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Redvine (*Brunnichia ovata*) and Trumpetcreeper (*Campsis radicans*) Management in Glufosinate- and Glyphosate-Resistant Soybean[1]

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Abstract: Three field studies were conducted during 1998 to 2002 at Stoneville, MS, to examine the efficacy of glufosinate and glyphosate on redvine and trumpetcreeper control in glufosinate- and glyphosate-resistant soybean. Glyphosate at 2.52 kg ae/ha applied approximately 3 wk before planting soybean reduced trumpetcreeper density (45 to 52%) but not redvine compared with no glyphosate in both glufosinate- and glyphosate-resistant soybean. However, glyphosate applied preplant reduced biomass of both species in glufosinate-resistant soybean. Glyphosate early postemergence (EPOST) followed by (fb) late postemergence (LPOST) had no effect on redvine density but reduced trumpetcreeper density (70%) compared with the no-herbicide control. There were no differences in densities and biomass of redvine and trumpetcreeper and soybean yield among isopropylamine, diammonium, and aminomethanamide dihydrogen tetraoxosulfate salts of glyphosate. Overall, trumpetcreeper is more susceptible to glyphosate than redvine. Glufosinate EPOST with or without acifluorfen or glufosinate EPOST fb LPOST had no effect on densities of redvine and trumpetcreeper but reduced biomass 45 to 76% and 35 to 58%, respectively, compared with the nontreated control. These results show that glyphosate preplant and POST in-crop applications can reduce trumpetcreeper density but not redvine, and glufosinate POST applications can suppress growth of both species.

Nomenclature: Acifluorfen; clomazone; glufosinate; glyphosate; lactofen; redvine, *Brunnichia ovata* (Walt.) Shinners #[3] BRVCI; soybean, *Glycine max* (L.) Merr. 'DP4690 RR', 'DP 5806 RR', 'AG 4702 RR', 'A 5547 LL'; trumpetcreeper, *Campsis radicans* (L.) Seem. ex Bureau # CMIRA.

Additional index words: Glyphosate formulation, perennial vine, transgenic soybean, weed biomass, weed density.

Abbreviations: Adt, aminomethanamide dihydrogen tetraoxosulfate; Dia, diammonium; EPOST, early postemergence; fb, followed by; Ipa, isopropylamine; LPOST, late postemergence; POST, postemergence; PRE, preemergence; WAP, weeks after planting soybean; WAT, weeks after late postemergence.

INTRODUCTION

Redvine and trumpetcreeper are native perennial vines capable of growing several meters in length. Both species have an extensive, deep-rooted system, which enables the plant to spread and survive environmental extremes (Elmore 1984; Elmore et al. 1989). Redvine and trumpetcreeper are found in cultivated fields, wastelands, fencerows, yards, riverbanks, swamps, and forests and are distributed extensively in the lower Mississippi Delta region. In cultivated fields, their infestations may range from spotty to severe with infestations confined mainly to fine-textured soils (Elmore et al. 1989; Shaw and Mack 1991; Shaw et al. 1991).

Redvine and trumpetcreeper are among the 10 most troublesome weeds in cotton (*Gossypium hirsutum* L.), soybean, and corn (*Zea mays* L.) in the midsouthern United States (Webster 2000, 2001). They are relatively disease-free native species that are difficult to manage because they can propagate from a deeply positioned and extensive root system (Elmore et al. 1989; Shaw and Mack 1991). Redvine (Shaw et al. 1991) and trumpetcreeper (Chachalis and Reddy 2000a) can also reproduce by seed and have potential to spread to new areas by dispersed seed. These vines reduce crop yield and quality and harvest efficiency (Elmore 1984). Severe infestations of these perennial vines result in loss of productivity of land (D. Chachalis and K. N. Reddy, unpublished

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[3] Letters following this symbol are a WSSA-approved computer code from *Composite List of Weeds*, Revised 1989. Available only on computer disk from WSSA, 810 East 10th Street, Lawrence, KS 66044-8897.

Table 1. Monthly rainfall and the 30-yr average during April through September at Stoneville, MS.

Month	Monthly rainfall					
	1998	1999	2000	2001	2002	30-yr average[a]
	cm					
April	11.0	16.1	28.2	10.1	8.3	13.6
May	11.7	14.5	17.6	12.9	7.2	12.6
June	4.0	7.1	15.6	7.0	10.5	9.5
July	14.5	2.6	1.6	8.0	8.4	9.3
August	1.8	0.6	0	21.5	7.0	5.8
September	7.4	4.4	6.6	7.7	19.6	8.6

[a] Monthly average rainfall during 1964 through 1993.

data). Edwards and Oliver (2001) observed that even low densities of trumpetcreeper can interfere with soybean, and one trumpetcreeper plant per 0.5 m^2 can cause 18% yield loss.

Many herbicides (e.g., acifluorfen, lactofen, paraquat) show promising redvine and trumpetcreeper control but kill only the top growth and have little or no effect on the rootstock. Desiccation of foliage is only temporary, often partial, and new sprouts arise from underground rootstocks. Dicamba or glyphosate applied in the spring or fall, either to a fallow field or after crop harvest, can reduce redvine and trumpetcreeper infestations (DeFelice and Oliver 1980; Edwards and Oliver 2001; Elmore et al. 1989; Hurst 1995, Shaw and Mack 1991). The success of a fall herbicide treatment is dictated by the extent of regrowth within the short time between harvest and herbicide application before frost (Elmore et al. 1989).

Transgenic soybean resistant to glyphosate and glufosinate provide the flexibility to use these nonselective herbicides to manage redvine and trumpetcreeper within the crop. With the expiration of the glyphosate patent, several other salt formulations of glyphosate are now commercially available for use in glyphosate-resistant soybean. Because of price reductions in recent years, glyphosate has become a more affordable option to manage redvine and trumpetcreeper in transgenic soybean. With registered use rates of glufosinate and glyphosate, control of these weeds is less than satisfactory (Chachalis and Reddy 2000b, 2004; Chachalis et al. 2001; Reddy 2000; Younce and Skroch 1989).

Redvine and trumpetcreeper establish and produce abundant foliage beginning in early spring. Treating actively growing redvine and trumpetcreeper plants 2 to 4 wk before planting with glyphosate at higher rates can enhance herbicide translocation to rootstocks. Follow-up applications of glyphosate in glyphosate-resistant soybean and glufosinate in glufosinate-resistant soybean may be sufficient to control those vines weakened by the preplant application of glyphosate. Whether this strategy can help manage redvine and trumpetcreeper was the focus of this investigation. The specific objectives of this research were (1) to determine the effect of preplant application of glyphosate on redvine and trumpetcreeper populations, (2) to study the efficacy of glufosinate and glyphosate on redvine and trumpetcreeper populations in glufosinate- and glyphosate-resistant soybean, respectively, and (3) to compare the efficacy of isopropylamine (Ipa), diammonium (Dia), and aminomethanamide dihydrogen tetraoxosulfate (Adt) salts of glyphosate on redvine and trumpetcreeper control.

MATERIALS AND METHODS

Field studies were conducted on a producer farm with natural and uniform infestations of redvine and trumpetcreeper near the USDA-ARS, Southern Weed Science Research Unit farm, Stoneville, MS. The soil was a Dundee silty clay loam (fine-silty, mixed, thermic Aeric Ochraqualfs) with pH 6.9 and 1.6% organic matter. The experimental area was tilled with a disk harrow followed by a field cultivator in the fall of each year. The studies were conducted under a nonirrigated environment. Monthly rainfall and the 30-yr average rainfall during April to September are presented in Table 1. Because of difficulty in soybean stand establishment, existing vegetation in no-glyphosate plots and new sprouts or partially killed redvine and trumpetcreeper plants in glyphosate preplant applied plots were desiccated with paraquat (1.1 kg ai/ha) at planting. Herbicide treatments were applied with a tractor-mounted sprayer with 8004 standard flat spray tips[4] delivering 187 L/ha water at 179 kPa. Experiments were conducted on the same site with plots maintained over the length of the experiment; therefore, years were treated as repeated measurements and included in the analysis as another split. The data were subjected to analysis of variance using Proc Mixed,

[4] TeeJet standard flat spray tips, Spraying Systems Co., North Avenue and Schmale Road, Wheaton, IL 60189.

Table 2. Redvine and trumpetcreeper density and biomass at 5 WAT as affected by preplant and POST herbicide applications in glyphosate-resistant soybean in 1998 and 1999.[a,b]

Main effect	Rate[c]	Application timing	Redvine Density	Redvine Biomass	Trumpetcreeper Density	Trumpetcreeper Biomass
	kg/ha		plants/m^2	g/m^2	plants/m^2	g/m^2
Year						
1998			3.4	—	4.4	—
1999			15.0	—	5.7	—
LSD (0.05)			5.2		NS	
Preplant						
No glyphosate	—	—	9.0	28.6	6.5	34.4
Glyphosate	2.52	Preplant	9.4	20.3	3.6	19.2
LSD (0.05)			NS	NS	1.8	NS
In-crop POST						
No herbicide	—	—	15.2	32.9	11.1	38.6
Glyphosate	0.84	EPOST	11.9	29.8	2.4	12.6
Glyphosate	0.84	EPOST	9.8	17.0	3.3	20.5
fb glyphosate	0.84	LPOST				
Acifluorfen	0.56	EPOST	4.4	16.1	4.2	49.3
Glyphosate	0.84	EPOST	8.3	12.5	4.3	15.6
+ acifluorfen	0.56					
Clomazone	1.40	PRE	6.9	39.5	2.7	5.9
fb glyphosate	0.84	EPOST				
fb glyphosate	0.84	LPOST				
Clomazone	1.40	PRE	7.9	23.5	7.3	45.2
fb lactofen	0.22	EPOST				
LSD (0.05)			NS	NS	3.4	30.3

[a] Abbreviations: EPOST, early postemergence; fb, followed by; LPOST, late postemergence; PRE, preemergence; WAT, weeks after LPOST; NS, not significant.
[b] Density data are averaged across 1998 and 1999. Biomass data are from 1999.
[c] Glyphosate rate was based on acid equivalent, and all other herbicide rates were based on active ingredient.

and the least square means were calculated (SAS 1998). Treatment means were separated at the 5% level of significance using Fisher's protected LSD test. Data were averaged across main effects because interactions were not significant.

Glyphosate-Resistant Soybean Study. The study was conducted in 1998 and 1999 to determine the effect of glyphosate applied preplant and postemergence (POST) on redvine and trumpetcreeper control in glyphosate-resistant soybean. The experiment was conducted in a split-plot arrangement of treatments in a randomized complete block design with preplant application of glyphosate as main plot and glyphosate in-crop POST application as subplot with four replications. Each subplot consisted of eight soybean rows spaced 57 cm apart and 4.6 m long. Treatments were assigned to the same plots in both years to assess the effect of consecutive glyphosate applications on redvine and trumpetcreeper populations.

Main plot treatments were preplant application of glyphosate at 2.52 kg ae/ha and no glyphosate. Subplot treatments were glyphosate early postemergence (EPOST) at 0.84 kg/ha, glyphosate EPOST at 0.84 kg/ha followed by (fb) glyphosate late postemergence (LPOST) at 0.84 kg/ha, acifluorfen EPOST at 0.56 kg ai/ha alone or in combination with glyphosate EPOST at 0.84 kg/ha, clomazone preemergence (PRE) at 1.4 kg ai/ha fb glyphosate EPOST at 0.84 kg/ha fb glyphosate LPOST at 0.84 kg/ha, clomazone PRE at 1.4 kg/ha fb lactofen LPOST at 0.22 kg ai/ha, and a nontreated control (Table 2). Clomazone PRE fb lactofen EPOST was included as a conventional standard because these herbicides have some activity on both vines (Anonymous 2004a, 2004b).

Glyphosate was applied preplant on April 22, 1998, and April 26, 1999. The commercial formulation of Ipa salt of glyphosate[5] with no adjuvant was used. At preplant application, redvine and trumpetcreeper plants were 10 to 40 cm tall depending on time of emergence. Soybean cultivar 'DP5806 RR' at 353,000 seeds/ha was planted on June 3, 1998, and May 14, 1999. Planting was delayed in 1998 because of rainfall. Pendimethalin at 0.84 kg ai/ha plus imazaquin at 0.14 kg ai/ha PRE was applied to entire experimental area to control all other weeds. PRE herbicides were broadcast applied immediately after planting, whereas EPOST and LPOST

[5] Roundup Ultra®, isopropylamine salt of glyphosate, Monsanto Agricultural Company, 800 North Lindbergh Boulevard, St. Louis, MO 63167.

treatments were applied 3 and 5 wk after planting (WAP) soybean, respectively.

Redvine and trumpetcreeper plants were counted in both years, and aboveground biomass in 1999 was harvested and dry weights were recorded from two randomly selected 0.84-m^2 areas in the middle of each plot at 5 wk after LPOST (WAT). Soybean crop failed in both years because of late summer drought (Table 1), and grain yields were too low to justify harvesting.

Glufosinate-Resistant Soybean Study. The study was conducted in 1999 and 2000 to determine the effect of glyphosate applied preplant and glufosinate applied POST on redvine and trumpetcreeper control in glufosinate-resistant soybean. The experiment was conducted in a split-plot arrangement of treatments in a randomized complete block design with preplant application of glyphosate as main plot and glufosinate POST application as subplot with four replications. Each subplot consisted of eight soybean rows spaced 57 cm apart and 4.6 m long. Treatments were assigned to the same plots in both years to assess the effect of consecutive glyphosate and glufosinate applications on redvine and trumpetcreeper populations.

Main plot treatments were preplant application of glyphosate and a no-glyphosate control. Subplot treatments were glufosinate EPOST at 0.41 kg ai/ha, glufosinate EPOST at 0.41 kg/ha fb glufosinate LPOST at 0.41 kg/ha, glufosinate at 0.41 kg/ha plus acifluorfen at 0.56 kg/ha EPOST, and a nontreated control. Glyphosate[5] at 2.52 kg/ha with no adjuvant was applied preplant on April 26, 1999, and April 26, 2000. Soybean cultivar 'A 5547 LL' at 353,000 seeds/ha was planted on May 14, 1999, and May 16, 2000. Pendimethalin at 0.84 kg/ha plus imazaquin at 0.14 kg ai/ha PRE was applied to the entire experimental area to control all other weeds. PRE herbicides were broadcast applied immediately after planting, whereas EPOST and LPOST treatments were applied 3 and 5 WAP, respectively.

Redvine and trumpetcreeper plants were counted, and aboveground biomass was harvested and dry weights were recorded from two randomly selected 0.84-m^2 areas in the middle of each plot at 3 WAT. Soybean crop failed in both years because of late summer drought (Table 1), and grain yields were too low to justify harvesting.

Glyphosate Formulations Study. The study was conducted in 2001 and 2002 to determine the efficacy of three salts of glyphosate on redvine and trumpetcreeper control in glyphosate-resistant soybean. Treatments were arranged in a randomized complete block design with four replications. Each plot consisted of four 19.8-m-long soybean rows spaced 102 cm apart. Treatments were assigned to the same plots in both years to assess the effect of consecutive glyphosate applications on redvine and trumpetcreeper populations. Soybean cultivars 'DP4690 RR' and 'AG 4702 RR' at 325,000 seeds/ha were planted on May 9, 2001, and May 9, 2002, respectively. Flumetsulam at 0.07 kg ai/ha plus metolachlor at 2.30 kg ai/ha PRE was applied immediately after planting to the entire experimental area to control all other weeds. Glyphosate EPOST at 1.26 kg/ha fb LPOST at 0.84 kg/ha was applied at 4 and 6 WAP, respectively. The commercial formulations of Ipa,[6] Dia,[7] and Adt[8] salts of glyphosate were applied. A nonionic surfactant[9] at 0.5% (v/v) was added to Adt salt formulation of glyphosate as suggested by the manufacturer. No surfactant was added to Ipa and Dia salt formulations of glyphosate because labels do not explicitly recommend.

Soybean injury was visually estimated on a scale of 0 (no soybean injury) to 100% (soybean death) at 1 and 14 d after EPOST and LPOST. Redvine and trumpetcreeper plants were counted, and aboveground biomass was harvested and dry weights were recorded from two randomly selected 0.84-m^2 areas in the middle of each plot at 3 WAT. Soybean was harvested from each entire plot using a combine, and grain yield was adjusted to 13% moisture.

RESULTS AND DISCUSSION

Glyphosate-Resistant Soybean Study. Glyphosate applied preplant did not reduce redvine density or biomass compared with no glyphosate (Table 2). Similarly, there were no differences in redvine density and biomass among glyphosate-based POST programs used in glyphosate-resistant soybean. Inclusion of clomazone and lactofen in herbicide programs did not improve redvine control, although clomazone (Anonymous 2004a) and lactofen (Anonymous 2004b) have been known to suppress redvine.

Trumpetcreeper density was reduced 45% with glyphosate applied preplant compared with no glyphosate; however, biomass was unaffected by glyphosate preplant

[6] Roundup Ultramax®, isopropylamine salt of glyphosate, Monsanto Agricultural Company, 800 North Lindbergh Boulevard, St. Louis, MO 63167.

[7] Touchdown® IQ, Diammonium salt of glyphosate, Syngenta Crop protection, 410 South Swing Road, Greensboro, NC 27419.

[8] Engame™, 1-aminomethanamide dihydrogen tetraoxosulfate salt of glyphosate, Entek, 6835 Deerpath Road, Suite E, Elkridge, MD 21075.

[9] Induce® nonionic low foam wetter–spreader adjuvant contains 90% nonionic surfactant (alkylaryl and alcohol ethoxylate surfactants) and fatty acids and 10% water, Helena Chemical Company, Suite 500, 6075 Poplar Avenue, Memphis, TN 38119.

application (Table 2). All in-crop herbicide treatments reduced trumpetcreeper density 34 to 78% compared with the no-herbicide control. Clomazone PRE fb glyphosate EPOST fb glyphosate LPOST was the only POST program that reduced trumpetcreeper biomass (85% reduction) compared with the no-herbicide control. The levels of reduction in trumpetcreeper density were similar to that of trumpetcreeper control reported by Younce and Skroch (1989).

Redvine density was higher in 1999 than in 1998, whereas trumpetcreeper densities were similar in both years (Table 2). This response may be partly due to foliar wash off of glyphosate from rainfall after preplant application in 1999. In 1999, rainfall of 2.0 cm occurred within 1 d after preplant application compared with a rain-free period of 6 d in 1998. A simulated rainfall of 2.5 cm within 24 h of glyphosate application reduced efficacy by 23 percentage points in redvine (Reddy 2000) and 19 percentage points in trumpetcreeper (Chachalis and Reddy 2004) compared with no rainfall. The effect of interaction between year and glyphosate preplant application as well as year by glyphosate in-crop POST on redvine and trumpetcreeper densities was not significant, indicating that glyphosate preplant and in-crop POST applications had a similar effect in both years.

Glufosinate-Resistant Soybean Study. Glyphosate applied preplant reduced redvine biomass 38% but had no effect on density compared with no glyphosate (Table 3). Glufosinate EPOST with or without acifluorfen or glufosinate EPOST fb LPOST had no effect on redvine density but reduced biomass 45 to 76% compared with no herbicide. Glyphosate applied preplant greatly reduced both density (52%) and biomass (59%) of trumpetcreeper compared with a no-glyphosate control. Similar to redvine, glufosinate EPOST with or without acifluorfen or glufosinate EPOST fb LPOST had no effect on density of trumpetcreeper but reduced biomass of trumpetcreeper 35 to 58% compared with the no-herbicide control.

Redvine density was lower in 2000 than in 1999 (Table 3). However, redvine biomass and trumpetcreeper density and biomass were not significantly different between 1999 and 2000. In 1999, rainfall of 2.0 cm occurred within 1 d after preplant application of glyphosate compared with a rain-free period of 7 d in 2000. This response may have resulted in partial loss of efficacy of preplant applied glyphosate in 1999. The effect of interaction between year and glyphosate preplant application as well as year by glufosinate in-crop POST on redvine and trumpetcreeper densities was not significant, indicating that glyphosate and glufosinate had a similar effect in both years.

Glyphosate Formulations Study. Glyphosate-Ipa, glyphosate-Dia, and glyphosate-Adt had no effect on redvine density and biomass compared with the no-herbicide control (Table 4). However, in trumpetcreeper, glyphosate treatment greatly reduced density (45 to 74%)

Table 3. Redvine and trumpetcreeper density and biomass at 3 WAT as affected by herbicide applications in glufosinate-resistant soybean in 1999 and 2000.[a,b]

Main effect	Rate	Application timing	Redvine		Trumpetcreeper	
			Density	Biomass	Density	Biomass
	kg/ha		plants/m²	g/m²	plants/m²	g/m²
Year						
1999			37.2	51.1	12.9	47.4
2000			12.0	32.2	5.3	28.0
LSD (0.05)			20.2	NS	NS	NS
Preplant						
No glyphosate	—	—	25.3	51.5	12.3	53.5
Glyphosate	2.52	Preplant	23.3	31.7	5.9	21.9
LSD (0.05)			NS	19.2	5.9	19.5
In-crop POST						
No herbicide	—	—	33.2	77.8	7.8	58.2
Glufosinate	0.41	EPOST	27.0	43.0	7.2	30.6
Glufosinate	0.41	EPOST	26.2	27.3	10.3	24.4
fb glufosinate	0.41	LPOST				
Glufosinate	0.41	EPOST	11.0	18.4	11.2	37.6
+ acifluorfen	0.56					
LSD (0.05)			NS	27.2	NS	27.6

[a] Abbreviations: EPOST, early postemergence; fb, followed by; LPOST, late postemergence; PRE, preemergence; WAT, weeks after LPOST; NS, not significant.

[b] Data are averaged across 1999 and 2000.

[c] Glyphosate rate was based on acid equivalent, and all other herbicide rates were based on active ingredient.

Table 4. Effect of glyphosate-Ipa, glyphosate-Dia, and glyphosate-Adt on redvine and trumpetcreeper density and biomass at 3 WAT in glyphosate-resistant soybean in 2001 and 2002.[a,b]

Main effect	Rate	Application timing	Redvine Density	Redvine Biomass	Trumpetcreeper Density	Trumpetcreeper Biomass
	kg ae/ha		plants/m²	g/m²	plants/m²	g/m²
Year						
2001			9.8	14.5	4.6	28.4
2002			3.9	7.8	1.9	11.6
LSD (0.05)			4.7	NS	1.6	12.5
Glyphosate formulation						
No herbicide	—	—	8.9	25.3	6.2	65.0
Glyphosate-Ipa	1.26 + 0.84	EPOST fb LPOST	6.6	4.9	1.7	4.3
Glyphosate-Dia	1.26 + 0.84	EPOST fb LPOST	6.1	9.2	1.6	5.8
Glyphosate-Adt	1.26 + 0.84	EPOST fb LPOST	5.8	5.1	3.4	4.8
LSD (0.05)			NS	NS	2.3	17.7

[a] Abbreviations: EPOST, early postemergence; fb, followed by; LPOST, late postemergence; WAT, weeks after LPOST; NS, not significant; Ipa, isopropylamine; Dia, diammonium; Adt, aminomethanamide dihydrogen tetraoxosulfate.

[b] Data are averaged across 2001 and 2002.

and biomass (91 to 93%) regardless of formulation compared with the no-herbicide control. The results indicated that the efficacy of glyphosate on these vines is similar regardless of formulation type studied. Consecutive glyphosate applications did reduce redvine and trumpetcreeper populations as evident from lower densities in 2002 than in 2001.

Glyphosate-Adt injured soybean, and visible injury (speckling and necrosis) was 36% at 1 d after EPOST and 19% 1 d after LPOST (Table 5). Soybean injury decreased over time, and soybean completely recovered from injury 14 d after EPOST or LPOST (data not shown). Apparently, speckling and necrosis were restricted to leaves that intercepted glyphosate spray because new growth after application did not exhibit injury. Others have reported soybean injury with glyphosate-Adt at the registered use rate (Reddy and Zablotowicz 2003) and with glyphosate-Ipa at the higher rate (Krausz and Young 2001). Glyphosate-Ipa and glyphosate-Dia did not injure glyphosate-resistant soybean. Soybean yields were higher (13 to 16%) with all glyphosate formulations than with the no-herbicide control (Table 5). Despite crop injury from glyphosate-Adt, soybean yields were similar among three glyphosate salt formulations. This finding agrees with the results of glyphosate-Ipa and glyphosate-Adt studies by others (Krausz and Young 2001; Reddy and Zablotowicz 2003). Soybean yield was higher in 2001 (3,150 kg/ha) than in 2002 (1,880 kg/ha), and these differences may have been due to differences in the environment and soybean cultivars used (data not shown).

These data demonstrated that glyphosate at 2.52 kg/ha applied preplant reduced density of trumpetcreeper, but not redvine, compared with no glyphosate in both glufosinate- and glyphosate-resistant soybean. Biomass of both species was reduced in only one of two studies, and that may have been due to differences in weather conditions. Glyphosate EPOST fb LPOST had no effect on redvine density but reduced trumpetcreeper density compared with the no-herbicide control. Glufosinate EPOST fb LPOST had no effect on density of redvine and trumpetcreeper but greatly reduced biomass of these

Table 5. Effect of glyphosate-Ipa, glyphosate-Dia, and glyphosate-Adt on glyphosate-resistant soybean injury and yield in 2001 and 2002.[a,b]

Glyphosate formulation	Rate	Application timing	Soybean injury 1 d after EPOST	Soybean injury 1 d after LPOST	Soybean yield
	kg ae/ha		%	%	kg/ha
No herbicide			0	0	2,270
Glyphosate-Ipa	1.26 + 0.84	EPOST fb LPOST	0	0	2,560
Glyphosate-Dia	1.26 + 0.84	EPOST fb LPOST	0	0	2,630
Glyphosate-Adt	1.26 + 0.84	EPOST fb LPOST	36	19	2,590
LSD (0.05)			2.7	2.7	250

[a] Abbreviations: EPOST, early postemergence; fb, followed by; LPOST, late postemergence; NS, not significant; Ipa, isopropylamine; Dia, diammonium; Adt, aminomethanamide dihydrogen tetraoxosulfate.

[b] Data are averaged across 2001 and 2002.

vines. This response may have resulted from severe desiccation of foliage with glufosinate and limited translocation of herbicide to rootstocks. Densities of redvine and trumpetcreeper were similar among Ipa, Dia, and Adt salts of glyphosate.

Overall, lack of reduction in redvine density even after multiple applications of glyphosate could be due to severe infestations and longer or larger rootstocks of redvine in the experimental area. Lethal amounts of herbicide may not have been accumulated in underground rootstocks of redvine because of limited translocation of glyphosate to rootstocks (Reddy 2000). Glyphosate is translocated to the rootstocks only if the rootstocks are connected to the shoots that intercepted glyphosate spray. Furthermore, glyphosate movement gradually decreases from the point of attachment of treated shoot to farther along the rootstock (D. Chachalis and K. N. Reddy, unpublished data). As a result, new flushes of shoots may have emerged from different rootstocks. Poor control of redvine may also be due to regrowth of plants that were partially controlled. Furthermore, moisture stress due to late summer drought in 1998, 1999, and 2000 potentially limited soybean's ability to compete with deep-rooted redvine. Lack of competition from soybean may have also favored reestablishment of redvine.

Trumpetcreeper is more susceptible to glyphosate than redvine. Higher glyphosate efficacy may be related to lower contact angle of spray solution due to greater microroughness of adaxial leaf surface and more hydrophilic nature of epicuticular waxes in trumpetcreeper compared with that of redvine (Chachalis et al. 2001). Currently, our studies are progressing toward integration of deep tillage with glyphosate to develop management strategies for redvine and trumpetcreeper in glyphosate-resistant soybean.

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