

# 2024 Soybean Science Research Report





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# Evaluation of Foliar Fungicides on Soybean, Princeton , KY, 2024

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## **INTRODUCTION**

The objective of this research was to determine which fungicide products have the best efficacy against foliar diseases of soybean and the best yield response relative to a non-treated check

## **METHODS & MATERIALS**

A field trial was conducted at the University of Kentucky Research & Education Center (UKREC) in Princeton, KY in 2024. Soybean cultivar 'NK43-Y9XFS' was planted on May 22, 2024, at 135,000 seeds/A. Plots were no-till planted into soybean stubble from the previous crop. Plots were 4 rows wide (on 30 inch row spacings) and 20 ft long. Each treatment was replicated four times in a randomized complete block design. Foliar fungicide treatments were applied to plots at the R3 soybean development stage (beginning pod stage) using a backpack sprayer calibrated to deliver 20 gal/A. Severity of frogeye leaf spot (caused by *Cercospora sojina*) was rated multiple times starting 2 weeks after treatment application, and then every two weeks after that. Disease severity was rated by evaluating leaves in the upper canopy and estimating the percentage of leaf area affected by frogeye leaf spot. Final disease ratings are reported below. Plots were harvested with a small plot combine equipped with a grain moisture and weigh system, and yields were calculated and standardized to bushels per acre at 13% moisture. Oil and protein concentrations of harvested seed also were determined.

## **RESULTS & DISCUSSION**

Final disease severity in the nontreated check was moderate (30%) (Table 1.). All treatments significantly reduced disease severity compared to the nontreated check. Revytek treated plots has the lowest frogeye leaf spot severity, but was not statistically different than all other fungicide treatments except Quadris, Aproach Prima, and Trivapro. Statistical differences did occur for grain moisture among treatments, but no statistical differences among treatments were observed for yield, oil concentration, or protein concentration.

## **ACKNOWLEDGEMENTS**

The authors thank the Atlantic Soybean Council, Mid-South Soybean Board, North Central Soybean Research Program, Southern Soybean Research Program, and the United Soybean Board for funding.

## **TABLES**

(continue next page)

TABLE 1. Effect of foliar fungicide treatments on frogeye leaf spot severity, soybean grain moisture, yield, oil concentration, and protein concentration at Princeton, KY in 2024.

Final

Product	Rate (fl oz/A)	Frogeye leaf spot severity (%)	Grain moisture (%)	Yield (bu/A)	Oil (%)	Protein (%)
Non treated check	.	30.0	11.4	58.5	20.2	34.6
Topguard EQ	5	13.4	11.2	63.5	20.9	33.9
Lucento	5	11.3	10.9	60.0	21.1	34.0
Trivapro	13.7	17.5	11.1	61.7	20.5	34.7
Quadris	6	21.3	10.9	66.7	20.6	34.6
Veltyma	7	10.9	11.2	62.4	20.6	34.6
Revytek	8	10.9	11.2	63.4	20.8	34.2
Initiate 720 + Monsoon + Topsin 4.5 FL	36+4+20	13.4	11.2	61.3	20.4	34.6
Delaro Complete	8	15.0	10.9	60.8	20.5	34.3
Miravis Neo	13.7	13.7	10.9	61.0	20.5	34.5
Topsin 4.5 FL	20	15.0	11.2	60.3	20.5	34.4
Miravis Top	13.7	12.9	10.9	63.3	20.6	34.2
Aproach Prima	6.8	20.0	10.8	60.1	20.7	34.2
	<b>LSD 0.05*</b>	<b>4.4</b>	<b>0.4</b>	<b>NS**</b>	<b>NS</b>	<b>NS</b>

\*Fisher's least significant difference with alpha = 0.05.

\*\*No significant differences detected.

# Evaluations of the Enlist E3 and Roundup Ready 2 XtendFlex Soybean Systems Using Traditional Herbicide Combinations

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## **OBJECTIVE**

The Roundup Ready 2 XtendFlex (dicamba, glyphosate, and glufosinate-resistant) and Enlist E3 (2,4-D, glyphosate, and glufosinate-resistant) soybean systems are the dominant herbicide-resistant soybean platforms in Kentucky. Both platforms have provided benefits to Kentucky soybean farmers with the recent increase in glyphosate and PPO-resistant broadleaves, especially the *Amaranthus* species. The heavy use of the systems and heavy reliance on the growth regulators (dicamba and 2,4-D) has created scenarios of potential resistance selection. In 2022 and 2023 numerous complaints of reduced dicamba, 2,4-D, and glufosinate efficacy were reported, although no resistance events have yet to be confirmed in Kentucky. However, resistance to 2,4-D, dicamba, and glufosinate have been confirmed in neighboring states. In the face of both potential resistance and increased regulatory restrictions the evaluation of combinations of herbicides related to the soybean resistance traits (dicamba, 2,4-D, glyphosate, and glufosinate) and combinations of older chemistries such as group 1 (clethodim, quizalofop, etc) group 14 (fomesafen, lactofen, etc) and group 2 (cloransulam, imazethapyr, etc) is needed in both herbicide-resistant soybean platforms.

## **METHODS & MATERIALS**

Research was initiated in 2023 and 2024 with two trials being established at the University of Kentucky Research and Education Center in Princeton, KY each year. In each year, one trial was placed on a field with a known population of waterhemp and a mixture of annual grass species. The second trial in each year was established on a field with a mixture of annual and perennial weeds common to Kentucky including: giant ragweed, smooth pigweed, prickly sides, morningglory species, broadleaf signalgrass, crabgrass, and johnsongrass.

Trials were designed as split blocks with two blocks: Roundup Ready 2 XtendFlex soybean and Enlist E3 soybean. Herbicide treatments consist of either herbicide related to the soybean trait package, traditional soybean herbicides, and a mixture of the two. A complete list of treatments can be found in Tables 1 and 2. All treatments will be replicated four times.

Plots were established on April 12, 2023 and April 15, 2024, with a burndown application of 40 fl oz Roundup PowerMax 3 plus 1 fl oz Sharpen plus 8 oz Canopy. Soybean were planted on April 13, 2023 and April 16, 2024. Early post applications were applied when weed species reached an average of two to four inches in height, with the late post occurring to either two-to-four-inch weeds or prior to June 30, whichever occurred first.

## **RESULTS AND DISCUSSION**

Waterhemp control ranged from 93 to 100 percent control in 2023 and 84 to 100 percent control

in 2024 in treatments that received either Enlist One or Xtendimax early postemergence followed by Liberty (Table 3 and Table 4). Similarly, the treatment receiving an application of Liberty early postemergence followed by Liberty late postemergence resulted in 94 to 100 percent control of waterhemp in 2023 and 95 to 99 percent control of waterhemp in 2024, 21 days after the late postemergence application (Table 3 & 4). The inclusion or exclusion of Select Max and Roundup PowerMax 3 did not influence waterhemp control, and annual grass densities were too inconsistent to evaluate within the trials. In contrast, the two treatments that exclude Enlist One and Xtendimax resulted in significantly lower waterhemp control at 21 days after postemergence application, especially in 2023. Prefix plus Select Max followed by Liberty resulted in 58 to 80 percent control in 2023 (Table 3). In 2024, these treatments performed better with the Liberty cleaning up the plots with 100 percent control 21 days after the late application of Liberty (Table 4). While Prefix plus Select Max followed by Cobra and Assure II resulted in the lowest control at 0 to 10 percent in 2023 and 45 to 65% in 2024 (Table 3 & 4). These results highlight the utility and value of glufosinate, 2,4-D, and dicamba in the Enlist and RR2XtendFlex soybean systems for controlling weed species such as waterhemp.

In the second trial giant ragweed was the predominate weed species in both years with a mixture of annual morningglory species, smooth pigweed, and giant foxtail also present in 2023 and morningglory and smooth pigweed present in 2024. In contrast to the waterhemp trial, all treatments resulted in acceptable control of all weed species present in the trial. Giant ragweed control was 94 to 100 percent in 2023 and 90 to 99 percent in 2024 across all treatments 21 days after the late postemergence applications (Table 5 & 6). Morningglory, smooth pigweed, and giant foxtail control was 100 percent across all treatments at the 21 days after late postemergence evaluation timing in 2023 (Table 7). Similarly in 2024, Morningglory and smooth pigweed control was 98 to 100 percent across all treatments at 21 days after the late postemergence application (Table 8). In contrast to the waterhemp trial, the inclusion or exclusion of glyphosate, glufosinate, 2,4-D, and/or dicamba did not influence late season weed control.

## **CONCLUSION**

Results from these studies highlight the utility of both the Enlist E3 and Roundup Ready 2 Xtend-Flex soybean systems, especially on fields with tough to control weeds such as waterhemp. The inclusion of glufosinate in all postemergence herbicide applications or the inclusion of Enlist One or Xtendimax in the early postemergence application resulted in 84 percent or greater waterhemp control. In contrast treatments lacking Enlist One, Xtendimax, or two passes of glufosinate resulted in unacceptable control of waterhemp. This highlights the need for the Enlist and Xtend-Flex soybean systems to allow for continued successful control of species such as waterhemp.

In contrast the study conducted on a field with a population of giant ragweed and other annual broadleaf and grass species resulted in 90 percent or greater control of across all treatments, even in treatments excluding the use of glyphosate, glufosinate, 2,4-D, and dicamba.

Overall this research emphasized the importance of evaluating the weed species present in each individual field and implementing herbicide programs that best fit those species. In the face of potential shortages, restrictions, and resistance it is important to recognize that while the Xtend-Flex and Enlist soybean systems offer flexibility; 2,4-D, dicamba, and glufosinate should be used judiciously. The implementation of older chemistries such as PPO-inhibitors, and ALS-inhibitors still have a fit in many of our soybean weed control strategies to ensure the continued viability of the limited number of postemergence soybean herbicides.

## **ACKNOWLEDGEMENTS**

We would like to thank the Kentucky Soybean Promotion Board for their funding support of this project.

## **TABLES**

**Table 1.** Early postemergence and late postemergence herbicide treatments applied to the trial evaluating waterhemp control in Roundup Ready 2 XtendFlex and Enlist E3 soybean systems.

<b>Soybean Trait Platform</b>	<b>Early Postemergence</b>	<b>Late Postemergence</b>	<b>Herbicide Program in Relation to Soybean Resistance Traits</b>
Roundup Ready 2 XtendFlex	Xtendimax + Roundup PowerMax3 + Dual II Magnum	Liberty + Roundup PowerMax3	Trait Related Herbicides
	Xtendimax + Select Max + Dual II Magnum	Liberty*	Trait Related Herbicide + Traditional Herbicides
	Liberty + Select Max + Dual II Magnum	Liberty*	Trait Related Herbicide + Traditional Herbicides
	Prefix + Select Max	Liberty*	Trait Related Herbicide + Traditional Herbicides
	Prefix + Select Max	Cobra + Assure II	Traditional Herbicides
Enlist E3	Enlist One + Roundup PowerMax3 + Dual II Magnum	Liberty + Roundup PowerMax3	Trait Related Herbicides
	Enlist One + Liberty + Dual II Magnum	Liberty + Roundup PowerMax3	Trait Related Herbicides
	Enlist One + Select Max + Dual II Magnum	Liberty*	Trait Related Herbicide + Traditional Herbicides
	Liberty + Select Max + Dual II Magnum	Liberty*	Trait Related Herbicide + Traditional Herbicides
	Prefix + Select Max	Liberty*	Trait Related Herbicide + Traditional Herbicides
	Prefix + Select Max	Cobra + Assure II	Traditional Herbicides



**Table 2.** Early postemergence and late postemergence herbicide treatments applied to the trial evaluating giant ragweed, morningglory, smooth pigweed, and giant foxtail control in Roundup Ready 2 XtendFlex and Enlist E3 soybean systems.

Soybean Trait Platform	Early Postemergence	Late Postemergence*	Herbicide Program in Relation to Soybean Resistance Traits
Roundup Ready 2 XtendFlex	Xtendimax + Roundup PowerMax3 + Dual II Magnum	Liberty + Roundup PowerMax3	Trait Related Herbicides
	Xtendimax + Select Max + Dual II Magnum	Liberty*	Trait Related Herbicide + Traditional Herbicides
	Liberty + Select Max + Dual II Magnum	Liberty*	Trait Related Herbicide + Traditional Herbicides
	Pursuit + Prefix	Liberty + Select Max	Trait Related Herbicide + Traditional Herbicides
	Firstrate + Prefix + Select Max	Cobra + Pursuit	Traditional Herbicides
Enlist E3	Enlist One + Roundup PowerMax3 + Dual II Magnum	Liberty + Roundup PowerMax3	Trait Related Herbicides
	Enlist One + Liberty + Dual II Magnum	Liberty + Roundup PowerMax3	Trait Related Herbicides
	Enlist One + Select Max + Dual II Magnum	Liberty*	Trait Related Herbicide + Traditional Herbicides
	Liberty + Select Max + Dual II Magnum	Liberty*	Trait Related Herbicide + Traditional Herbicides
	Pursuit + Prefix	Liberty + Select Max	Trait Related Herbicide + Traditional Herbicides
	Firstrate + Prefix + Select Max	Cobra + Pursuit	Traditional Herbicides

**Table 3.** Waterhemp control 21 days after late postemergence treatment in 2023.

Early Post Treatment	Late Post Treatment	Enlist Soybean	XtendFlex Soybean
----- % Visual Waterhemp Control <sup>a</sup> -----			
Untreated		0 C	0 C
Enlist One – 2 pt OR Xtendimax -22 fl oz + Roundup PwrMax3 – 30 fl oz Dual II Magnum – 1.33 pt	Liberty – 32 fl oz + Roundup PwrMax3 – 30 fl oz	100 A	96 A
Enlist One – 2 pt + Liberty – 30 fl oz + Dual II Magnum – 1.33 pt	Liberty – 29 fl oz + Roundup PwrMax3 – 30 fl oz	100 A	-
Enlist One – 2 pt OR Xtendimax – 22 fl oz + Select Max – 12 fl oz + Dual II Magnum – 1.33 pt	Liberty – 32 fl oz	100 A	93 A
Liberty – 30 fl oz + Select Max – 12 fl oz + Dual II Magnum – 1.33 pt	Liberty – 32 fl oz	94 AB	100 A
Prefix -2.33 pt + Select Max – 12 fl oz	Liberty – 32 fl oz	80 B	58 B
Prefix – 2.33 pt + Select Max – 12 fl oz/a	Cobra – 12.5 fl oz + Assure II – 10 fl oz	0 C	10 C

<sup>a</sup> Means within a column followed by a different letter are statistically different. Tukey HSD  $\alpha=0.05$

**Table 4.** Waterhemp control 21 days after late postemergence treatment in 2024.

Early Post Treatment	Late Post Treatment	Enlist Soybean	XtendFlex Soybean
Untreated		0 C	0 c
Enlist One – 2 pt OR Xtendimax -22 fl oz + Roundup PwrMax3 – 30 fl oz Dual II Magnum – 1.33 pt	Liberty – 32 fl oz + Roundup PwrMax3 – 30 fl oz	100 A	98 a
Enlist One – 2 pt + Liberty – 30 fl oz + Dual II Magnum – 1.33 pt	Liberty – 29 fl oz + Roundup PwrMax3 – 30 fl oz	100 A	-
Enlist One – 2 pt OR Xtendimax – 22 fl oz + Select Max – 12 fl oz + Dual II Magnum – 1.33 pt	Liberty – 32 fl oz	100 A	84 a
Liberty – 30 fl oz + Select Max – 12 fl oz + Dual II Magnum – 1.33 pt	Liberty – 32 fl oz	99 A	95 a
Prefix -2.33 pt + Select Max – 12 fl oz	Liberty – 32 fl oz	100 A	100 a
Prefix – 2.33 pt + Select Max – 12 fl oz/a	Cobra – 12.5 fl oz + Assure II – 10 fl oz	65 B	45 b

---- % Visual Waterhemp Control<sup>a</sup> ----

<sup>a</sup> Means within a column followed by a different letter are statistically different. Tukey HSD  $\alpha=0.05$

**Table 5.** Giant ragweed control 21 days after late postemergence treatment.in 2023.

Early Post Treatment	Late Post Treatment	Enlist Soybean	XtendFlex Soybean
		---- % Visual Giant Ragweed Control <sup>a</sup> ----	
Untreated		0 B	0 b
Enlist One – 2 pt OR Xtendimax -22 fl oz + Roundup PwrMax3 – 30 fl oz Dual II Magnum – 1.33 pt	Liberty – 32 fl oz + Roundup PwrMax3 – 30 fl oz	100 A	100 a
Enlist One – 2 pt + Liberty – 30 fl oz + Dual II Magnum – 1.33 pt	Liberty – 29 fl oz + Roundup PwrMax3 – 30 fl oz	100 A	-
Enlist One – 2 pt OR Xtendimax – 22 fl oz + Select Max – 12 fl oz + Dual II Magnum – 1.33 pt	Liberty – 32 fl oz	100 A	100 a
Liberty – 30 fl oz + Select Max – 12 fl oz + Dual II Magnum – 1.33 pt	Liberty – 32 fl oz	100 A	100 a
Prefix -2.33 pt + Pursuit – 4 fl oz	Liberty – 32 fl oz + Select Max – 12 fl oz	98 A	94 a
Prefix – 2.33 pt + Select Max – 12 fl oz/a + FirstRate – 0.3 oz/a	Cobra – 12.5 fl oz + Pursuit – 4 fl oz	99 A	94 a

<sup>a</sup> Means within a column followed by a different letter are statistically different. Tukey HSD  $\alpha=0.05$

**Table 6.** Giant ragweed control 21 days after late postemergence treatment.in 2024.

Early Post Treatment	Late Post Treatment	Enlist Soybean	XtendFlex Soy-bean
Untreated		0 B	0 b
Enlist One – 2 pt OR Xtendimax -22 fl oz + Roundup PwrMax3 – 30 fl oz Dual II Magnum – 1.33 pt	Liberty – 32 fl oz + Roundup PwrMax3 – 30 fl oz	90 A	93 a
Enlist One – 2 pt + Liberty – 30 fl oz + Dual II Magnum – 1.33 pt	Liberty – 29 fl oz + Roundup PwrMax3 – 30 fl oz	91 A	-
Enlist One – 2 pt OR Xtendimax – 22 fl oz + Select Max – 12 fl oz + Dual II Magnum – 1.33 pt	Liberty – 32 fl oz	92 A	94 a
Liberty – 30 fl oz + Select Max – 12 fl oz + Dual II Magnum – 1.33 pt	Liberty – 32 fl oz	94 A	95 a
Prefix -2.33 pt + Pursuit – 4 fl oz	Liberty – 32 fl oz + Select Max – 12 fl oz	91 A	99 a
Prefix – 2.33 pt + Select Max – 12 fl oz/a + FirstRate – 0.3 oz/a	Cobra – 12.5 fl oz + Pursuit – 4 fl oz	98 A	95 a

----- % Visual Giant Ragweed Control<sup>a</sup> -----

<sup>a</sup> Means within a column followed by a different letter are statistically different. Tukey HSD  $\alpha=0.05$

**Table 7.** Morningglory, smooth pigweed, & giant foxtail control 21 days after late postemergence treatment in 2023.

Early Post Treatment	Late Post Treatment	Enlist Soybean	XtendFlex Soybean
		---- % Visual Weed Control <sup>a</sup> ----	
Untreated		0 B	0 b
Enlist One – 2 pt OR Xtendimax -22 fl oz + Roundup PwrMax3 – 30 fl oz Dual II Magnum – 1.33 pt	Liberty – 32 fl oz + Roundup PwrMax3 – 30 fl oz	100 A	100 a
Enlist One – 2 pt + Liberty – 30 fl oz + Dual II Magnum – 1.33 pt	Liberty – 29 fl oz + Roundup PwrMax3 – 30 fl oz	100 A	-
Enlist One – 2 pt OR Xtendimax – 22 fl oz + Select Max – 12 fl oz + Dual II Magnum – 1.33 pt	Liberty – 32 fl oz	100 A	100 a
Liberty – 30 fl oz + Select Max – 12 fl oz + Dual II Magnum – 1.33 pt	Liberty – 32 fl oz	100 A	100 a
Prefix -2.33 pt + Pursuit – 4 fl oz	Liberty – 32 fl oz + Select Max – 12 fl oz	100 A	100 a
Prefix – 2.33 pt + Select Max – 12 fl oz/a + FirstRate – 0.3 oz/a	Cobra – 12.5 fl oz + Pursuit – 4 fl oz	100 A	100 a

<sup>a</sup> Means within a column followed by a different letter are statistically different. Tukey HSD  $\alpha=0.05$

Table 8. Morningglory, & smooth pigweed, control 21 days after late postemergence treatment in 2024.

Early Post Treatment	Late Post Treatment	Enlist Soybean	XtendFlex Soybean
---- % Visual Weed Control <sup>a</sup> ----			
Untreated		0 B	0 b
Enlist One – 2 pt OR Xtendimax -22 fl oz + Roundup PwrMax3 – 30 fl oz Dual II Magnum – 1.33 pt	Liberty – 32 fl oz + Roundup PwrMax3 – 30 fl oz	97 A	100 a
Enlist One – 2 pt + Liberty – 30 fl oz + Dual II Magnum – 1.33 pt	Liberty – 29 fl oz + Roundup PwrMax3 – 30 fl oz	99 A	-
Enlist One – 2 pt OR Xtendimax – 22 fl oz + Select Max – 12 fl oz + Dual II Magnum – 1.33 pt	Liberty – 32 fl oz	97 A	100 a
Liberty – 30 fl oz + Select Max – 12 fl oz + Dual II Magnum – 1.33 pt	Liberty – 32 fl oz	99 A	100 a
Prefix -2.33 pt + Pursuit – 4 fl oz	Liberty – 32 fl oz + Select Max – 12 fl oz	98 A	100 a
Prefix – 2.33 pt + Select Max – 12 fl oz/a + FirstRate – 0.3 oz/a	Cobra – 12.5 fl oz + Pursuit – 4 fl oz	99 A	100 a

<sup>a</sup> Means within a column followed by a different letter are statistically different. Tukey HSD  $\alpha=0.05$

# Snail Species Found in Soybean and Corn Fields in Kentucky

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## INTRODUCTION (objective)

Snails and slugs are becoming an emergent pest in soybeans, and their frequency and damage seem to be increasing during the last 10 years. It is important to identify these mollusks to find if they are native or invasive species. In 2022, 2023, and 2024, snails were observed causing injuries to soybeans and corn in western Kentucky (Figure 1) (Villanueva 2022, 2023 and 2024). Currently in many southern states (Florida, Georgia), an invasive species, *Bulimulus bonariensis*, was found in Florida (Rabelo et al. 2022) and has become an endemic species. *Bulimulus bonariensis* feeds on peanut pods prostrated on the soil (Rabelo et al., 2022), contaminates harvesting pecans, and congregates in irrigation structures on clogs harvest equipment and contaminates harvest pecan nuts (Aceves-Doria, 2020; Abney, personal communication). *Bulimulus bonariensis* was previously reported as a native species of Argentina and Brazil. It causes abundant damage to soybeans in Argentina (Frana and Masoni 2007 and 2011).

The native species described in this document were not previously reported feeding on corn or soybeans anywhere else in the US. The reasons for their incursion into field crops and high population numbers with the capability to cause economic losses to soybeans or corn are unknown.

The objective of this report is to identify the most common snails found in commercial soybeans and corn fields.



Figure 1. At least 20 acres of a commercial soybean field were consumed by the native snail *Mesodon clausus* in Eddyville KY. Photo on the right shows older plants (light yellow colored) while dark green plants were replanted after field was treated with metaldehyde pellets.



## **METHODS & MATERIALS**

In this study, we had the collaboration of Dr. F. Borrero (USDA APHIS PPQ PEIP National Identification Services—Philadelphia, PA). He identified the snail species found in commercial soybean fields. Species found in these fields were collected while causing injuries to soybeans or corn. These damages includes feeding on seedlings or defoliation on later stages of soybean development or presented in fields without causing any visual damage to soybeans. All specimens were sent to Dr. Borrero’s laboratory.

## **RESULTS & DISCUSSION**

Several species of snails were found in soybean fields but the most common were the following species

### **Mesodon clausus** (Polygyridae)

This snail is commonly known as the “yellow globelet snail” and belongs to the Polygyridae family. It is 0.5 to 0.7 inches (13.6-18.0 mm) wide, with a height of 0.4 to 0.5 in (10-13 mm), and has a shell with 5 or more whorls (Figure 2). This snail has a patchy distribution and is often found along river floodplains and wetlands. It is well distributed in the southern, midwestern, and eastern United States. It was found in Lyon, Caldwell, Christian, and Trigg counties, in KY. It was not reported as a pest of soybeans, but in 2022 and 2024 we have records of its abundant injuries to commercial soybean fields. It has affected germinating plants, cotyledons, as well as plants in more advanced development stages. For soybean growers in Kentucky, this species may be an emergent pest as its populations can explode rapidly; however, many aspects of its phenology, ecology, and habitats need to be investigated.



**Figure 2.** (Left) *Mesodon clausus* also known as the “yellow globelet snail” feeding on cotyledon, and (right) the same species found in corn fields. This species was found feeding on both soybeans and corn in 2022, 2023 and 2024.

*Ventridens intertextus* (Gastrodontidae)

This species was found to cause damage to corn in 2023. This species is found in woods with acid soils, in leaf litter. In Kentucky, it is found in hardwood forest ravines, hillsides, and acidic ridgetops (Dourson et al., 2010). But in Tennessee, *V. intertextus* has been reported in young forests where dolomite is predominant; it belongs to the Gastrodontidae family and is also known as the “pyramid dome snail.” This species is medium-sized with a diameter of up to 0.8 inches and a shell with 5–6 spirally striated whorls (Figure 3) and a dome-shaped spire. The body is about twice as long. They tend to have a thickened basal callus inside the aperture.



**Figure 3.** (left) *Ventridens intertextus* also known as the “pyramid dome snail” in laboratory colony feeding on carrots. (Photo: Raul Villanueva)

*Novisuccinea ovalis* (Say) (Succineidae)

This snail is a medium-sized snail with a transparent, glossy yellow shell. The shell is fragile and has a relatively low spire and an oval aperture about two-thirds the height of the entire shell. The snail is pale with dark upper antennae. It can be found among herbaceous plants along ditches, streams, or rivers, but also in hillside woods, sometimes hundreds of meters from water. It typically occurs in moderate to low numbers. This species is found throughout the eastern and midwestern states and some Canadian provinces. In 2017, we found this species by mid-May, whereas in 2024, we found this species from late July to mid-September in commercial soybean fields in Lyon and Graves counties. Damages were observed in primary leaves, cotyledons, foliage in plants during the flowering stage, and developing flowers (Figure 4).



**Figure 4.** *Novisuccinea ovalis* (left) different snail stages, and (right) holes on leaves during R1 development stage of soybeans plants. (Photos: Raul Villanueva)

*Triodopsis hopetonensis* (Polygyridae)

This snail lives in moderately damp habitats and often occurs in large numbers. It may be found in woodland, in open grassy areas, and very commonly in urban settings. *Triodopsis hopetonensis* is widespread from Louisiana to Maryland. Its common name is the Magnolia threetooth snail. In the bottom left photo of Figure 5, the threetooth that refers to its common name can be observed. Evident damage to soybeans has not been observed. We found this species in one field with *M. clausus*.



**Figure 5.** *Triodopsis hopetonensis* (left) showing the threetoothed feature that is characteristic of this species in the upside snail. Right image shows a comparisons of *T. hopetonensis* and *M. clausus*. (Photos: Raul Villanueva)

*Catinella vermeta* (Succineidae)

This is the smallest snail species found in soybeans in Kentucky soybean fields and the smallest species in the Succineidae family reported in Virginia. Its pale shell has convex whorls, deep sutures, and a shorter aperture relative to the rest of its shell. Shells often appear dull gray as they are frequently coated with mud. *Catinella vermeta* is sometimes found in numbers upon soaked logs, in damp seasonal channels, old beaver ponds, wet meadows, or along the margins of ponds and swamps. It can be found in both shady and sunny microhabitats. This species was found in soybean fields in Marion and Christian counties in western Kentucky. It is 0.11 to 0.27 inches (4-6.8 mm) wide, with a height of 0.27 to 0.43 in (7-11 mm), and has a shell with 3 or more whorls (Figure 6).



**Figure 6.** *Catinella vermeta* found feeding on soybean cotyledons in April and May 2024. (Photos: Raul Villanueva)

## **CONCLUSION**

Five snail species were found in commercial corn and soybean fields in 2024. Of the five species of snail found in this report, *Mesodon clausus* and *N. ovalis* can be potential emergent pests for commercial soybeans. In 2022, 2023, and 2024, their populations reached numbers that required the application of molluscicide baits or replanting. In 2024, approximately 30,000 acres of soybeans required the application of molluscicide baits for the control of snails and slugs. In some fields, up to 2 or more applications of molluscicides were necessary to control snail populations. If molluscicides were not used, 3 to 4 soybean replantings were conducted to have plant densities to obtain yields for economic profit.

## **ACKNOWLEDGEMENTS**

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# Evaluation of Soybean Varieties for Post-emergence Metribuzin Tolerance

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Differences in Metribuzin injury among soybean varieties (half the test plot was sprayed). The variety on the left is a susceptible variety while the variety on the right is a sensitive cultivar.

## INTRODUCTION

Metribuzin is an older chemistry herbicide that may become an important tool in controlling herbicide resistant [Palmer amaranth and waterhemp \(pigweed\)](#) , as well as other annual grasses and broadleaf weeds in soybean production. Though the risk of crop damage is high, soybean varieties do differ in tolerance to Metribuzin. Due to the serious issue of herbicide resistant Palmer amaranth in soybean production, preliminary research in this area is needed, even though Metribuzin has been shown to kill soybean foliage. Some universities have experimented with pre-emergent Metribuzin applications, but no one has studied variety response to post-emergence application. If differences in post-emergence tolerance to Metribuzin are identified among varieties, this may open new avenues for weed management in soybeans.

Identifying post-emergence Metribuzin application rates, levels of varietal resistance and combinations with other herbicides may open the door to new ways to control herbicide resistant Palmer Amaranth and waterhemp. Metribuzin tolerance differences have been reported among wheat varieties and needs to be studied in/among soybean varieties. Metribuzin is a selective triazinone herbicide and its use in soybean may become a critical tool in the future as weeds develop re-

sistance to other herbicides, such as [glyphosate](#) , ALS and ACCase chemistries. Metribuzin and paraquat are the only two herbicides still effective for managing palmer amaranth in some regions Arkansas. With the support of the Kentucky Soybean Promotion Board, Metribuzin tolerance among soybean varieties was evaluated in the 2024 growing season.

## **METHODOLOGY**

The University of Kentucky soybean variety testing program planted a Metribuzin tolerance trial at Woodford County, KY on April 29, 2024. 127 soybean varieties were planted in a randomized complete block design with 3 replicated plots per variety. Plots were planted into a conventionally tilled seedbed and were 5 ft wide by 16 ft long. Plots were harvested at maturity using a small plot combine.

To determine the proper application rate (to damage, but not kill), Metribuzin 75 WDG was applied to half of each plot at a rate of 1, 2, and 6 ounces active ingredient per acre on May 31, June 28 and July 15<sup>th</sup> respectively. Varieties were rated for injury on July 12<sup>th</sup> (2 weeks following the 2 ounce application). An injury rating scale of 1 to 5 was used to indicate if varieties were tolerant (1) or susceptible (5) to Metribuzin. The final 6 oz application was applied just to see what would happen.

## **RESULTS AND DISCUSSION**

This University of Kentucky trial is the 1<sup>st</sup> known trial to evaluate soybean varietal differences in post-emergence Metribuzin tolerance. These preliminary results should not be used for application guidance since much more research is needed. Fortunately, the mid-southern and southern soybean boards have funded researchers at the University of Kentucky and University of Arkansas to study in fine detail what underlies the varietal differences between soybean lines for metribuzin tolerance.

The initial application of 1 oz per acre on May 31<sup>st</sup> (to plants approximately 8 inches tall) did not cause sufficient observable damage (though some stunting was observed). The second application to the same area on June 28<sup>th</sup> at a 2 ounce per acre rate did cause damage to the canopy and differences in injury level were recorded among varieties on July 12<sup>th</sup> (Table 1). Injury rating differences among varieties ranged from 1.0 (no damage) to 4.0 (serious damage) and averaged 2.5. A final application of 6 ounces per acre was applied to the treated area just to see the effect, which further damaged the canopy, but did not kill the plants. When compared to an adjoining non-treated variety trial, grain yields were reduced by 9.2 bushels per acre (61.4 vs 52.2 – data not shown) in the Metribuzin treated plots.

Varietal tolerance to Metribuzin may become a very important factor for soybean growers who have glyphosate resistant pigweeds in their fields. These results may help researchers assess potential for crop injury for a given variety when using post-emergence applications of Metribuzin. Likewise, in the future, seed companies may be able to use this type of data to determine the potential for injury and make variety specific recommendations on the post emergence use of Metribuzin for their clients.

## **TABLES**

Table 1. Kentucky Soybean Variety Post-Emergence Metribuzin Tolerance.

<b><u>Variety</u></b>	<b><u>Maturity Group</u></b>	<b><u>Herbicide Technology</u></b>	<b><u>Metribuzin Injury</u></b>
Revere 3908XFS	3.9	Xtend/STS	1.0
STINE 39EH23	3.9	E3	1.0
Golden Harvest GH4775E3S	4.7	Enlist E3, STS	1.0
Golden Harvest GH4944XFS	4.9	XTFlex/STS	1.0
HS 37E10	3.7	Enlist	1.3
Innvictis A3974XF	3.9	XTFlex	1.3
PB 3323 E3 S	3.3	E3, STS	1.3
ARMOR 41-F65	4.1	XTFlex	1.3
Fortus 4335E	4.3	Enlist E3	1.3
HS 44E40	4.4	Enlist	1.3
Innvictis A4503XF	4.5	XTFlex	1.3
Xitavo XO 4364E	4.3	Enlist E3	1.3
Xitavo XO 4405E	4.4	Enlist E3	1.3
Innvictis A4862XF	4.8	XTFlex	1.3
HS 38F20	3.8	XTFlex	1.7
Xitavo XO 3795E	3.7	Enlist E3	1.7
PB 4424 E3 S	4.4	Enlist E3, STS	1.7
STINE 42EG23	4.2	Enlist E3, STS	1.7
STINE 43EG29	4.3	Enlist E3, STS	1.7
APEX AE4640S	4.6	Enlist E3, STS	1.7
HS 48E40	4.8	XTFlex	1.7
Innvictis A4664XF	4.6	XTFlex	1.7
PB 4726 E3 S	4.7	Enlist E3, STS	1.7
HS 34E40	3.4	Enlist	2.0
HS 37E40	3.7	Enlist	2.0
NUTECH 35N05E	3.5	E3	2.0
STINE 39EF32	3.9	E3	2.0
Xitavo XO 3855E	3.9	Enlist E3	2.0
APEX AE4341S	4.3	Enlist E3, STS	2.0
ASGROW AG43XF5	4.3	XTFlex	2.0
Golden Harvest GH4345XFS	4.3	XTFlex/STS	2.0
Golden Harvest GH4433E3S	4.4	Enlist E3, STS	2.0
Revere 44-F44	4.4	Xtend	2.0
STINE 45EH29	4.5	Enlist E3	2.0
Xitavo XO 4255E	4.2	Enlist E3	2.0
ARMOR 46-E75S	4.6	Enlist E3, STS	2.0
Dyna-Gro S48XF35	4.8	XTFlex	2.0
Integra XF4875S	4.8	XTFlex/STS	2.0
HS 39F30	3.9	XTFlex	2.3
NUTECH 37N03E	3.7	E3	2.3
ARMOR 45-F65	4.5	XTFlex	2.3
Dyna-Gro S43XF85S	4.3	XTFlex	2.3
Innvictis B4553E	4.5	Enlist E3	2.3
NUTECH 42N05E	4.2	Enlist E3	2.3

Continued>

<b>Variety</b>	<b>Maturity Group</b>	<b>Herbicide Technology</b>	<b>Metribuzin Injury</b>
PIONEER P42A84E	4.2	Enlist E3	2.3
Golden Harvest GH5253E3	5.2	Enlist E3	2.3
Innvictis A4814XFS	4.8	XTFlex	2.3
NUTECH 49N05E	4.9	Enlist E3	2.3
PB 4624 E3 S	4.6	Enlist E3, STS	2.3
PIONEER P49Z02E	4.9	Enlist E3	2.3
Revere 49-F36	4.9	XTFlex	2.3
STINE 48EE20	4.8	Enlist E3	2.3
USG 7495XFS	4.9	XTFlex/STS	2.3
Xitavo XO 4772E	4.7	Enlist E3	2.3
Xitavo XO 4894E	4.8	Enlist E3	2.3
CATALYST CT3933E3	3.9	E3	2.7
CHANNEL 3725RXF	3.7	XTFlex	2.7
Dyna-Gro S38EN75	3.8	Enlist E3	2.7
HS 36E40	3.6	Enlist	2.7
HS 38E20	3.8	Enlist	2.7
PB 3925 E3 S	3.9	E3, STS	2.7
ASGROW AG44XF4	4.4	XTFlex/STS	2.7
ASGROW AG45XF3	4.5	XTFlex/STS	2.7
CATALYST CT4413E3S	4.4	Enlist E3, STS	2.7
CONNECT 4525E	4.5	Enlist E3, STS	2.7
Golden Harvest GH4214E3S	4.2	Enlist E3, STS	2.7
HS 40E30	4.0	Enlist	2.7
HS 45E00	4.5	Enlist	2.7
Innvictis A4102XF	4.1	XTFlex	2.7
PIONEER P45Z75E	4.5	Enlist E3	2.7
STINE 41EG20	4.1	Enlist E3, STS	2.7
STINE 44EH23	4.4	Enlist E3	2.7
ASGROW AG46XF3	4.6	XF/SR	2.7
ASGROW AG47XF5	4.7	XF/SR	2.7
ASGROW AG49XF4	4.9	XF/SR	2.7
DM 48F53	4.8	XTFlex	2.7
Fortus 4655ES	4.6	Enlist E3, STS	2.7
Golden Harvest GH4864XFS	4.8	XTFlex/STS	2.7
HS 46F40	4.8	Enlist	2.7
HS 48F40	4.6	XTFlex	2.7
Integra XF4634S	4.6	XTFlex/STS	2.7
PIONEER P48A14E	4.8	Enlist E3	2.7
Revere 47-F77	4.7	XTFlex/STS	2.7
Revere 4826XFS	4.8	XTFlex	2.7
STINE 46EE20	4.6	Enlist E3	2.7
ARMOR 39-E35S	3.9	Enlist/E3/STS	3.0
ASGROW AG36XF4	3.6	XTFlex	3.0
Golden Harvest GH3774E3	3.7	E3	3.0

Continued>



<u>Variety</u>	<u>Maturity Group</u>	<u>Herbicide Technology</u>	<u>Metribuzin Injury</u>
HS 39E40	3.9	Enlist	3.0
Innvictis B3934E	3.9	Enlist E3	3.0
NUTECH 38N05E	3.8	E3	3.0
NUTECH 39N08E	3.9	E3	3.0
Revere 39-E71	3.9	Enlist E3	3.0
ASGROW AG40XF5	4.0	XTFlex/STS	3.0
ASGROW AG42XF4	4.2	XTFlex	3.0
CHANNEL 4125RFX	4.1	XTFlex	3.0
CHANNEL 4525RFX	4.5	XTFlex	3.0
Dyna-Gro S40EN54	4.0	Enlist E3	3.0
Fortus 4125ES	4.1	Enlist E3, STS	3.0
Golden Harvest GH4093E3	4.0	Enlist E3	3.0
USG 7435XFS	4.3	XTFlex/STS	3.0
ARMOR 46-F15S	4.6	XTFlex/STS	3.0
ARMOR 48-E95	4.8	Enlist E3	3.0
ASGROW AG48XF3	4.8	XF/SR	3.0
Dyna-Gro S47XF23S	4.7	XTFlex	3.0
Innvictis A4924XF	4.9	XTFlex	3.0
NuTech 47N04E	4.7	Enlist E3	3.0
STINE 46EG92	4.6	Enlist E3, STS	3.0
USG 7474XFS	4.7	XTFlex/STS	3.0
NUTECH 36N06E	3.6	E3	3.3
Revere 36-E54	3.6	Enlist E3	3.3
CONNECT 4025E	4.0	Enlist E3	3.3
Dyna-Gro S41XF65	4.1	XTFlex	3.3
Dyna-Gro S45EN25	4.5	Enlist E3	3.3
HS 41E40	4.1	Enlist	3.3
HS 42E40	4.2	Enlist	3.3
NUTECH 43N06E	4.3	Enlist E3	3.3
DM 46F54S	4.6	XTFlex	3.3
Golden Harvest GH4995E3S	4.9	Enlist E3, STS	3.3
Innvictis B4904E	4.9	Enlist E3	3.3
NUTECH 47N11BE	4.7	Enlist E3	3.3
USG 7463XF	4.6	XTFlex	3.3
ASGROW AG38XF3	3.8	XTFlex	3.7
HS 36F40	3.6	XTFlex	3.7
NUTECH 43N11BE	4.3	Enlist E3	3.7
PIONEER P45A81E	4.5	Enlist E3	3.7
ASGROW AG33XF3	3.3	XTFlex	4.0
PIONEER P38A28E	3.8	Enlist E3	4.0
NUTECH 45N10E	4.5	Enlist E3	4.0
<b>Average</b>			<b>2.5</b>

**Metribuzin Injury ratings: 1 = no injury; 5 = severe injury.**



