Activation and Length of Residual Herbicides Under Furrow and Sprinkler Irrigation

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RESEARCH PROBLEM

Evolution and spread of glyphosate-resistant Palmer amaranth across the U.S. Midsouth has increased the cost of weed management in glyphosate-resistant cotton systems. Palmer amaranth emerges throughout the growing season and is hard to control after emergence because of its rapid growth (Garvey, 1999; Jha and Norsworthy, 2009). Widespread prevalence of resistance to acetolactate synthase (ALS)-inhibiting herbicides in the U.S. Midsouth has rendered control of Palmer amaranth in cotton ineffective with over-the-top applications of postemergence (POST) applied ALS herbicides such as Envoke (trifloxysulfuron) and Staple (pyrithiobac) (Norsworthy et al., 2008). Therefore, season-long residual control of Palmer amaranth is needed.

BACKGROUND INFORMATION

The activity and length of residual soil active herbicides depends on soil type and available soil moisture. Soil-applied herbicides need 0.5 to 1.0 inch of precipitation or irrigation within 7 to 10 days of application (Hager et al., 2011). Most of the cotton area planted in Arkansas is irrigated through furrow or sprinkler irrigation. Variable soil moisture can lead to differences in the residual herbicide activity and ultimately Palmer amaranth control in furrows and on beds.

RESEARCH DESCRIPTION

Studies were conducted in 2011 and 2012 to determine activation and length of residual herbicides under both furrow and sprinkler irrigation at the Northeast Research and Extension Center, Keiser, Ark. and at the Lonn Mann Cotton Research Station, Marianna, Ark. The soil texture at Keiser was clay and at Marianna was silt loam. Both furrow and sprinkler irrigation studies were laid out in a randomized complete block design with a 2 (site: bed vs. furrow) by 18 factorial arrangement of treatments (soil-applied herbicides applied at labeled rate

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for cotton, corn, or soybean: AAtrex, Balance Flexx, Callisto, Caparol, Cotoran, Direx, Dual Magnum, Envoke, Laudis, Outlook, Prowl, Reflex, Sencor, Staple, Valor, Warrant, Zidua, and a nontreated control). Data for two years were pooled and analysis of variance was conducted to assess differences in Palmer amaranth control among herbicides and between furrows and beds using Fisher's protected least significant difference test ($\alpha = 0.05$). Palmer amaranth control data were analyzed as repeated measures to determine length of residual herbicide activity over a 6-week period [2, 3, and 6 weeks after treatment (WAT)].

RESULTS AND DISCUSSION

Furrow Irrigation Study

Averaged over herbicides, no biological difference was observed for Palmer amaranth control between beds and furrows at both locations (data not shown). Averaged over beds and furrows, Palmer amaranth control at Keiser with all herbicides except Envoke (76%) and Staple (80%) was ≥ 92% at 2 WAT (Table 1). Palmer amaranth control with all herbicides at 3 WAT was similar to 2 WAT but decreased for all herbicides by 2 to 17 percentage points by 6 WAT, except Callisto (94% vs. 93%), Dual Magnum (98% vs. 96%), Sencor (99% vs. 98%), and Staple (80% vs. 75%). At Marianna, control with all herbicides except Envoke (63%), Staple (70%), Laudis (85%), Balance Flexx (88%), and Prowl (87%) was ≥ 90% at 2 WAT (Table 2). By 6 WAT, the only herbicide with control similar to 2 WAT was Direx (95% vs. 93%). These studies demonstrated that the length of residual activity for Palmer amaranth control varied for herbicides depending upon soil type and more herbicides at Keiser (AAtrex, Balance Maxx, Callisto, Caparol, Dual, Outlook, Reflex, Sencor, Valor, Warrant, and Zidua) compared to Marianna (Caparol, Direx, and Zidua) provided ≥ 90% residual control over a 6-wk period.

Sprinkler Irrigation Study

Averaged over herbicides, a small reduction in Palmer amaranth control on beds compared to furrow was observed at 2 WAT (97% vs. 99%, respectively) and 3 WAT (95% vs. 99%, respectively), but no difference in control was observed at 6 WAT (92% vs. 93%, respectively) (data not shown). The subtle difference in control may be attributed to greater moisture being retained in furrows. Averaged over beds and furrows, Palmer amaranth control with all herbicides, except Cotoran (89%) at 2 WAT was >90% (Table 3). Palmer amaranth control with all herbicides at 3 WAT remained similar to 2 WAT, except for a decrease in control with Envoke (84% vs. 97%). By 6 WAT, only AAtrex, Callisto, and Sencor controlled Palmer amaranth similar to 2 WAT. Palmer amaranth control with all other herbicides at 6 WAT was less than at 2 WAT, but control with AAtrex, Callisto, Sencor, Dual, Zidua, Valor, Outlook, and Warrant was ≥90%.

PRACTICAL APPLICATION

In both furrow and sprinkler irrigation studies, no cotton residual herbicide provided complete control at 2, 3, or 6 WAT. Dual Magnum, Valor, and Warrant were the only herbicides labeled in cotton that provided at least 90% Palmer amaranth control at Keiser under both furrow and sprinkler irrigation through 6 WAT. Additionally, Caparol and Reflex at Keiser and Direx and Caparol at Marianna were the cotton herbicides that controlled Palmer amaranth ≥90% in furrow irrigation. Unfortunately, 90% control is unacceptable in fields of Roundup Ready cotton with high populations of glyphosate-resistant Palmer amaranth; hence, residual herbicides should be applied every 2 to 3 weeks from planting through crop canopy formation (layby) to overlay residual control and minimize the number of Palmer amaranth escapes that must be removed either chemically (when possible), mechanically, or manually.

LITERATURE CITED

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Table 1. Palmer amaranth control with soil-applied residual herbicides at the Northeast Research and Extension Center, Keiser, Ark., under furrow irrigation averaged over site (beds and furrows) and years at 2, 3, and 6 weeks after treatment (WAT).

	Palmer amaranth control			Difference in residual Palmer amaranth control		
Herbicide[†]	2 WAT	3 WAT	6 WAT	2 vs 3 WAT	2 vs 6 WAT	3 vs 6 WAT
	----------%----------					
AAtrex	100 a[‡]	100 a	93 b-d	NS[§]	**	**
Balance	99 a	98 ab	95 ab	NS	**	**
Callisto	94 de	95 b-d	93 a-c	NS	NS	NS
Caparol	98 a-c	96 b-d	90 c-e	NS	**	**
Cotoran	95 cd	94 cd	84 ef	NS	**	**
Direx	94 de	92 de	87 d-f	NS	**	**
Dual	98 ab	97 a-c	96 ab	NS	NS	NS
Envoke	76 g	71 g	59 h	NS	**	**
Laudis	92 e	90 e	88 ef	NS	*	NS
Outlook	98 ab	98 a-c	94 bc	NS	**	**
Prowl	92 e	88 e	79 fg	NS	**	**
Reflex	95 cd	95 b-d	92 b-d	NS	*	NS
Sencor	99 a	99 a	98 a	NS	NS	NS
Staple	80 f	80 f	72 g	NS	NS	NS
Valor	96 b-d	96 b-d	92 b-d	NS	**	**
Warrant	98 ab	97 a-c	94 a-c	NS	**	**
Zidua	98 ab	98 a-c	96 ab	NS	**	*

[†]All herbicides were applied at labeled field rates based on soil type.
[‡]Columns with the same letter are not significantly different ($P \leq 0.05$).
[§]Abbreviations: NS, not significant at α = 0.05; *, significant at α = 0.05; **, significant at α = 0.01.

Table 2. Palmer amaranth control with soil-applied residual herbicides at the Lonn Mann Cotton Research Station, Marianna, Ark., under furrow irrigation averaged over beds and furrows and years at 2, 3, and 6 weeks after treatment (WAT).

	Palmer amaranth control			Difference in residual Palmer amaranth control		
Herbicide[†]	2 WAT	3 WAT	6 WAT	2 vs 3 WAT	2 vs 6 WAT	3 vs 6 WAT
	----------%----------					
AAtrex	99 a[‡]	99 a	85 c-e	NS[§]	**	**
Balance	88 ef	77 gh	62 hi	**	**	**
Callisto	96 a-c	95 c-f	85 b-e	NS	**	**
Caparol	99 a	99 a	90 a-c	NS	**	**
Cotoran	94 b-d	92 ef	76 fg	NS	**	**
Direx	95 a-d	96 a-e	93 a	NS	NS	NS
Dual	97 ab	94 d-f	78 ef	NS	**	**
Envoke	63 h	53 j	43 j	**	**	NS
Laudis	85 f	73 h	56 i	**	**	**
Outlook	97 ab	95 c-f	83 b-e	NS	**	**
Prowl	87 f	83 g	70 gh	NS	**	**
Reflex	92 cd	92 f	85 b-e	NS	**	**
Sencor	98 ab	97 a-c	87 b-d	NS	**	**
Staple	70 g	64 i	42 j	*	**	**
Valor	92 cd	95 b-f	85 b-e	NS	*	**
Warrant	91 de	96 a-d	82 d-f	NS	**	**
Zidua	99 a	98 ab	91 ab	NS	**	**

[†]All herbicides were applied at labeled field rates based on soil type.
[‡]Columns with the same letter are not significantly different ($P \leq 0.05$).
[§]Abbreviations: NS, not significant at α = 0.05; *, significant at α = 0.05; **, significant at α = 0.01.

Table 3. Palmer amaranth control with soil-applied residual herbicides at the Northeast Research and Extension Center, Keiser, Ark., under sprinkler irrigation averaged over beds and furrows and years at 2, 3, and 6 weeks after treatment (WAT).

	Palmer amaranth control			Difference in residual Palmer amaranth control		
Herbicide[†]	2 WAT	3 WAT	6 WAT	2 vs 3 WAT	2 vs 6 WAT	3 vs 6 WAT
	----------%----------					
AAtrex	100 a[‡]	100 a	99 a	NS[§]	NS	NS
Balance	98 ab	96 ab	89 a-d	NS	**	*
Callisto	100 a	100 a	99 a	NS	NS	NS
Caparol	93 b-d	86 c-e	66 fg	NS	**	**
Cotoran	89 d	82 de	68 e-g	NS	*	NS
Direx	96 b-d	91 b-d	82 d-f	NS	**	*
Dual	100 a	100 a	97 ab	NS	*	*
Envoke	97 a-c	84 e	72 g	**	**	**
Laudis	97 a-c	94 b-d	84 c-f	NS	**	**
Outlook	97 a-c	95 a-c	93 a-d	NS	*	NS
Prowl	91 d	92 a-c	84 c-e	NS	*	*
Reflex	94 b-d	93 b-d	87 b-d	NS	*	NS
Sencor	100 a	100 a	99 a	NS	NS	NS
Staple	92 cd	90 c-e	63 g	NS	**	**
Valor	98 a-c	99 ab	93 a-d	NS	*	*
Warrant	98 a-c	94 a-c	91 a-d	NS	*	NS
Zidua	99 ab	96 ab	94 a-c	NS	*	NS

[†]All herbicides were applied at labeled field rates based on soil type.
[‡]Columns with the same letter are not significantly different ($P \leq 0.05$).
[§]Abbreviations: NS, not significant at α = 0.05; *, significant at α = 0.05; **, significant at α = 0.01.