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Influence of Cultural Practices and Herbicide Programs for Managing Glyphosate-Resistant Palmer Amaranth in Cold-Tolerant Sorghum

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Influence of Cultural Practices and Herbicide Programs for Managing Glyphosate-Resistant Palmer Amaranth in Cold-Tolerant Sorghum

Abstract

The widespread evolution of glyphosate-resistant (GR) Palmer amaranth (*Amaranthus palmeri* S. Wats) has become a serious management concern for grain sorghum producers in western Kansas. To develop an integrated weed management (IWM) system, a field study was conducted at the Kansas State University Agricultural Research Center (KSU-ARC) in Hays, KS, in 2018, to evaluate the effect of sorghum hybrid, row spacing, and herbicide programs on GR Palmer amaranth control, shoot dry weight reduction, and sorghum grain yield. Treatments included two cold-tolerant grain sorghum hybrids: Pioneer 87P06 (commercial check) and ATx645/ ARCH12012R (developed by the KSU-ARC breeding program); row spacing of 15-in. (narrow) and 30-in. (standard); and three herbicide programs: 1) a preemergence (PRE) application of Degree Xtra at 2.5 qt/a, 2) PRE applied Degree Xtra at 2.5 qt/a followed by (*fb*) a sequential postemergence (POST) application of Huskie at 15 fl oz/a, and 3) a nontreated weedy check. The experiment was conducted in a randomized complete block design with a factorial arrangement of treatments and 3 replications. Sorghum hybrids were planted on April 17, 2018, in no-till wheat stubble using a seeding rate of approximately 69,696 seeds per acre. Plots were uniformly infested with a GR Palmer amaranth population prior to sorghum planting. Results indicated that both PRE alone and PRE *fb* POST programs provided an excellent, season-long control (> 97%) of GR Palmer amaranth. In nontreated weedy plots, GR Palmer amaranth density was not affected by sorghum hybrid or row spacing; however, its shoot dry weight was reduced by 37% with 15-in. compared to 30-in. rows. Sorghum grain yield of Pioneer 87P06 was increased by 27% in 15-in. compared to 30-in. rows; whereas, row spacing had no effect on grain yield of ATx645/ARCH12012R hybrid. These preliminary results suggest that combination of narrow row spacing (15-in.) and PRE application of Degree Xtra can potentially be utilized for effective and season-long control of GR Palmer amaranth in early-planted (cold-tolerant) grain sorghum.

Keywords

cold-tolerant grain sorghum, Palmer amaranth, row spacing, sorghum hybrid

Authors

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Summary

The widespread evolution of glyphosate-resistant (GR) Palmer amaranth (*Amaranthus palmeri* S. Wats) has become a serious management concern for grain sorghum producers in western Kansas. To develop an integrated weed management (IWM) system, a field study was conducted at the Kansas State University Agricultural Research Center (KSU-ARC) in Hays, KS, in 2018, to evaluate the effect of sorghum hybrid, row spacing, and herbicide programs on GR Palmer amaranth control, shoot dry weight reduction, and sorghum grain yield. Treatments included two cold-tolerant grain sorghum hybrids: Pioneer 87P06 (commercial check) and ATx645/ARCH12012R (developed by the KSU-ARC breeding program); row spacing of 15-in. (narrow) and 30-in. (standard); and three herbicide programs: 1) a preemergence (PRE) application of Degree Xtra at 2.5 qt/a, 2) PRE applied Degree Xtra at 2.5 qt/a followed by (*fb*) a sequential postemergence (POST) application of Huskie at 15 fl oz/a, and 3) a nontreated weedy check. The experiment was conducted in a randomized complete block design with a factorial arrangement of treatments and 3 replications. Sorghum hybrids were planted on April 17, 2018, in no-till wheat stubble using a seeding rate of approximately 69,696 seeds per acre. Plots were uniformly infested with a GR Palmer amaranth population prior to sorghum planting. Results indicated that both PRE alone and PRE *fb* POST programs provided an excellent, season-long control (> 97%) of GR Palmer amaranth. In nontreated weedy plots, GR Palmer amaranth density was not affected by sorghum hybrid or row spacing; however, its shoot dry weight was reduced by 37% with 15-in. compared to 30-in. rows. Sorghum grain yield of Pioneer 87P06 was increased by 27% in 15-in. compared to 30-in. rows; whereas, row spacing had no effect on grain yield of ATx645/ARCH12012R hybrid. These preliminary results suggest that combination of narrow row spacing (15-in.) and PRE application of Degree Xtra can potentially be utilized for effective and season-long control of GR Palmer amaranth in early-planted (cold-tolerant) grain sorghum.

Introduction

Palmer amaranth (*Amaranthus palmeri* S. Wats) is a problematic weed species in Kansas cropping systems, including grain sorghum. It is a summer annual dicot with extended period of emergence (May through end of September). Palmer amaranth has aggressive growth characteristics and is highly competitive. It is a prolific seed producer (a single female plant can produce up to 0.6 million seeds) (Keeley et al., 1987). Due to its extended period of emergence and rapid growth, it demonstrates greater competitive ability and causes significant crop yield losses. Season-long infestation of Palmer amaranth at a density of 0.15 plants ft^{-2} is known to cause up to 63% yield reduction in grain sorghum (Ward et al., 2013).

In recent years, herbicide-resistant (HR) Palmer amaranth has become a serious challenge to Kansas growers. Glyphosate-resistant (GR) Palmer amaranth was first documented in Kansas in 2011 (Heap, 2019). A more recent field survey has revealed that resistance to glyphosate is fairly common among Palmer amaranth populations across western and central parts of Kansas. In addition, a single Palmer amaranth population with multiple resistance to sulfonylureas (ALS inhibitors), atrazine (PS II inhibitor), mesotrione (HPPD inhibitor), glyphosate (EPSPS inhibitor), and 2,4-D (synthetic auxins) has also been reported recently from a Kansas sorghum field (Heap, 2019; Kumar et al., 2019). The increasing reports of Palmer amaranth populations with resistance to glyphosate and other herbicide chemistries necessitate the development of integrated weed management (IWM) strategies for effective Palmer amaranth control in grain sorghum production.

Cultural practices such as hybrid selection and narrow row spacing alone or in conjunction with herbicides can alter crop-weed competition and can potentially be utilized for weed control. Therefore, the main objectives of this research were to 1) evaluate the effect of sorghum hybrid, row spacing, and herbicide programs on GR Palmer amaranth control in cold-tolerant grain sorghum, and 2) determine the ultimate impact of these factors on sorghum grain yield.

Procedures

A field study was conducted at the Kansas State University Agricultural Research Center (KSU-ARC) near Hays, KS, in 2018. The experiment was set up in a randomized complete block design with factorial combination of treatments and 3 replications. The three treatment factors included sorghum hybrids, row spacing, and herbicide programs. Two cold-tolerant sorghum hybrids were investigated: a commercial hybrid Pioneer 87P06, and ATx645/ARCH12012R from the K-State breeding program. The two row spacing included 30-in. (standard spacing) and 15-in. (narrow spacing). Herbicide programs included preemergence (PRE) alone, PRE followed by (*fb*) postemergence (POST), and a nontreated weedy check. Degree Xtra at 2.5 qt/a was used in PRE program. Huskie at 15 fl oz/a was used in POST program. Field study was established on April 17, 2018. Seeds of GR Palmer amaranth population were uniformly broadcasted prior to sorghum planting.

Data on percent visual control of Palmer amaranth (on a scale of 0 to 100%, 0 = no control, 100 = complete control) were collected at biweekly intervals throughout the growing season. Palmer amaranth biomass was also collected using two 0.5 square yard quadrats from the center of each plot prior to sorghum harvest. Data on sorghum grain yields were also recorded for each plot using a plot combine. All data were subjected to ANOVA using PROC MIXED in SAS v. 9.4 (SAS Inst., Cary, NC) and means were separated by Fisher's protected least significant difference test ($P < 0.05$).

Results

Results indicated that both PRE alone and PRE *fb* POST programs provided excellent and season-long control (97%) of GR Palmer amaranth (Figure 1). Interestingly, a sequential POST application of Huskie at 15 fl oz/a did not improve the GR Palmer amaranth control, when applied to PRE program (Figure 2). In nontreated weedy plots, GR Palmer amaranth density was not affected by sorghum hybrid or row spacing (data not shown). However, the shoot dry weights of Palmer amaranth were reduced by 37% with 15-in. compared to 30-in. row spacing (Figure 3). Results from earlier studies at K-State reported that weed growth in 10-in. spaced sorghum rows was reduced by 24% compared to 20-in. spaced rows and by 45% when compared to 30-in. spaced rows (Staggenborg et al., 1999). In another study, it was concluded that grain sorghum was equally competitive in 15- and 30-in. row spacing when weed pressure was low, but as weed pressure increased, grain sorghum was more competitive in 15-in. row spacing (Limon-Ortega et al., 1998). In the current study, sorghum grain yield of Pioneer 87P06 was increased by 27% in 15-in. compared to 30-in. rows; whereas, row spacing had no effect on grain yield of ATx645/ARCH12012R hybrid (Figure 4).

Conclusions and Implications

Based on these results, the combination of narrow row spacing (15-in.) and PRE application of Degree Xtra at 2.5 qt/a has a potential to be used for effective and season-long control of GR Palmer amaranth in early-planted (cold-tolerant) grain sorghum. Future research would be needed to further validate these results by repeating this study in Hays and other locations across western Kansas.

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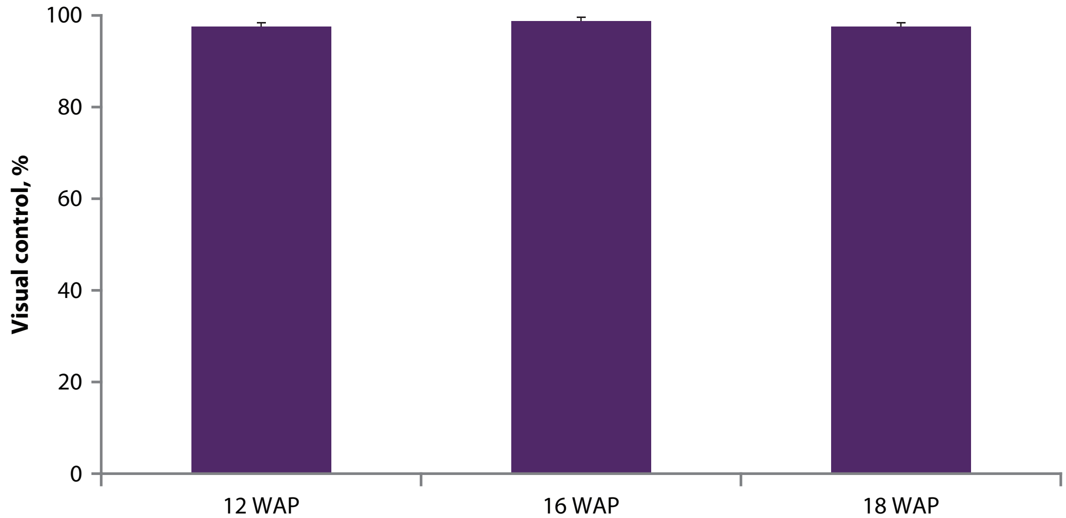

Figure 1. Effect of PRE herbicide program on visual control (%) of glyphosate-resistant Palmer amaranth at 12, 16, and 18 weeks after planting (WAP) of grain sorghum.

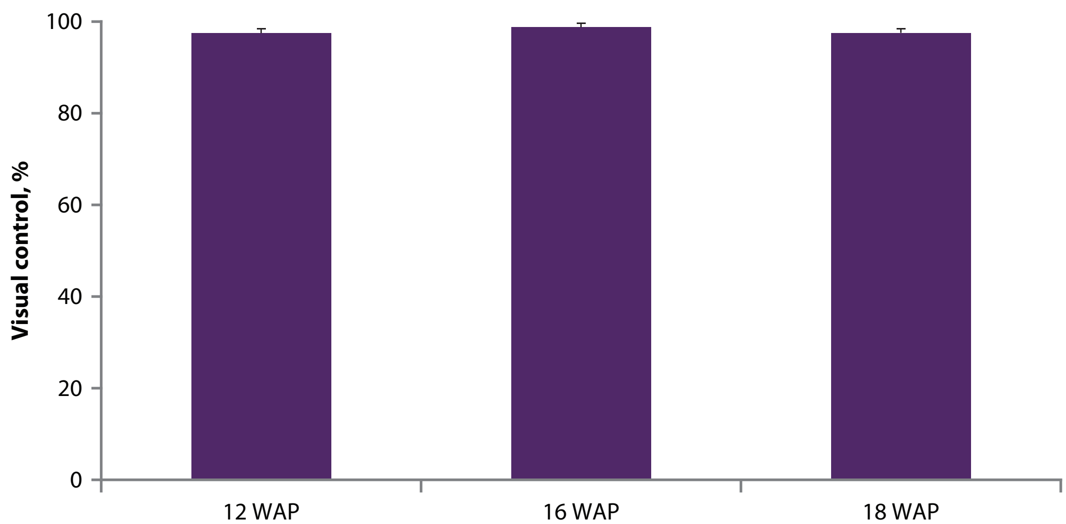

Figure 2. Effect of preemergence followed by (*fb*) postemergence herbicide program on visual control (%) of glyphosate-resistant Palmer amaranth at 12, 16, and 18 weeks after planting (WAP) of grain sorghum.

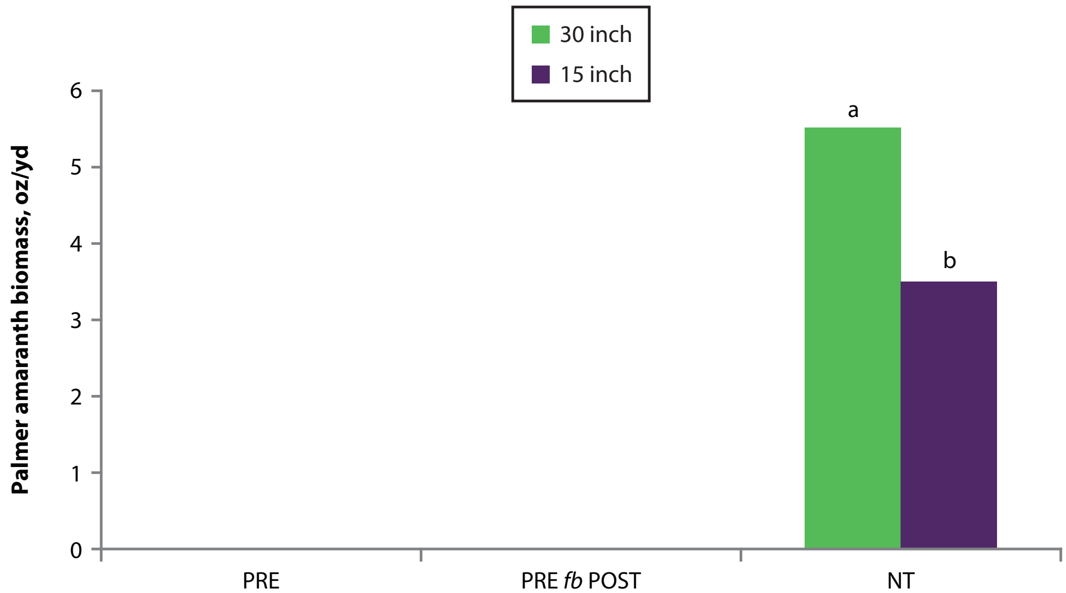

Figure 3. Effect of row spacing on glyphosate-resistant Palmer amaranth biomass (oz/yd) prior to sorghum harvest. PRE = preemergence. *fb* = followed by. POST = postemergence. NT = no-till. Bars with similar letters are not different based on Fisher's protected LSD test at *P* < 0.05.

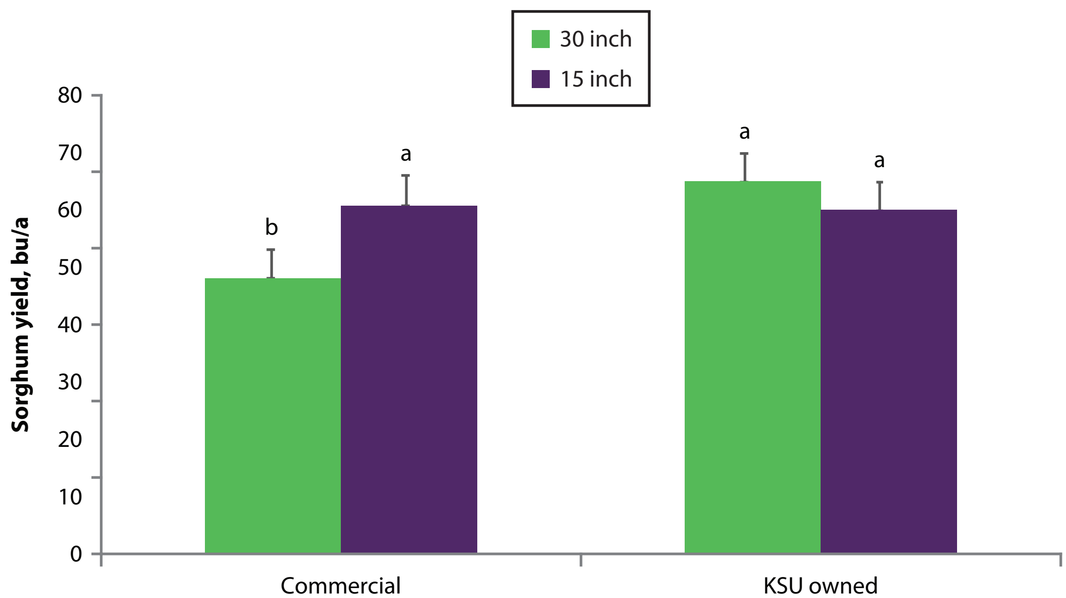

Figure 4. Interaction of row spacing and hybrids on sorghum grain yield (bu/a). Bars with similar letters are not different based on Fisher's protected LSD test at *P* < 0.05.