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Influence of Cover Crops on Management of *Amaranthus* Species in Glyphosate- and Glufosinate-Resistant Soybean

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A field study was conducted for the 2014 and 2015 growing season in Arkansas, Indiana, Illinois, Missouri, Ohio, and Tennessee to determine the effect of cereal rye and either oats, radish, or annual ryegrass on the control of *Amaranthus* spp. when integrated with comprehensive herbicide programs in glyphosate-resistant and glufosinate-resistant soybean. *Amaranthus* species included redroot pigweed, waterhemp, and Palmer amaranth. The two herbicide programs included were: a PRE residual herbicide followed by POST application of foliar and residual herbicide (PRE/POST); or PRE residual herbicide followed by POST application of foliar and residual herbicide, followed by another POST application of residual herbicide (PRE/POST/POST). Control was not affected by type of soybean resistance trait. At the end of the season, herbicides controlled 100 and 96% of the redroot pigweed and Palmer amaranth, respectively, versus 49 and 29% in the absence of herbicides, averaged over sites and other factors. The PRE/POST and PRE/POST/POST herbicide treatments controlled 83 and 90% of waterhemp at the end of the season, respectively, versus 14% without herbicide. Cover crop treatments affected control of waterhemp and Palmer amaranth and soybean yield, only in the absence of herbicides. The rye cover crop consistently reduced *Amaranthus* spp. density in the absence of herbicides compared to no cover treatment.

Nomenclature: Glufosinate; glyphosate; common waterhemp, *Amaranthus rudis* Sauer; Palmer amaranth, *Amaranthus palmeri* S. Wats.; redroot pigweed, *Amaranthus retroflexus* L.; Italian ryegrass, *Lolium perenne* L. ssp. *multiflorum* (Lam.) Husnot; cereal rye, *Secale cereale* L.; oat, *Avena sativa* L.; radish, *Raphanus sativus*; soybean, *Glycine max* L. Merr.

Key words: Cover crops, nonchemical weed control, weed suppression.

Amaranthus species have become the primary herbicide-resistant weeds in much of the corn (*Zea mays* L.), soybean, and cotton (*Gossypium hirsutum* L.) growing areas of the United States. Palmer amaranth and common waterhemp were recently ranked among the third and fourth most problematic weeds to manage in soybean and all crops, respectively, in the United States (Van Wychen 2016). These weeds are difficult to control, and often require complex herbicide programs, because of their propensity to evolve herbicide resistance and other biological characteristics. Characteristics of biology that contribute to these difficulties include high fecundity, plasticity, prolonged emergence period, high growth rate, adaptability to shading, and the ability to thrive in various environments and under various tillage systems (Hartzler et al. 2004; Jha, Norsworthy, Bridges, and Riley 2008; Jha, Norsworthy, Riley, and Bielenberg et al. 2008; Schwartz et al. 2016; Steckel et al. 2003; Ward et al. 2013; Webster and Grey 2015).

These characteristics, and widespread herbicide resistance, drive the need to use multiple applications and incorporate multiple–site-of-action herbicides for effective control of Palmer amaranth and common waterhemp (Anonymous 2013, 2016). The more effective herbicide programs include residual herbicides applied at the time of soybean planting

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followed by a POST herbicide applied to small weeds in combination with a residual herbicide (Bell, Norsworthy, Scott, and Popp 2015). Including herbicides with residual activity in POST treatments can minimize the need for a subsequent application. Residual herbicides applied prior to or at planting are an essential component to minimize the variability in common waterhemp control that can occur with herbicide programs that use only POST herbicides (Legleiter et al. 2009). Full-season control of glyphosate-resistant Palmer amaranth exceeded 80% only for herbicide programs where an effective PRE herbicide treatment was followed with a POST fomesafen application (Miller and Norsworthy 2016). Bell, Norsworthy, Scott, and Popp (2015) also determined that programs containing both PRE and POST herbicides provided better Palmer amaranth control than a POST-only program, and had much greater influence on control than did soybean row spacing or seeding rate.

New soybean trait technologies, such as resistance to auxinic and 4-hydroxyphenylpyruvate dioxygenase (HPPD)-inhibiting herbicides, do not necessarily allow for less comprehensive herbicide programs for common waterhemp or Palmer amaranth control (Meyer et al. 2015); rather, these traits allow PRE plus POST programs to be developed for effective control of both weeds over a wide range of geographies and environments. In the absence of PRE herbicide, a single POST application of dicamba controlled glyphosate-resistant common waterhemp less than 62%, while sequential POST applications provided at least 72% control (Spaunhorst and Bradley 2013). In similar studies, dicamba applied POST once or twice controlled 88% to 89% of common waterhemp, demonstrating potential utility as a component of an integrated management program (Spaunhorst et al. 2014). Dicamba and 2,4-D contributed negligible residual control of Palmer amaranth and common waterhemp compared with treatments utilizing various combinations of isoxaflutole, *S*-metolachlor, flumioxazin, pyroxasulfone, and mesotrione (Meyer et al. 2016).

Common waterhemp and Palmer amaranth have demonstrated an ability to readily evolve resistance to herbicides that are used repeatedly, as well as to evolve multiple resistance. This ultimately limits the duration of effectiveness of any novel herbicide site of action introduced for control of populations already resistant to one or more sites of action. It should be considered that, while resistance to group 4 and 27 herbicides may be novel in soybeans, these sites of action have previously been extensively used in corn for control of common waterhemp and Palmer amaranth. Rosenbaum and Bradley (2013) sampled common waterhemp populations from 144 fields in Missouri, and glyphosate resistance was more likely to occur where soybean was grown continuously and glyphosate was used exclusively for several seasons. Resistance to groups 2, 4, 5, 9, 14, and 27 occurs in common waterhemp in the United States as well as multiple resistance to various combinations of these sites of action (Bernards et al. 2012; Heap 2016). Similarly for Palmer amaranth, multiple resistance to groups 2, 3, 5, 9, 14, and 27 has been confirmed.

Weed scientists acknowledge that reliance on herbicides almost exclusively for weed management in major field crops ultimately facilitates the evolution of resistance (Norsworthy et al. 2012). Ultimately, herbicide site-of-action diversification influences the rate at which resistance evolves, albeit resistance occurs more frequently for some weed species than for others. The difficulty in controlling Palmer amaranth and common waterhemp, and their propensity to readily evolve resistance, has driven research on the integration of chemical and nonchemical methods, with the ultimate goal of reducing the seedbank density. For example, in-season management of Palmer amaranth, and subsequent reduction in population density, was optimized through use of an effective PRE plus POST residual herbicide program in combination with integrated management strategies such as chaff removal from fields, cover crops, or weed seed burial during planting bed formation (Norsworthy et al. 2016).

Altering tillage or cultural factors can improve control of these weedy species in soybean and influence the emergence pattern and persistence of seed. Following a seed rain event, the germination and emergence of common waterhemp could be greater under no-till versus tilled conditions, albeit tillage increases the persistence of common waterhemp seed (Steckel et al. 2007). Leon and Owen (2006) observed four times greater waterhemp emergence under no-till compared with chisel plow or moldboard plow conditions, and also a longer period of emergence in the former. Similar results occurred in a study by Refsell and Hartzler (2009), along with the observation that common waterhemp seed remained near the surface in no-tillage, but was found primarily between 9- and 15-cm depths in chisel plow conditions. The use of deep tillage following a rye cover crop or full-season wheat crop, in combination with PRE application of residual herbicides, resulted in greater control and reduced seed production of Palmer amaranth, and higher soybean yield (Bell et al. 2016). Comparing emergence with and without soybean canopy, Jha and Norsworthy (2009) observed a decline in Palmer amaranth emergence following the increased light interception that occurred after soybean canopy development. These results would appear to indicate a benefit to narrow row spacing that could facilitate earlier canopy development, although >90% of the emergence occurred prior to canopy closure. Where PRE herbicides were used, no difference in Palmer amaranth emergence occurred among soybean seeding rates, although higher seeding rates reduced emergence in the absence of herbicide (Bell, Norsworthy, and Scott 2015). In one study of integrated approaches to common waterhemp control, the use of a comprehensive herbicide program (PRE fb POST plus residual), narrow soybean row spacing, and higher seeding rates resulted in the most effective control and reduction in density of common waterhemp, and highest soybean yields (Schultz et al. 2015).

The role that cover crops can have in management of Palmer amaranth and common waterhemp is also of great interest, as can be seen in the results of recent research. Full-season soybean production systems using a cereal rye cover crop or soybean double-cropped with wheat (*Triticum aestivum* L.) reduced Palmer amaranth emergence more than did systems without deep tillage, cereal rye, or wheat (DeVore et al. 2013). When used in combination with deep tillage, the cereal rye and wheat systems provided an additional reduction in emergence in one of two years compared with deep tillage alone. Crimson clover (*Trifolium incarnatum* L.) and hairy vetch (*Vicia villosa* Roth) controlled 62% and 58% of Palmer amaranth in the absence of herbicides, respectively, prior to POST herbicide application in corn, and reduced the growth rate of Palmer amaranth (Wiggins et al. 2015). Cereal rye and wheat provided more effective control of Palmer amaranth in cotton than did crimson clover or hairy vetch (Wiggins et al. 2016). These cereals or cereal–legume blends reduced Palmer amaranth emergence by half compared with no cover crops, but the combination of cover crops and PRE herbicides did not result in adequate control. Some land grant universities are already making recommendations for the integration of specific cover crops in management programs for Palmer amaranth (L Steckel, personal communication). The objective of this multi-state project is to determine the effect of cereal rye and oat, radish, or Italian ryegrass, integrated with comprehensive herbicide programs, on crop yield and the control of *Amaranthus* species in glyphosate- and glufosinate-resistant soybean.

Materials and Methods

A field study was conducted at a total of 13 sites in Arkansas, Indiana, Illinois, Missouri, Ohio, and Tennessee over three years, starting in the fall of 2013 and ending in the fall of 2015 (Table 1). The study was conducted over two seasons in areas with known infestations of redroot pigweed (two sites), common waterhemp (five sites), or Palmer amaranth (six sites). The common waterhemp and Palmer amaranth populations were resistant to glyphosate, while redroot pigweed populations were glyphosate-sensitive. Treatments were arranged in a split-split-plot design with four replications. The main plot was cover crop, and the split plot was soybean herbicide-resistance trait, and the split-split plot was herbicide treatment. The two cover crops were cereal rye and a second cover crop that varied by site among Italian ryegrass, spring oat, or forage radish (Table 2). In addition, a no-cover treatment was included at all sites. Across all sites, cover crops were seeded from September 23 to November 20 in 2013 and from September 11 to October 9 in 2014, using appropriate seeding rates based on local recommendations. Seeding rates ranged from 67 to 134 kg ha^{-1} for cereal rye, 67 to 100 kg ha^{-1} for oat, 6.6 to 11 kg ha^{-1} for radish, and 22 kg ha^{-1} for Italian ryegrass. The tillage and cropping situation into which cover crops were planted included no-till and tilled sites, with previous crop of silage or field corn (*Zea mays* L.), cotton (*Gossypium hirsutum* L.), or soybean. Cover crops were seeded with a drill at all sites.

Glyphosate- and glufosinate-resistant soybean of appropriate maturity for the site was planted the following spring at a row spacing ranging from 19 to 96 cm (Table 1). The soybeans were planted in May, with the exception of the Missouri site in 2015, where planting was delayed until June 25 (Table 2). Winter conditions killed the spring oat and forage

Table 1. Site description information for 2014 and 2015 cover crop experiments. Abbreviations: OM, organic matter; CEC, cation exchange capacity; Gly-R, glyphosate-resistant; Glu-R, glufosinate-resistant.

		Soil properties				Soybean variety			
Test site	Year	Texture	%OM	pH	CEC	Gly-R	Glu-R	Row spacing	Weed
								(cm)	
AR	2014	Silt loam	2.0	6.5	13.1	AG4933	P95L01	96	AMAPA
	2015	Silt loam	2.0	5.5	13.1	AG4933	P95L01	91	AMAPA
IN	2014	Silt loam	3	6.7	16.3	AG2933	BE2984L	38	AMAPA
	2015	Silt loam	2.9	6.9	12.3	AG2933	BE2984	38	AMAPA
IL	2014	Silt loam	2.1	6.9	12.7	AG3832	HS42L22	76	AMATA
	2015A	Silt loam	2.1	6.9	12.4	AG3832	HS42L22	19	AMATA
	2015B	Silt loam	2.3	6.7	9.8	AG3832	HS42L22	19	AMATA
MO	2014	Silty clay loam	1.1	6.8	-	AG3832	LL3579	38	AMATA
	2015	Silt loam	2.3	6.5	9.2	AG3832	LL3579	76	AMATA
OH	2014	Silty clay loam	3.5	6.6	22	P35T58R	P34T35L	38	AMARE
	2015	Silty clay loam	1.7	7	15	P35T97R2	CZ3841LL	38	AMARE
TN	2014	Silt loam	1.7	6.4	-	AG4633	LL4650	38	AMAPA
	2015	Silt loam	1.7	6.4	-	AG4633	LL4850	38	AMAPA

radish without need for additional herbicides. The entire experimental area was treated with glyphosate and 2,4-D ester at 0.84 and 0.56 kg ae ha^{-1}, respectively, between late March and mid-May, to terminate the cereal rye, Italian ryegrass, and emerged weeds (Table 2). Cover crop termination timing ranged from 0 to 6 weeks before planting.

The herbicide treatments in this study represent the comprehensive approach required for Palmer amaranth control. Treatments within each combination of cover crop and soybean herbicide-resistance trait included 1) nontreated; 2) PRE/POST, consisting of PRE residual herbicide followed by POST application of foliar and residual herbicide 21 d after planting (DAP); and 3) PRE/POST/POST, consisting of PRE residual herbicide followed by POST application of foliar and residual herbicide 21 DAP, followed by another POST application of residual herbicide 42 DAP. At some sites, the PRE herbicides were applied with the glyphosate and 2,4-D, while at other sites these were separated by a month or more, with PRE herbicide always applied at the time of soybean planting.

The PRE residual herbicide was flumioxazin applied at 90 g ai ha^{-1}. The first POST treatment in glyphosate-resistant soybean consisted of glyphosate at 0.84 kg ha^{-1}, fomesafen at 0.35 kg ai ha^{-1}, and metolachlor at 1.4 kg ai ha^{-1}. This treatment included ammonium sulfate at 2% (w/v) (Winfield Solutions LLC, St. Paul, MN) and methylated seed oil at 1% (v/v) (Helena Chemical Company, Collierville, TN). The first POST treatment in glufosinate-resistant soybean consisted of glufosinate and metolachlor at 0.65 and 1.4 kg ai ha^{-1}, respectively, and also included ammonium sulfate at 2% (w/v). The second POST treatment in both systems was acetochlor at 1.3 kg ai ha^{-1}. Herbicides were applied in a volume of 143 L ha^{-1}. Other application parameters varied among sites based upon standard practices.

Control of *Amaranthus* species was evaluated, and population density measured at the time of each POST application and just prior to soybean harvest. Control was evaluated using a scale of 0 to 100, where 0 represented no control and 100 represented complete control (no plants evident). Population density was measured 21 DAP by counting plants within 0.5-m^2 quadrants placed at two locations in each plot. These 0.5-m^2 areas were marked and used for subsequent measurements at 42 DAP and preharvest. At maturity, soybean was mechanically harvested, and seed yield measured and adjusted to 13% moisture for analysis. Data were combined among the sites for each *Amaranthus* species, and analyzed by the SAS GLIMMEX procedure for mixed models. Means were separated using Fisher's protected LSD at the 95% level of probability. Cover crop biomass was not measured.

Results and Discussion

The herbicide programs effectively controlled redroot pigweed and Palmer amaranth, regardless of

Table 2. Cover crop, herbicide application, and soybean planting date information.

Test site	Year	Cover crop[a]/seed rate (kg ha^{-1}) Cover 1	Cover 2	Cover plant	Cover termination	Soybean plant[b]
AR	2014	SECCE/90	RAPSS/11	Sept 28	May 1	May 23
	2015	SECCE/90	RAPSS/10	Nov 15	April 22	May 13
IN	2014	SECCE/90	LOLMG/22	Sept 27	May 20	May 27
	2015	SECCE/90	LOLMG/22	Sept 19	May 6	May 18
IL	2014	SECCE/134	AVESA/101	Sept 23	April 18	May 6
	2015A	SECCE/134	AVESA/101	Sept 26	April 17	May 1
	2015B	SECCE/134	AVESA/101	Sept 30	April 18	May 4
MO	2014	SECCE/112	RAPSS/6.7	Nov 20	May 16	May 23
	2015	SECCE/112	RAPSS/6.7	Sept 11	May 27	June 25
OH	2014	SECCE/101	AVESA/67	Oct 11	April 17	May 5
	2015	SECCE/101	AVESA/67	Oct 9	April 14	May 4
TN	2014	SECCE/67	AVESA/67	Sept 23	March 20	May 12
	2015	SECCE/67	AVESA/67	Oct 9	March 20	May 4

[a] Cover crop abbreviations: AVESA, spring oat; LOLMG, Italian ryegrass; RAPSS, forage radish; SECCE, cereal rye.

[b] PRE herbicides were applied between 29 d before and 1 d after soybean planting.

the presence or absence of a cover crop, and they were only slightly less effective on common waterhemp. Averaged over cover crops and soybean resistance traits, plots that received either POST herbicide treatment had 100% control of redroot pigweed at the end of the season, while the plots without herbicide averaged 49% control. Control of Palmer amaranth control exceeded 96% for either POST treatment, but was only 29% in the absence of herbicides. The PRE/POST and PRE/POST/POST treatments controlled 83% and 90% of common waterhemp at the end of the season, respectively, while no herbicide treatment resulted in 14% control. Differences among cover crop treatments were observed only in the absence of herbicides, and the magnitude of these differences varied among species and evaluation timings.

The control and population density of redroot pigweed was affected only by the herbicide factor throughout the season, and this was due to differences between herbicide treatments and the nontreated control. There was no difference between the PRE/POST and PRE/POST/POST treatments, and no interactions with cover crop and soybean herbicide resistance trait. The herbicides provided 81% to 85% control of redroot pigweed at 21 DAP, 95% at 42 DAP, and 100% at harvest, while control in the nontreated plots ranged from 0% to 49% when averaged over cover crops and soybean herbicide resistance trait (data not shown). Population density for the PRE/POST and PRE/POST/POST treatments averaged 8, 1, and 0 plants m^{-2} at 21 DAP, 42 DAP, and harvest, respectively, and 25, 18, and 2 plants m^{-2} in the nontreated plots (data not shown). Soybean grain yield was higher where herbicides were used compared with the nontreated plots, at 4,170 to 4,430 versus 2,080 kg ha^{-1} (data not shown).

Herbicides controlled at least 92% of the Palmer amaranth throughout the season, while control in the absence of herbicides ranged from 16% to 29%, averaged over cover crop, soybean herbicide-resistance trait, and site. There was a consistent interaction between cover crop and herbicide, which reflected the higher control provided by cereal rye compared with a different cover crop or no cover crop, in the absence of herbicides (Figure 1). The cereal rye controlled 34% to 49% of the Palmer amaranth over the season, while control did not exceed 22% for the other cover crop species. At 21 DAP, the other cover crops provided higher control than did the no-cover treatment, 16% versus 5%, although differences at this level of control are of little biological importance. Population density at 21 DAP was affected only by herbicide, ranging from 7 to 8 plants m^{-2} where herbicide was applied versus 25 plants m^{-2} for the nontreated, averaged over other factors (data not shown). A similar interaction occurred for population density at 42 DAP and harvest (Figure 2). Density was uniformly low where herbicide was applied, with no difference between PRE/POST and PRE/POST/POST herbicide treatments or among cover crops. In the absence of herbicides, density was

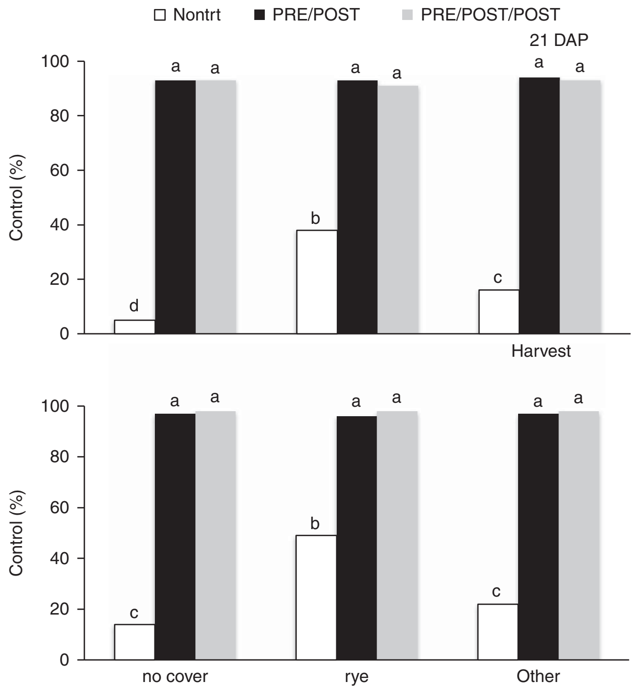

Figure 1. Effect of cover crop and herbicide treatment on control of Palmer amaranth 21 d after planting and at harvest, averaged over soybean resistance trait and site. Means with the same letter are not different based on Fisher's protected LSD (0.05).

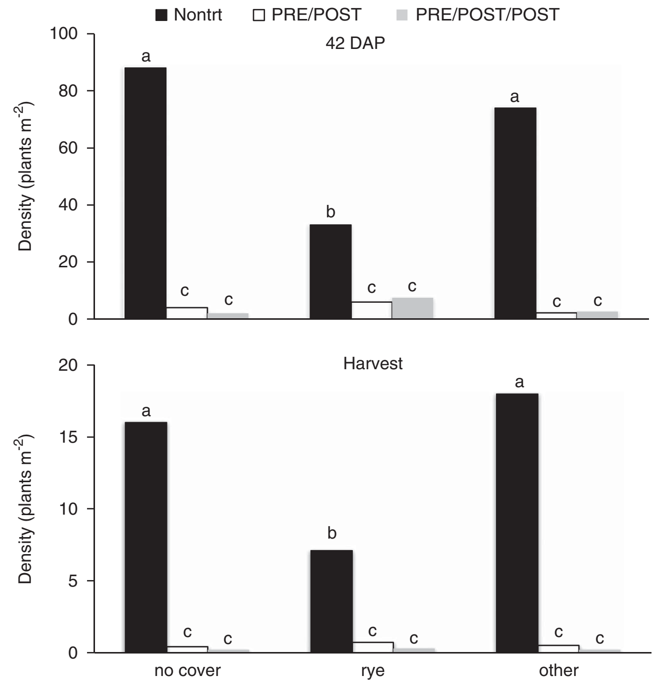

Figure 2. Effect of cover crop and herbicide treatment on population density of Palmer amaranth 42 d after planting and at harvest, averaged over soybean resistance trait and site. Means with the same letter are not different based on Fisher's protected LSD (0.05).

approximately 50% lower for cereal rye versus the other cover crops or no cover treatments. These differences in control and density were reflected in soybean yields, for which there was an interaction between herbicide and cover crop. Soybean grain yield was highest where herbicides were applied, with no difference between the PRE/POST and PRE/POST/POST treatments regardless of cover crop (data not shown). Differences among cover crops occurred in the absence of herbicide, in the following order: cereal rye > other cover crop > no cover, at 2,820, 2,280, and 1,880 kg ha^{-1}, respectively.

As was seen with Palmer amaranth, control of common waterhemp at 21 and 42 DAP did not vary between the PRE/POST and PRE/POST/POST treatments, but control did not exceed 88% (Figure 3). An interaction between cover crops and herbicide treatment reflected the higher control from cereal rye versus the other cover crop and no cover treatments in the absence of herbicides. The cereal rye controlled 47% and 19% of the common waterhemp at 21 and 42 DAP, respectively, but control did not exceed 13% for the other cover crop treatments. There was no interaction among factors at harvest (Figure 4). Averaged over other factors, the cereal rye and other cover crops provided similar levels of control, 63% to 66%, versus 58% for the no cover treatment (data not shown). In the absence of herbicide, control did not exceed 19% for any cover crop treatment. Unlike the Palmer amaranth results, the PRE/POST/POST treatment was more effective than the PRE/POST treatment at the end of the season (Figure 4). The PRE/POST/POST and PRE/POST treatments controlled 90% and 83% of the common waterhemp, respectively, averaged over other factors, while control in the nontreated plots was 13%. This was also reflected by population density results, where the PRE/POST/POST resulted in lower density than the PRE/POST treatment at harvest, 2 versus 7 plants m^{-2}. Density was similar between the two herbicide treatments 21 and 42 DAP, ranging from 111 to 125 plants m^{-2} (data not shown).

Control of common waterhemp was generally lower throughout the season compared with control of redroot pigweed or Palmer amaranth. The more comprehensive herbicide treatment resulted in greater common waterhemp control at harvest, which was not observed for the other species. These differences reflect the apparent additional control of

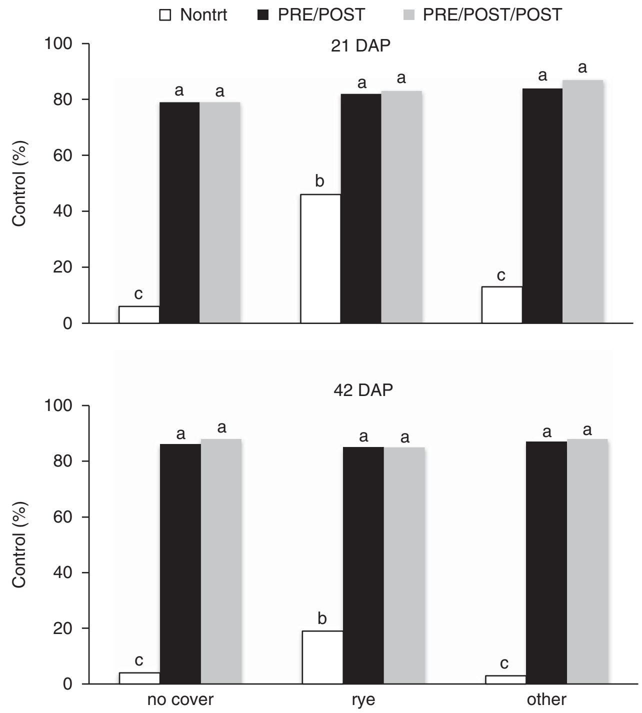

Figure 3. Effect of cover crop and herbicide treatment on control of common waterhemp 21 and 42 d after planting, averaged over soybean resistance trait and site. Means with the same letter are not different based on Fisher's protected LSD (0.05).

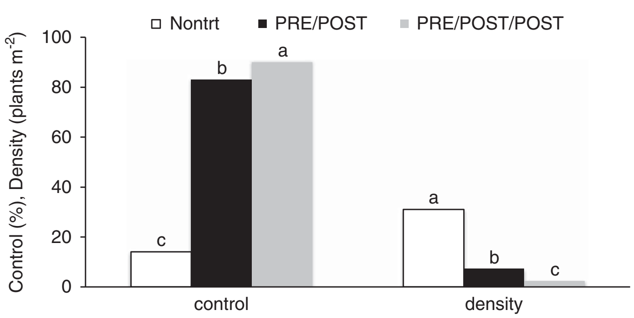

Figure 4. Effect of herbicide treatment on common waterhemp control and population density at harvest, averaged over cover crop treatment, herbicide resistance trait, and site. Means with the same letter are not different based on Fisher's protected LSD (0.05).

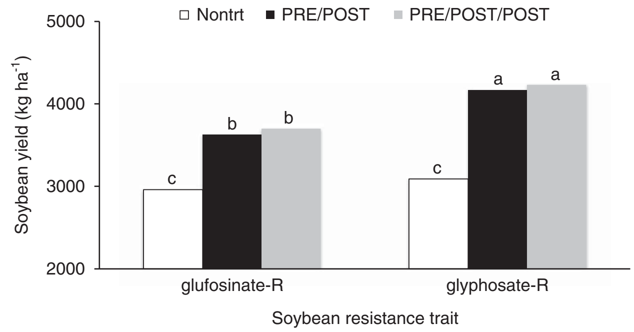

Figure 5. Effect of herbicide treatment on soybean seed yield, averaged over cover crop treatment and common waterhemp site. Means with the same letter are not different based on Fisher's protected LSD (0.05).

late-emerging common waterhemp plants from the second POST application of acetochlor. This effect, and the overall lower common waterhemp control compared to the other species, may have been partly due to the higher population densities of common waterhemp. The density of common waterhemp at 21 and 42 DAP in the no-cover treatments ranged from 650 to 820 plants m^{-2}, but ranged from only 15 to 23 and 80 to 88 plants m^{-2} for redroot pigweed and Palmer amaranth, respectively (data not shown). The end-of-season density was lower for all three species, due to the combined effect of herbicide treatments and the soybean canopy, but common waterhemp density was still approximately two and sixteen times higher than Palmer amaranth and redroot pigweed density in nontreated, no cover crop areas.

Soybean grain yields at common waterhemp sites showed similar trends to those at sites infested with other species, in that the lack of herbicide resulted in lower yield compared with the two herbicide treatments (Figure 5). However, an interaction between herbicide and soybean herbicide-resistance trait occurred, and in the presence of herbicides, the glyphosate-resistant soybean yields were higher than the glufosinate-resistant soybean yields. Since there were no differences in control between the soybean herbicide-resistance traits, this would appear to reflect the higher yield potential for the glyphosate-resistant soybean cultivars used here, in comparison to the glufosinate-resistant cultivars. In this study, there was no attempt made to control variation in yield potential between the two selected soybean cultivars. The differences in yield here thus has little meaning except to show the importance of effective weed management on obtaining maximum yields.

The results of this study showed that cereal rye has more potential than the other cover crops tested (spring oat, forage radish, and Italian ryegrass) to contribute to control of *Amaranthus* species when integrated into a comprehensive herbicide program. The presence of the cover crops did not influence control with the herbicide programs used here.

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However, the control contributed by the cover crop could presumably improve control where the population density of the weeds was high, or where environmental conditions reduce herbicide effectiveness. Where control from the cover crops helps to reduce the population density within the first month or so following soybean planting, there would presumably be reduced selection for resistance to the herbicides used in POST treatments.

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