comparison to 5000 and 4500 seeds/m^2 of harvest area contained within the grain tank and shattering at the combine header, respectively.

Discussion and Conclusions

Initial screens of twenty-two ryegrass populations from across Kentucky revealed that at least 8 populations were potentially resistant to pinoxaden and seven of those populations showing increased tolerance to the premix of pinoxaden and fenoxaprop (Axial Bold). Additional dose response screens of the eight populations are currently on-going to confirm pinoxaden resistance. The majority of these potentially resistant populations occurred in either Simpson or Todd Counties where a large proportion of wheat is grown in Kentucky and have historically dealt with ryegrass as a problematic weed species in this crop. Many growers within this region have relied heavily on pinoxaden based herbicides for postemergence control of ryegrass, and thus it is not surprising to find a high proportion of potential pinoxaden resistance occurring in this region. Looking toward the future, it should be assumed that pinoxaden resistance in ryegrass will continue to occur and spread in wheat growing regions of Kentucky.

The reality of inevitable widespread resistance to pinoxaden, calls for alternative practices to control ryegrass in wheat. One potential non-chemical control method is the use of harvest weed seed control units at harvest. These units are integrated into harvesting equipment and crush weed seed contained within the fine chaff portion of the combine. The successful use of this machinery depends on seed being retained on ryegrass seed heads prior to wheat harvest and being taken into harvest equipment and contained within the chaff of the crop that is distributed behind the combine. The initial results of this research show that at least 80 percent ryegrass seed is retained on the seed head prior to harvest. Additionally, distribution of ryegrass seeds at harvest were primarily contained within the chaff and grain tank of the combine. Although, about 25% of the seed retained on the seed head did shatter at the combine head at harvest would not have been subject to the harvest weed seed control mechanism. These initial results indicate that harvest weed seed control could be an additional tool for wheat growers dealing with herbicide resistant annual ryegrass, although research is ongoing and further evaluations are needed.

Table 1. Initial Herbicide Screening of 22 Italian (annual) ryegrass populations collected from across Kentucky. Means in bold and with an asterisk are significantly different than the susceptible population.

	Axial XL		**Axial Bold**	
	16.4fl oz/a	**32.8 fl oz/a**	**15 fl oz/a**	**30 fl oz/a**
Population	---------------- % Visual Control 28 Days After Treatment ----------------			
Susceptible	85	96	75	80
Ballard 1	72	88	78	94
Daviess 1	57	70	**46***	66
Daviess 2	93	92	83	93
Daviess 3	83	88	63	90
Hickman 1	**23***	**47***	55	67
Logan 1	60	71	60	93
Logan 2	84	90	70	88
Logan 3	81	90	67	86
Pulaski 1	59	75	69	70
Simpson 1	59	72	56	70
Simpson 2	73	80	58	76
Simpson 3	**16***	**14***	**11***	21
Simpson 4	**22***	**28***	**21***	32
Simpson 5	**24***	**34***	**42***	44
Simpson 6	**21***	**26***	**18***	27
Simpson 7	75	89	79	96
Todd 1	**4***	**12***	**8***	**6***
Todd 2	**6***	**12***	**8***	10
Todd 3	**9***	**12***	**5***	12
Warren 1	77	91	90	92
Warren 2	68	95	54	91
Warren 3	70	87	73	77
Wayne 1	70	91	76	85

Figure 1. Distribution of annual ryegrass seed prior to wheat harvest comparing seed retained on the seed head and seed that had "rained" onto the ground.

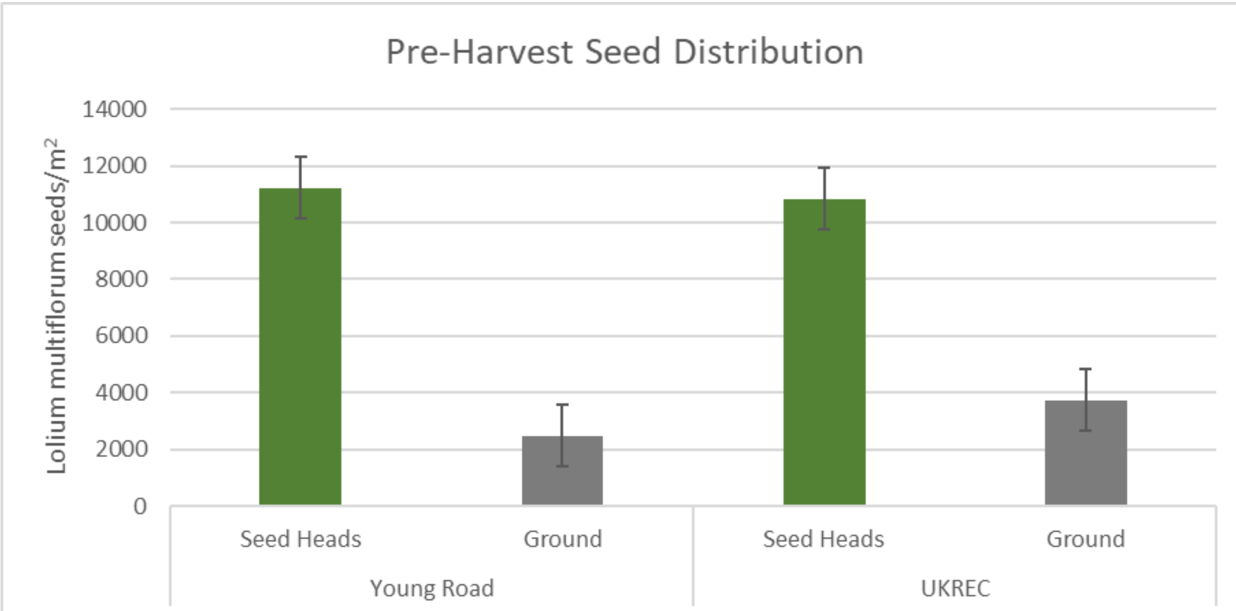

Figure 2. Comparison of annual ryegrass shattered at the comine head, ryegrass seed in the chaff, and ryegass seed in the combine grain tank durign wheat harvest.