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## Efficacy of Late-Season Herbicide Programs for Controlling Palmer Amaranth in Postharvest Wheat Stubble

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# Efficacy of Late-Season Herbicide Programs for Controlling Palmer Amaranth in Postharvest Wheat Stubble

## Abstract

Late-season control of Palmer amaranth in wheat stubble is a challenge for Kansas producers. The objective of this study was to determine the effectiveness of POST herbicide programs (with multiple modes of actions) for late-season control of Palmer amaranth in postharvest wheat stubble. The study was conducted at the Kansas State University Agricultural Research Center in Hays, KS, in 2019. The study site had a natural seedbank of Palmer amaranth that emerged immediately after wheat harvest. All selected herbicide programs were tested 3 weeks after wheat harvest, when Palmer amaranth plants had attained a height of 2 to 2.5 feet with inflorescence initiation. Twenty-four herbicide programs comprising Roundup PowerMax, Clarity, 2,4-D, Aatrex, Gramoxone, Sencor, Valor SX, Spartan, Sharpen, Authority Supreme, Kochiavore, Panther MTZ, and Huskie applied alone or in tank-mixtures were tested at recommended-use rates. All herbicide treatments were arranged in a randomized complete block design with four replications. Visual Palmer amaranth control was assessed at 2, 4, and 8 weeks after treatment (WAT) by using a rating scale of 0–100% (where 0 = no control and 100% = complete plant death). The aboveground Palmer amaranth biomass and seed production were determined by harvesting plants from a 10.7-ft<sup>2</sup> quadrat placed at the center of each plot 8 WAT. All tested herbicide programs, except Kochiavore and a tank-mixture of Huskie + Aatrex provided > 88% control of Palmer amaranth 8 WAT. In contrast, late-season control of Palmer amaranth did not exceed 71% at 8 WAT with Kochiavore or a tank-mixture of Huskie plus Aatrex treatments. Consistent with visual control (%), a majority of those tested programs significantly reduced shoot dry weights (>77% reduction) and seed production (>93% reduction) of Palmer amaranth compared to nontreated weedy check. Overall, these results suggest that several POST herbicide programs exist that growers can utilize for effective late-season control of Palmer amaranth in postharvest wheat stubble.

## Keywords

Palmer amaranth, herbicide options, wheat stubble

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## Summary

Late-season control of Palmer amaranth in postharvest wheat stubble is a challenge for Kansas producers. The objective of this study was to determine the effectiveness of POST herbicide programs (with multiple modes of actions) for late-season control of Palmer amaranth in postharvest wheat stubble. The study was conducted at the Kansas State University Agricultural Research Center in Hays, KS, in 2019. The study site had a natural seedbank of Palmer amaranth that emerged immediately after wheat harvest. All selected herbicide programs were tested 3 weeks after wheat harvest, when Palmer amaranth plants had attained a height of 2 to 2.5 feet with inflorescence initiation. Twenty-four herbicide programs comprising Roundup PowerMax, Clarity, 2,4-D, Aatrex, Gramoxone, Sencor, Valor SX, Spartan, Sharpen, Authority Supreme, Kochiavore, Panther MTZ, and Huskie applied alone or in tank-mixtures were tested at recommended-use rates. All herbicide treatments were arranged in a randomized complete block design with four replications. Visual Palmer amaranth control was assessed at 2, 4, and 8 weeks after treatment (WAT) by using a rating scale of 0–100% (where 0 = no control and 100% = complete plant death). The aboveground Palmer amaranth biomass and seed production were determined by harvesting plants from a 10.7-ft<sup>2</sup> quadrat placed at the center of each plot 8 WAT. All tested herbicide programs, except Kochiavore and a tank-mixture of Huskie + Aatrex provided > 88% control of Palmer amaranth 8 WAT. In contrast, late-season control of Palmer amaranth did not exceed 71% at 8 WAT with Kochiavore or a tank-mixture of Huskie plus Aatrex treatments. Consistent with visual control (%), a majority of those tested programs significantly reduced shoot dry weights (>77% reduction) and seed production (>93% reduction) of Palmer amaranth compared to nontreated weedy check. Overall, these results suggest that several POST herbicide programs exist that growers can utilize for effective late-season control of Palmer amaranth in postharvest wheat stubble.

## Introduction

Palmer amaranth (*Amaranthus palmeri* S. Wats.) has become the most problematic weed species in agronomic crops across western and central parts of Kansas (Thompson et al., 2018). It is a dioecious (male and female flowers on separate plants) summer annual broadleaf weed that belongs to the pigweed family (Ward et al., 2013). Palmer amaranth manifests several unique biological traits such as extended period of emergence, aggressive growth (1 to 2 inch per day), and prolific seed production (a single

female plant can produce up to 0.6 million seeds) (Keeley et al., 1987; Steckel et al., 2004; Ward et al., 2013). In addition, Palmer amaranth is also highly prone to develop herbicide resistance (Heap, 2020).

Glyphosate-resistant (GR) Palmer amaranth is fairly common in Kansas fields. Recent Palmer amaranth surveys from south central Kansas have also revealed the prevalence of reduced sensitivity (potential resistance) to glyphosate (EPSPS inhibitor), chlorsulfuron (ALS inhibitors), atrazine (PS II inhibitor), and mesotrione (HPPD inhibitor) among field populations (Kumar et al., 2020). The multiple herbicide-resistant (MHR) Palmer amaranth is now a serious management concern to Kansas growers. Currently, Palmer amaranth populations are reported with resistance to one or more of the following herbicide site(s) of action, including sulfonylureas (ALS inhibitors), atrazine (PS II inhibitor), mesotrione (HPPD inhibitor), glyphosate (EPSPS inhibitor), and recently to 2,4-D (synthetic auxins) in Kansas (Heap, 2020; Kumar et al., 2019).

Palmer amaranth after wheat harvest can grow and produce significant numbers of seeds (Bagavathiannan et al., 2012). The seedbank allows Palmer amaranth to establish and reproduce, making management more challenging in the subsequent growing seasons. In order to prevent the further spread of GR Palmer amaranth, it is critical to develop postharvest Palmer control strategies in wheat stubble. Therefore, the objective of this study was to determine the effectiveness of late-season POST herbicide programs on control and seed production of Palmer amaranth in postharvest wheat stubble.

## Procedures

The field study was conducted at the Kansas State University Agricultural Research Center (KSU-ARC) near Hays, KS, in 2019. Winter wheat (variety 'Joe') was planted at the experimental site in fall of 2018 and harvested on July 11, 2019. The study site had a natural Palmer amaranth seedbank. Palmer amaranth seedlings emerged immediately after wheat harvest. Twenty-four selected herbicide programs were tested when Palmer amaranth plants reached to the height of 2 to 2.5 ft and were showing signs of inflorescence initiation. Treatments were arranged in a randomized complete block design, with 4 replications. All herbicide programs were tested at recommended-use rates (Table 1). All herbicide treatments were applied on August 2, 2019, with a CO<sub>2</sub>-pressurized backpack sprayer equipped with TeeJet AIXR 110015 flat spray nozzle tips (Spraying Systems Co., Wheaton, IL) calibrated to deliver 15 gallons per acre spray solution. Data on visual Palmer amaranth control on a scale of 0 to 100% (0 = no control and 100 = complete control) were collected at 2, 4, and 8 weeks after treatment (WAT). Aboveground shoot biomass was determined by hand-harvesting Palmer amaranth plants from a square yard quadrat at the center of each plot at 8 WAT. Palmer amaranth plants collected for biomass were threshed and cleaned to determine the seed production in each treatment. Data on Palmer amaranth control (%), biomass, and seed production were subjected to ANOVA using PROC MIXED in SAS v. 9.3 software (SAS Inst. Inc., Cary, NC). Means were separated using Fisher's protected least significant difference test at  $P < 0.05$ .

## Results

### *Efficacy of Late-Season Herbicide Programs*

All tested herbicide programs provided >88% control of Palmer amaranth at 8 WAT, except Kochiavore and a tank-mixture of Huskie + Aatrex (Figures 1 and 2). A majority of the tested programs significantly reduced Palmer amaranth shoot biomass (>77% reduction) and seed production (>93% reduction) compared to nontreated weedy check (Figures 3 and 4). Among all tested programs, the least reduction in Palmer amaranth shoot biomass (9% reduction) and seed production (72% reduction) was observed with a tank mixture of Huskie + Aatrex in comparison to nontreated weedy check (Figures 3 and 4).

### *Conclusions and Implications*

These preliminary results indicated that several alternatives (other than glyphosate) POST burndown herbicides—including Clarity, 2,4-D, Gramoxone, Sharpen, and Liberty—exist which can be utilized in combination with Aatrex, Authority Supreme, Panther MTZ, Sencor, Spartan, and Valor for effective late-season control of Palmer amaranth in postharvest wheat stubble.

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**Table 1. List of herbicide programs tested for controlling Palmer amaranth in postharvest wheat stubble at the Kansas State University Agricultural Research Center in 2019**

Treatment #	Herbicide programs <sup>a,b</sup>	Rate (oz/a)	Herbicide groups
1	Nontreated	---	---
2	Roundup PowerMax	32	9
3	Clarity	16	4
4	2,4-D amine	32	4
5	Roundup PowerMax + Clarity	32+16	9 & 4
6	Roundup PowerMax + 2,4-D amine	32+32	9 & 4
7	Clarity + Aatrex	16+16	4 & 5
8	Clarity + 2,4-D amine	16+32	4
9	Gramoxone	48	22
10	Gramoxone + Aatrex	48+16	22 & 5
11	Gramoxone + Sencor	48+5	22 & 5
12	Gramoxone+ Valor	48+2	22 & 14
13	Gramoxone + 2,4-D amine	48+32	22 & 4
14	Gramoxone + Spartan	48+4	22 & 14
15	Gramoxone + Authority Supreme	48+10	22 & 14, 15
16	Gramoxone + Panther MTZ	48+15	22 & 5, 14
17	Sharpen	2	14
18	Sharpen + Aatrex	2+16	14 & 5
19	Sharpen + Sencor	2+5	14 & 5
20	Sharpen + 2,4-D amine	2+32	14 & 4
21	Kochiavore	16	4 & 6
22	Huskie + Aatrex	15+16	6, 27 & 5
23	Liberty	36	10
24	Liberty + 2,4-D amine + Roundup PowerMax	36+32+32	10, 4, 9
25	Liberty + Clarity + Roundup PowerMax	36+16+32	10, 4, 9

<sup>a</sup> Herbicide treatments were applied on 2- to 2.5-ft tall Palmer amaranth plants showing inflorescence initiation in postharvest wheat stubble.

<sup>b</sup> All treatments were applied with appropriate adjuvants as dictated by each herbicide label.

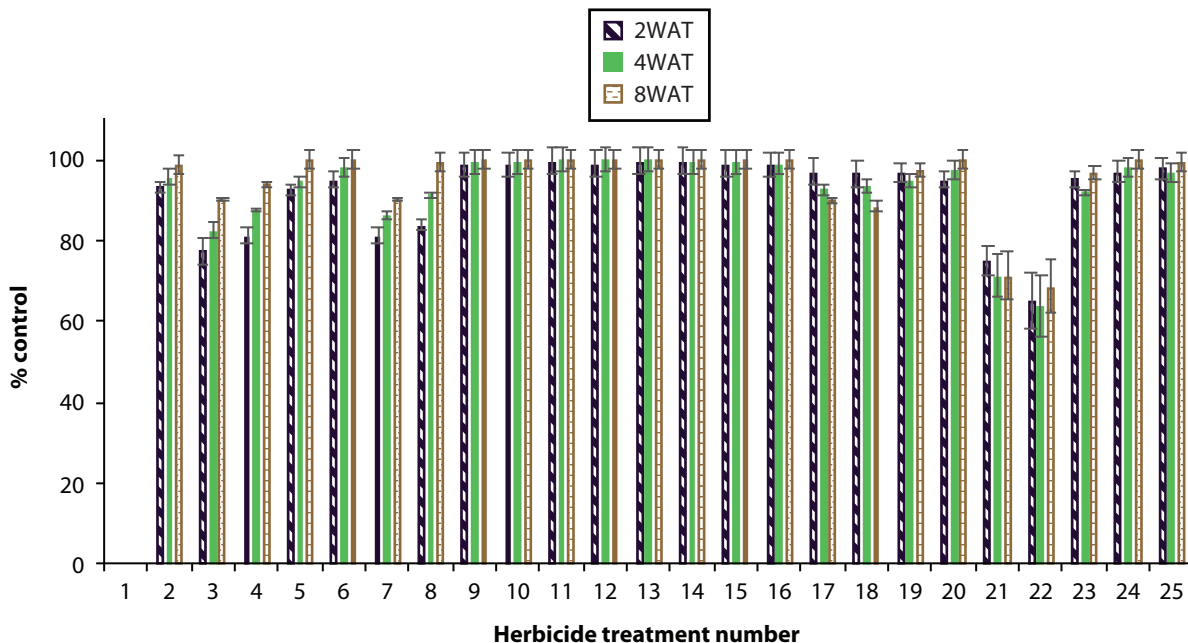


Figure 1. Effect of late-season herbicide programs on Palmer amaranth control at 2, 4, and 8 weeks after treatment (WAT) in postharvest wheat stubble.

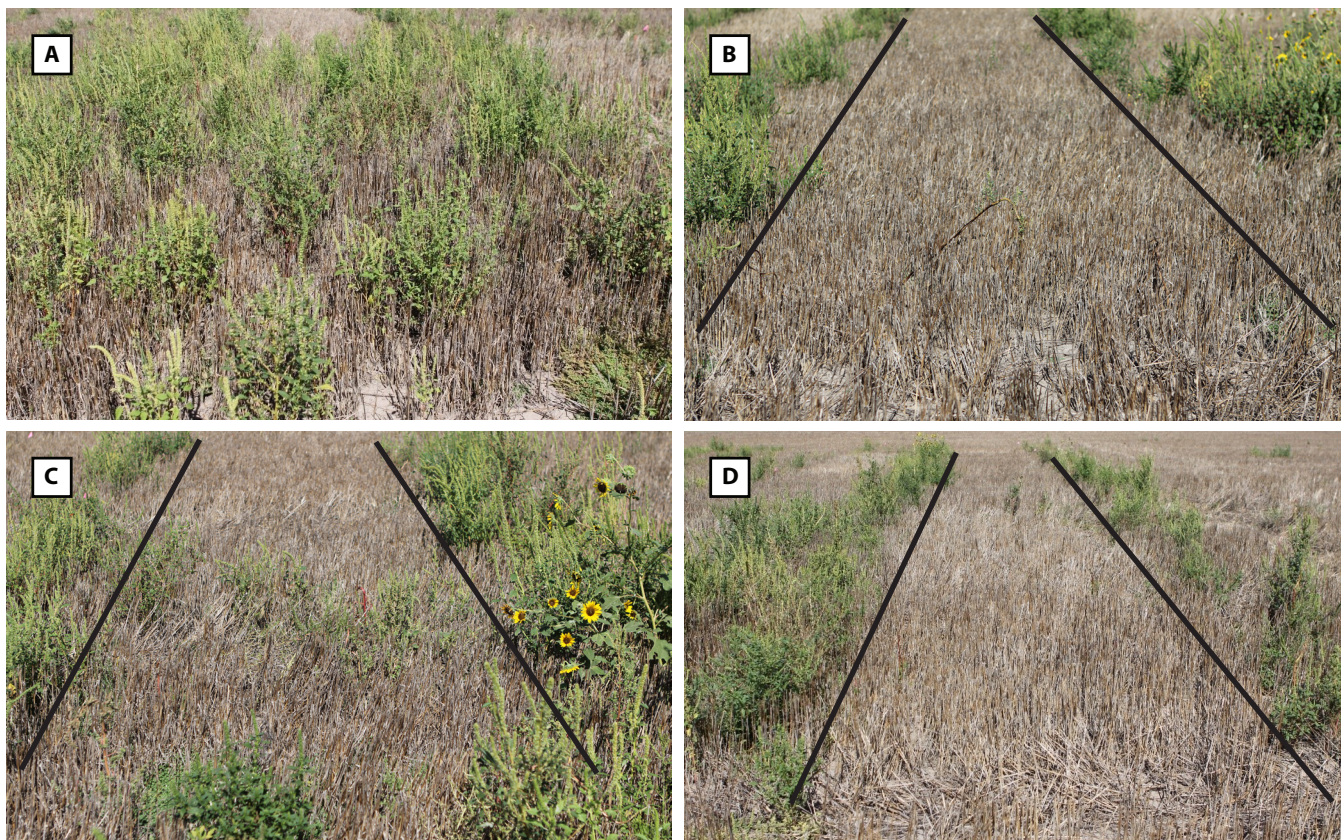


Figure 2. Palmer amaranth control in postharvest wheat stubble at 8 WAT: A) Nontreated; B) Gramoxone alone; C) Kochiavore; and D) Liberty + Clarity + Roundup PowerMax.

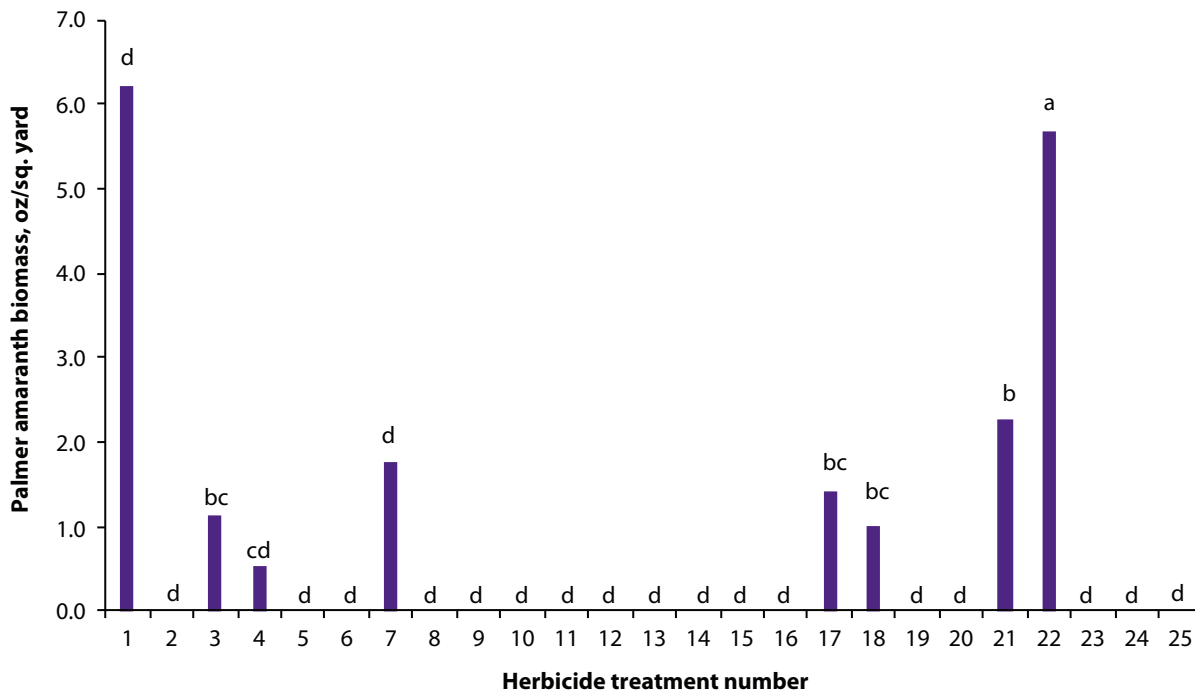


Figure 3. Effect of late-season herbicide programs on Palmer amaranth shoot biomass at 8 weeks after treatment in postharvest wheat stubble.

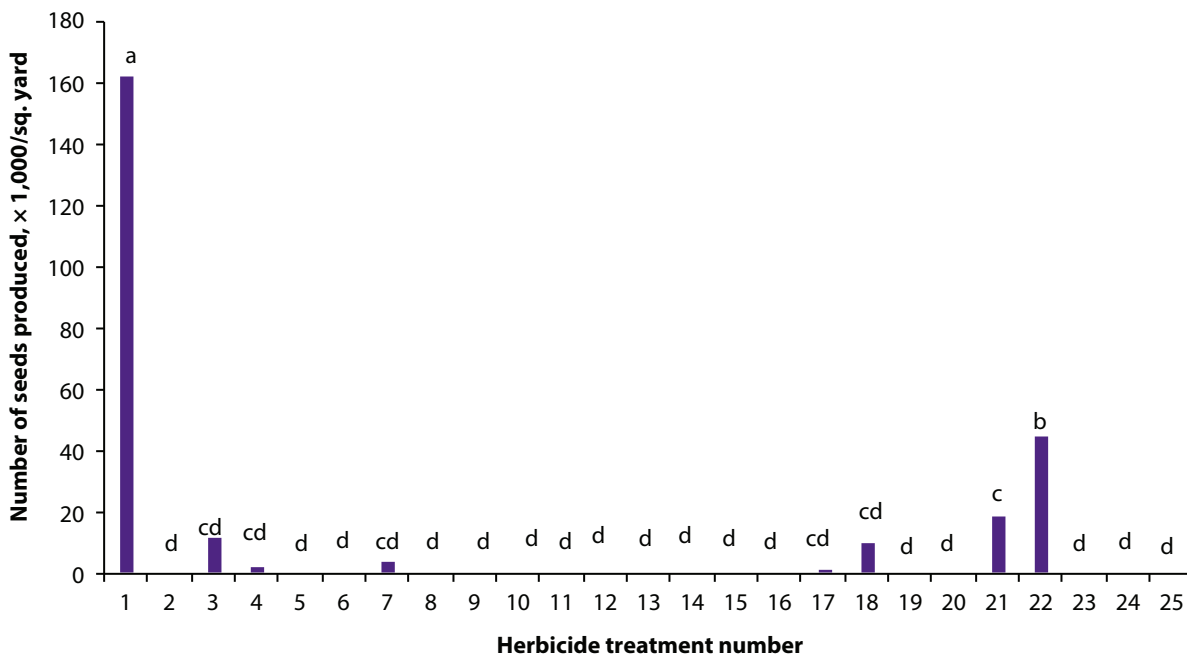


Figure 4. Effect of late-season herbicide programs on Palmer amaranth seed production in postharvest wheat stubble.