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Interaction of 2,4-D with Glyphosate or Graminicides on Grass Weed Control in Enlist E3 Soybeans

Abstract

The introduction of Enlist E3 soybean allows growers to use postemergence (POST) applications of low-volatile formulations of 2,4-D choline (Enlist One) for in-season control of glyphosate-resistant weeds. The POST applications of Enlist One and glyphosate (Roundup PowerMax) mixture can be tank-mixed with clethodim (Select Max) or quizalofop (Assure II) for both grass and broadleaf weed control. However, reduced control of grass weed species has previously been reported when graminicides (Select Max or Assure II) are tank-mixed with auxinic herbicides (2,4-D or dicamba). The main objective of this research was to determine the effectiveness of Enlist One, Roundup PowerMax, Select Max, and/or Assure II alone or in various combinations on grass weed control in Enlist E3 soybean. Field experiments were conducted during the 2020 growing season at the Kansas State University Agricultural Research Center (KSU-ARC) near Hays, KS, and the University of Nebraska near Lincoln, NE (UNL). The dominant grass species at the KSU-ARC site were southwest cupgrass and green foxtail. The predominant grass species at the UNL site were giant foxtail, hairy cupgrass and fall panicum. Herbicide treatments, including Select Max, Assure II, and Roundup PowerMax applied at V3-V4 soybean stage alone or in combination with Enlist One; and sequential treatments of Enlist One followed by (separated by 5 days) Select Max, Assure II and/or Roundup PowerMax, and vice-versa were investigated. Results from the KSU-ARC site indicated that sequential treatment of Enlist One at 5 days prior to the application of Assure II provided the highest control (87% to 90%) of southwest cupgrass and green foxtail at 28 days after treatment (DAT). In contrast, control of both grass species did not exceed 78% with the rest of the treatments. Soybean grain yields ranged from 7 to 16 bu/a for the majority of the treatments. Results from UNL site showed that the addition of Enlist One to Select Max or Assure II or applied in sequential treatments at 5 days after the application of these graminicides reduced control of giant foxtail (69% to 79%), hairy cupgrass (70% to 79%), and fall panicum (69% to 79%) at 28 DAT compared to graminicides alone (93 to 97%). Furthermore, an addition of Roundup PowerMax to tank-mixtures of Enlist One with Select Max or Assure II improved the control of all three weed species. Soybean grain yields ranged from 21 to 55 bu/a for the majority of the treatments. In conclusion, these results support the hypothesis that Enlist One can compromise the efficacy of Select Max or Assure II; however, addition of Roundup PowerMax to these tank-mixtures can help to optimize grass weed control in Enlist E3 soybean.

Keywords

auxinic herbicides, glyphosate, graminicide, herbicide interaction, 2, 4-D, clethodim, Enlist soybean

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Interaction of 2,4-D with Glyphosate or Graminicides on Grass Weed Control in Enlist E3 Soybeans

R. Liu, I. Effertz, T. Lambert, A. Jhala,¹ and V. Kumar

Summary

The introduction of Enlist E3 soybean allows growers to use postemergence (POST) applications of low-volatile formulations of 2,4-D choline (Enlist One) for in-season control of glyphosate-resistant weeds. The POST applications of Enlist One and glyphosate (Roundup PowerMax) mixture can be tank-mixed with clethodim (Select Max) or quizalofop (Assure II) for both grass and broadleaf weed control. However, reduced control of grass weed species has previously been reported when graminicides (Select Max or Assure II) are tank-mixed with auxinic herbicides (2,4-D or dicamba). The main objective of this research was to determine the effectiveness of Enlist One, Roundup PowerMax, Select Max, and/or Assure II alone or in various combinations on grass weed control in Enlist E3 soybean. Field experiments were conducted during the 2020 growing season at the Kansas State University Agricultural Research Center (KSU-ARC) near Hays, KS, and the University of Nebraska near Lincoln, NE (UNL). The dominant grass species at the KSU-ARC site were southwest cupgrass and green foxtail. The predominant grass species at the UNL site were giant foxtail, hairy cupgrass and fall panicum. Herbicide treatments, including Select Max, Assure II, and Roundup PowerMax applied at V3-V4 soybean stage alone or in combination with Enlist One; and sequential treatments of Enlist One followed by (separated by 5 days) Select Max, Assure II and/or Roundup PowerMax, and vice-versa were investigated. Results from the KSU-ARC site indicated that sequential treatment of Enlist One at 5 days prior to the application of Assure II provided the highest control (87% to 90%) of southwest cupgrass and green foxtail at 28 days after treatment (DAT). In contrast, control of both grass species did not exceed 78% with the rest of the treatments. Soybean grain yields ranged from 7 to 16 bu/a for the majority of the treatments. Results from UNL site showed that the addition of Enlist One to Select Max or Assure II or applied in sequential treatments at 5 days after the application of these graminicides reduced control of giant foxtail (69% to 79%), hairy cupgrass (70% to 79%), and fall panicum (69% to 79%) at 28 DAT compared to graminicides alone (93 to 97%). Furthermore, an addition of Roundup PowerMax to tank-mixtures of Enlist One with Select Max or Assure II improved the control of all three weed species. Soybean grain yields ranged from 21 to 55 bu/a for the majority of the treatments. In conclusion, these results support the hypothesis that Enlist One can compromise the efficacy of Select Max or Assure II; however, addition of Roundup PowerMax to these tank-mixtures can help to optimize grass weed control in Enlist E3 soybean.

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Introduction

The introduction of Enlist E3 soybean has stacked tolerance to glyphosate (Roundup PowerMax), glufosinate (Liberty), and 2,4-D (Enlist One), which allows growers to use Enlist One for in-season weed control, especially for managing glyphosate-resistant weeds. Acetyl-CoA-Carboxylase (ACCase) (Group 1) inhibiting herbicides (also known as graminicides) can provide effective control of a wide range of annual and perennial grass species. The POST application of Enlist One can be tank-mixed with Roundup PowerMax and/or graminicides (Select Max or Assure II) for broad spectrum weed control in Enlist E3 soybean. However, tank-mixing Enlist One may antagonize the efficacy of glyphosate (Roundup PowerMax) or graminicides for grass weed control. The main objective of this research was to determine the effectiveness of Roundup PowerMax, Select Max and/or Assure II alone or in various tank-mix combinations with Enlist One on grass weed control in Enlist E3 soybean.

Procedures

Field experiments were conducted at the KSU-ARC and UNL sites to evaluate the effectiveness of Roundup PowerMax, Assure II, and/or Select Max alone or in various combinations with Enlist One for grass weed control in Enlist E3 soybean. An Enlist E3 soybean variety AG34X7 was planted at 156,900 seeds/a on May 20, 2020, at the KSU-ARC site, and on May 11, 2020, at the UNL site. The main grass weed species targeted at KSU-ARC were southwest cupgrass and green foxtail, whereas giant foxtail, hairy cupgrass and fall panicum were predominant grass weed species at the UNL site. Experiments were established in randomized complete block design with 3 replications. A total of 14 herbicide programs including a non-treated weedy check were tested (Table 1). All herbicide treatments were applied with CO₂-operated backpack sprayer using TTI11003 spray nozzles calibrated at 15 gallons per acre at 40 PSI. At harvest, data were collected on percent visual control of each grass species at 14, 28, and 54 days after treatment (DAT), aboveground shoot dry biomass (g) at the end of the season, as well as soybean grain yield (bu/a). All data were subjected to ANOVA using PROC MIXED in SAS v. 9.0 (SAS Inst. Inc., Cary, NC). Means were separated using Fisher's protected LSD test ($\alpha = 0.05$).

Results

Grass Control

Results from the KSU-ARC site indicated that an application of Enlist One followed by (*fb*) 5 days after POST (5 DAP) of Select Max provided the highest grass control (87 to 90%) of both grass weed species at 28 DAT (Figure 1A). Control of both grass species did not exceed 78% with the rest of the treatments. Assure II applied alone or tank mixed with Enlist One had poor grass control; however, an addition of Roundup PowerMax to the tank-mixture of Enlist One and Assure II improved the control of both grass weed species (Figure 1A). At the UNL site, results indicated that tank-mixture of Enlist One with Select Max or Assure II reduced the control of all three grass species compared to Select Max or Assure II applied alone at 28 DAT (Figure 1B). An addition of Roundup PowerMax to the tank-mixtures of Enlist One with Select Max or Assure II restored the efficacy of both graminicides on all three grass species (Figure 1B).

Shoot Dry Biomass

Among all treatments, Roundup PowerMax alone or in tank-mixture with Enlist One or Enlist One plus Assure II, tank-mixtures of Enlist One with Assure II or Select Max, and sequential treatments of Roundup PowerMax *fb* Enlist One or Enlist One *fb* Roundup PowerMax provided the highest reductions (65 to 80%) in shoot dry biomass of both grass weed species at the KSU-ARC site (Figure 2A). At the UNL site, Select Max or Assure II applied alone or tank mixed with Enlist One plus Roundup PowerMax, and sequential treatment of Enlist One *fb* Assure II had the highest total shoot dry biomass reductions (88 to 96%) (Figure 2B).

Enlist E3 Soybean Yield

Enlist E3 soybean yield at the KSU-ARC site ranged from 7 to 16 bu/a, and 21 to 55 bu/a at the UNL site (Figure 3).

Conclusions

These preliminary results suggest that tank-mixing Enlist One with Select Max or Assure II can compromise the grass weed control in Enlist E3 soybean. The addition of Roundup PowerMax to tank-mixtures of Enlist One with Assure II or Select Max could restore the efficacy on grass weed control.

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Table 1. Herbicide programs tested at the Kansas State University Agricultural Research Center near Hays, KS, and the University of Nebraska near Lincoln, NE, sites in Enlist E3 soybean

Trt	Herbicide programs ¹	Rate	Timing
		fl oz/a	
1	Non-treated	-	-
2	Select Max ²	16	EPOST
3	Assure II ²	8	EPOST
4	Roundup PowerMax ³	32	EPOST
5	Select Max ² + Enlist One	16 + 32	EPOST
6	Assure II ² + Enlist One	8 + 32	EPOST
7	Roundup PowerMax ³ + Enlist One	32 + 32	EPOST
8	Roundup PowerMax ³ + Select Max ² + Enlist One	32 + 16 + 32	EPOST
9	Roundup PowerMax ³ + Assure II ² + Enlist One	32 + 8 + 32	EPOST
10	Enlist One <i>fb</i> Roundup PowerMax ³	32 <i>fb</i> 32	EPOST <i>fb</i> 5 DAEP
11	Enlist One <i>fb</i> Select Max ²	32 <i>fb</i> 16	EPOST <i>fb</i> 5 DAEP
12	Enlist One <i>fb</i> Assure II ²	32 <i>fb</i> 8	EPOST <i>fb</i> 5 DAEP
13	Roundup PowerMax ³ <i>fb</i> Enlist One	32 <i>fb</i> 32	EPOST <i>fb</i> 5 DAEP
14	Select Max ² <i>fb</i> Enlist One	16 <i>fb</i> 32	EPOST <i>fb</i> 5 DAEP
15	Assure II ² <i>fb</i> Enlist One	8 <i>fb</i> 32	EPOST <i>fb</i> 5 DAEP

¹All treatments were applied using a CO₂-operated backpack sprayer equipped with Turbo Teejet TTI11003 nozzles.

²Nonionic surfactant (NIS) at 0.25% v/v was included.

³Ammonium sulfate (AMS) at 2% wt/v was included.

EPOST = early postemergence. *fb* = followed by. DAEP = days after early postemergence.

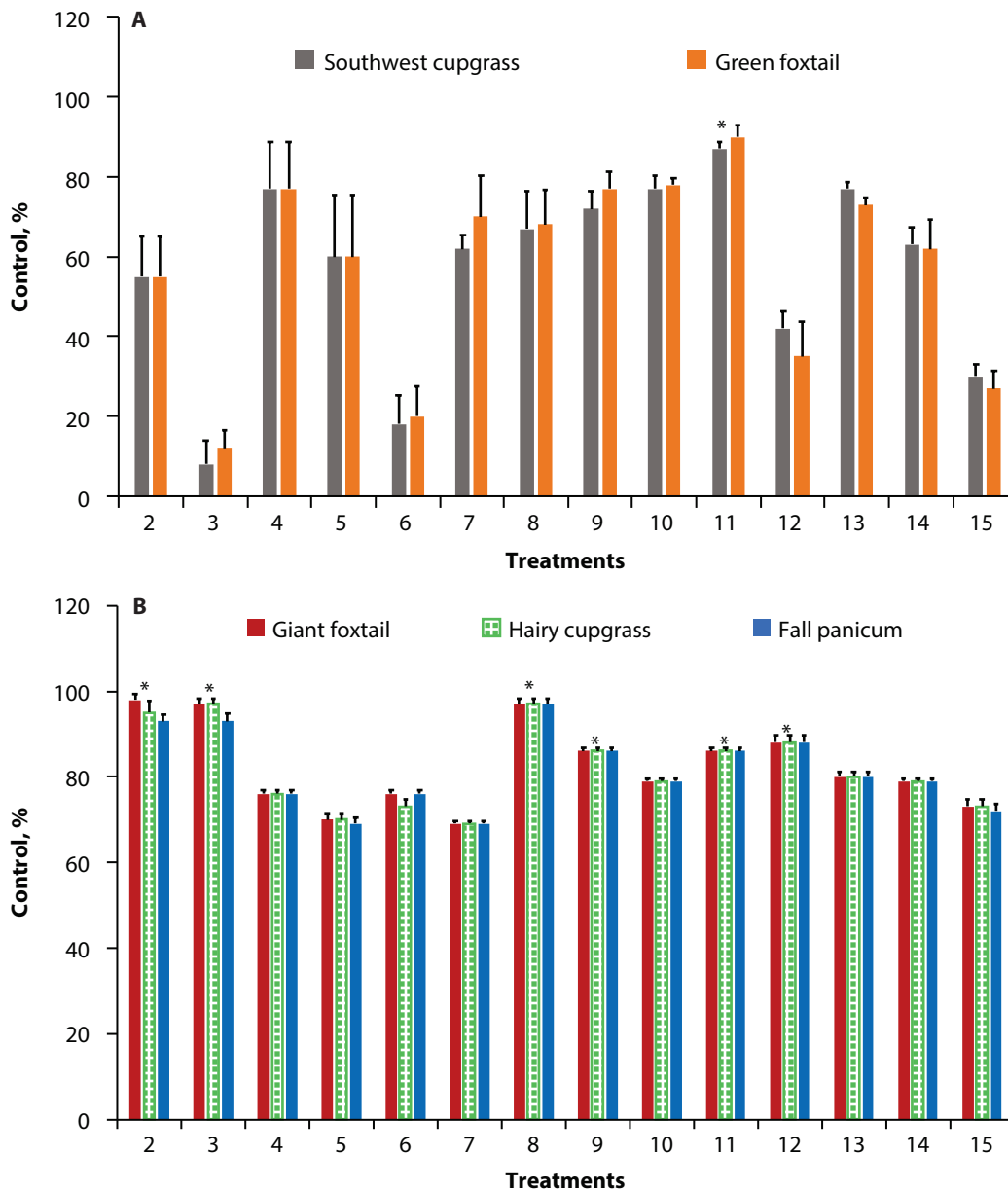


Figure 1. Effect of selected herbicide treatments on grass weed control (%) at 28 days after treatment (DAT): A) Kansas State University Agricultural Research Center near Hays, KS; B) University of Nebraska near Lincoln, NE. *Indicates significant differences from other treatments.

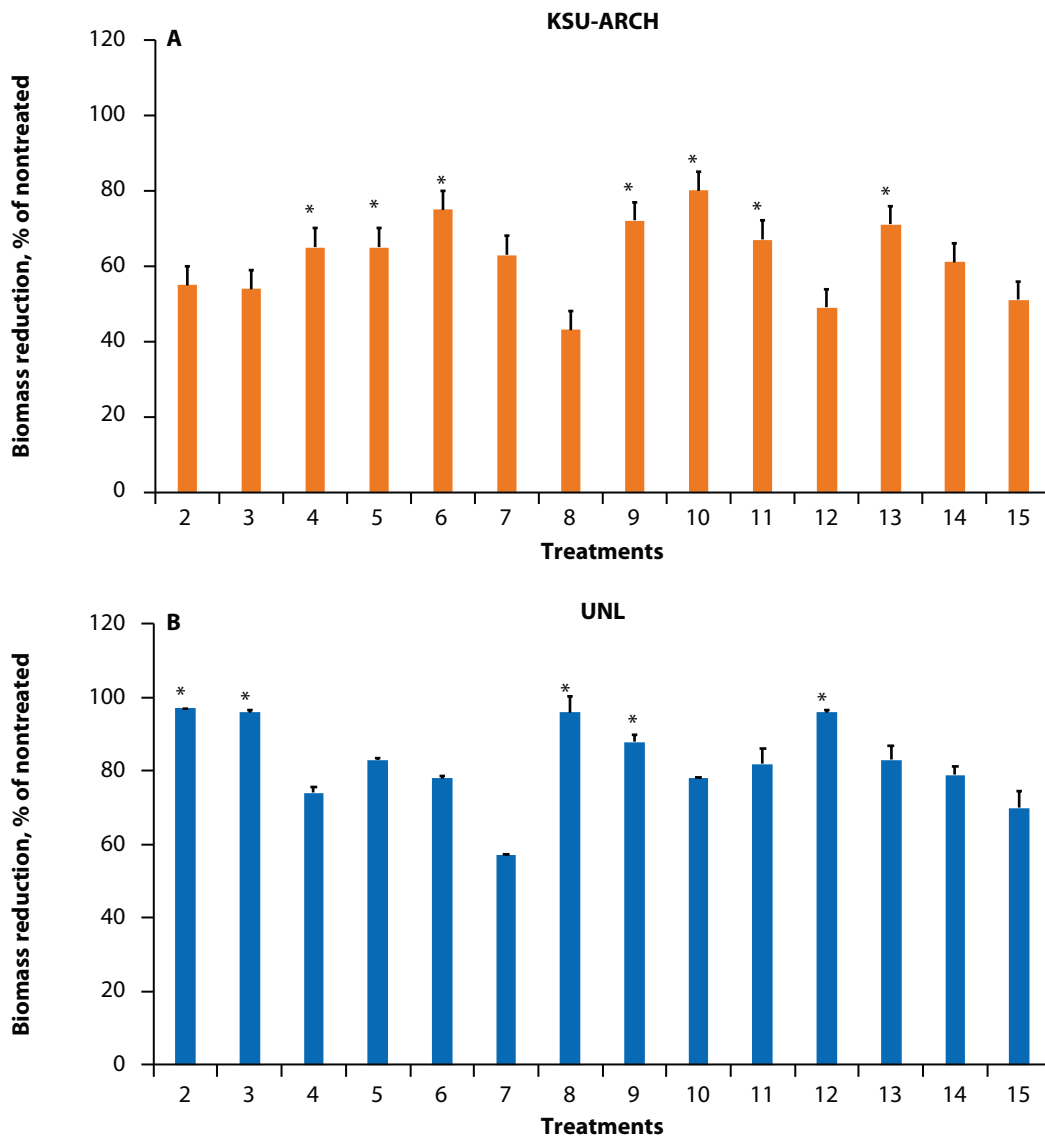


Figure 2. Effect of selected herbicide treatments on total shoot dry biomass reduction (% of nontreated) of grass species at A) Kansas State University Agricultural Research Center near Hays, KS; B) University of Nebraska near Lincoln, NE. *Indicates significant differences from other treatments.

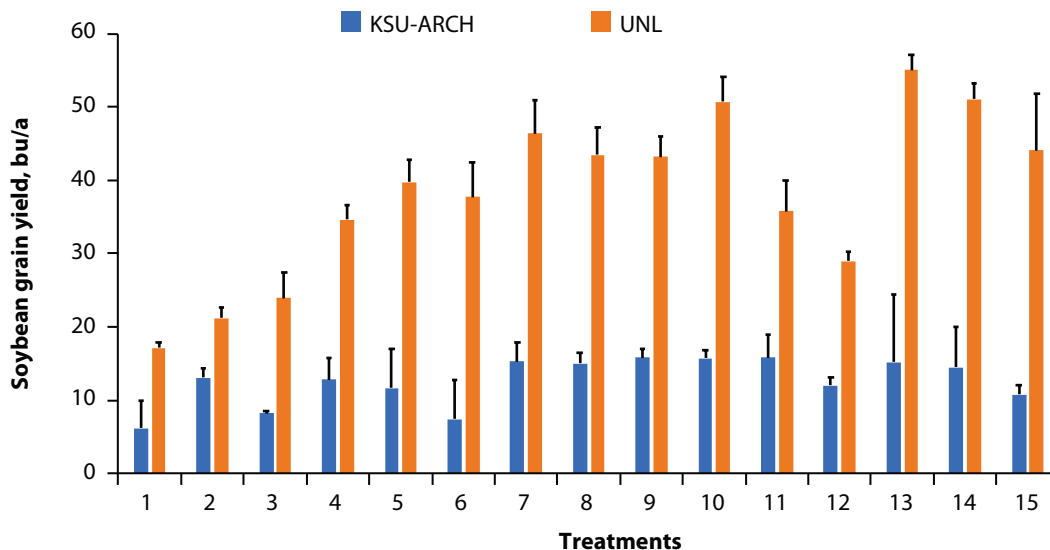


Figure 3. Effect of selected herbicide treatments on Enlist E3 soybean grain yield at the Kansas State University Agricultural Research Center (KSU-ARC) near Hays, KS, and the University of Nebraska near Lincoln, NE (UNL).