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Auxinic Herbicide Mixtures for Controlling Multiple Herbicide-Resistant Kochia in Fallow

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Auxinic Herbicide Mixtures for Controlling Multiple Herbicide-Resistant Kochia in Fallow

Abstract

Kochia resistant to glyphosate (Roundup), chlorsulfuron (Glean), and dicamba (Banvel or Clarity) has become quite common in the U.S. Great Plains, whereas multiple resistance to additional herbicides, including fluroxypyr (Starane Ultra), atrazine (AAtrex), and metribuzin (Sencor) has also been reported recently. Effective management of these multiple herbicide-resistant (MHR) kochia populations warrants the need of alternative herbicide strategies. The main objective of this research was to investigate the efficacy of auxinic herbicides, including Duplosan (dichlorprop-p), Weedone (2,4-D), Clash (dicamba), and/or Pixxaro (premix of halauxifen and fluroxypyr) alone or in various combinations for controlling MHR kochia. Separate greenhouse and field experiments were conducted at the Kansas State University Agricultural Research Center (KSU-ARC) in Hays, KS. Greenhouse studies included an MHR kochia population (resistant to glyphosate, dicamba, fluroxypyr, chlorsulfuron, atrazine, and metribuzin) from Garden City, KS, and a susceptible (SUS) kochia population from Hays, KS. The postemergence (POST) applied herbicide programs, including Clash Weedone, Duplosan alone or in tank-mix combinations were tested. Field experiments were conducted in a fallow field at KSU-ARC with a natural infestation of kochia population with multiple resistance to glyphosate and dicamba. Herbicides, including Duplosan, Weedone, Clash, and Pixxaro were tested alone or in tank-mix combinations. Results from greenhouse study indicated that Clash, Duplosan, and Weedone applied alone provided inadequate control (5 to 42%) of MHR kochia at 21 days after treatment (DAT). In contrast, control of SUS population was 83 to 92% with Clash and Duplosan alone treatments. Tank-mixing Duplosan with Clash and/or Clash + Weedone significantly improved visible control (72 to 90%) of MHR kochia as compared to Duplosan, Clash, or Weedone alone treatments. Similarly, tank-mixing Clash to Duplosan or Pixxaro (two-way mixtures) and to Duplosan + Weedone, Pixxaro + Duplosan or Pixxaro + Weedone (three-way mixtures), provided an excellent control (91 to 97%) of MHR kochia compared to Clash, Pixxaro, Weedone, and Duplosan alone treatments in a field study. Altogether, these results suggest that tankmixing Clash with Duplosan and/or Pixxaro can potentially provide synergistic effect in controlling MHR kochia in fallow fields.

Keywords

auxinic herbicides; fallow; kochia; multiple herbicide resistance; POST herbicides

Authors

V. Kumar, T. Lambert, R. Liu, R. S. Currie, and P. W. Stahlman

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Summary

Kochia resistant to glyphosate (Roundup), chlorsulfuron (Glean), and dicamba (Banvel or Clarity) has become quite common in the U.S. Great Plains, whereas multiple resistance to additional herbicides, including fluroxypyr (Starane Ultra), atrazine (AAtrex), and metribuzin (Sencor) has also been reported recently. Effective management of these multiple herbicide-resistant (MHR) kochia populations warrants the need of alternative herbicide strategies. The main objective of this research was to investigate the efficacy of auxinic herbicides, including Duplosan (dichlorprop-p), Weedone (2,4-D), Clash (dicamba), and/or Pixxaro (premix of halauxifen and fluroxypyr) alone or in various combinations for controlling MHR kochia. Separate greenhouse and field experiments were conducted at the Kansas State University Agricultural Research Center (KSU-ARC) in Hays, KS. Greenhouse studies included an MHR kochia population (resistant to glyphosate, dicamba, fluroxypyr, chlorsulfuron, atrazine, and metribuzin) from Garden City, KS, and a susceptible (SUS) kochia population from Hays, KS. The postemergence (POST) applied herbicide programs, including Clash Weedone, Duplosan alone or in tank-mix combinations were tested. Field experiments were conducted in a fallow field at KSU-ARC with a natural infestation of kochia population with multiple resistance to glyphosate and dicamba. Herbicides, including Duplosan, Weedone, Clash, and Pixxaro were tested alone or in tank-mix combinations. Results from greenhouse study indicated that Clash, Duplosan, and Weedone applied alone provided inadequate control (5 to 42%) of MHR kochia at 21 days after treatment (DAT). In contrast, control of SUS population was 83 to 92% with Clash and Duplosan alone treatments. Tank-mixing Duplosan with Clash and/or Clash + Weedone significantly improved visible control (72 to 90%) of MHR kochia as compared to Duplosan, Clash, or Weedone alone treatments. Similarly, tank-mixing Clash to Duplosan or Pixxaro (two-way mixtures) and to Duplosan + Weedone, Pixxaro + Duplosan or Pixxaro + Weedone (three-way mixtures), provided an excellent control (91 to 97%) of MHR kochia compared to Clash, Pixxaro, Weedone, and Duplosan alone treatments in a field study. Altogether, these results suggest that tank-mixing Clash with Duplosan and/or Pixxaro can potentially provide synergistic effect in controlling MHR kochia in fallow fields.

Introduction

Multiple herbicide-resistant (MHR) kochia is an ever-increasing challenge for producers in the U.S. Great Plains, including Kansas (Kumar et al., 2019). The wide-

spread resistance to glyphosate and acetolactate synthase (ALS) inhibiting herbicides has been reported among kochia populations in the region (Heap, 2021). Growers are relying extensively on dicamba applications (both preemergence and POST) for controlling glyphosate and ALS inhibitor-resistant kochia. Unfortunately, dicamba resistance in kochia populations has also been evident in several states in the region (Kumar et al., 2019; LeClere et al., 2018). In addition to glyphosate, ALS inhibitors, and dicamba resistance, multiple resistance to fluroxypyr, atrazine, and metribuzin has also been reported in a single kochia population in western Kansas (Kumar et al., 2021). Increasing cases of MHR kochia populations in the region warrant implementation of alternative herbicide strategies for their effective management. The main objective of this research was to investigate the effectiveness of auxinic herbicides, including Duplosan, Weedone (2,4-D), Clash (dicamba), and/or Pixxaro (halauxifen + fluroxypyr) herbicides alone or in various combinations for controlling MHR kochia.

Procedures

Greenhouse Study

A greenhouse study was conducted at the KSU-ARC in Hays, KS, by using an MHR kochia population (resistant to glyphosate, dicamba, fluroxypyr, chlorsulfuron, atrazine, and metribuzin) from Garden City, KS, and a susceptible (SUS) population from the Hays research farm. Kochia plants from both populations were grown in 4-inch square plastic pots containing commercial potting mixture under greenhouse conditions. Actively growing kochia plants (3- to 4-inch tall) from both populations were separately treated with Clash (8 fl oz/a), Weedone (8.5 fl oz/a), Duplosan (16 fl oz/a) alone or in tank-mix combinations using a cabinet spray chamber. All herbicide treatments included a nonionic surfactant (NIS) at 0.25% v/v. Data on percent control of MHR and SUS plants were visually assessed at 21 days after treatment (DAT). The shoot dry biomass of each treated plant was also determined at 21 DAT.

Field Study

A field study was conducted in the 2020 growing season at KSU-ARC in a fallow field (soybean stubble) with natural infestation of a kochia population resistant to glyphosate and dicamba. The study was laid out in a randomized complete block design with 4 replications. Each plot size was 10-ft wide × 30-ft long. Herbicide programs, including Duplosan (16 fl oz/a), Weedone (16 fl oz/a), Clash (16 fl oz/a), and Pixxaro (6 fl oz/a) were tested alone or in various tank-mix combinations (2- or 3-way). All herbicide treatments were applied to 3- to 4-inch tall kochia plants using a CO_2-operated backpack sprayer equipped with AIXR 110015 nozzles. All treatments included nonionic surfactant (NIS) at 0.25% v/v. Data on kochia control were visually assessed at biweekly intervals throughout the growing season.

Statistical Analyses

All data collected in the greenhouse and field studies were subjected to analysis of variance (ANOVA) using PROC MIXED in SAS 9.3 (SAS Inst. Inc., Cary, NC). Means were separated using Fisher's protected LSD test ($\alpha = 0.05$).

Results

Greenhouse Study

Results indicated that Clash, Duplosan, and Weedone applied alone provided inadequate control (5 to 42%) of MHR kochia at 21 DAT (Figure 1A). In contrast, the Clash and Duplosan alone treatments provided 83 to 92% control of SUS population. Tank-mixing Duplosan with Clash and/or Clash + Weedone provided 72% to 90% control of MHR kochia as compared to the Duplosan, Clash or Weedone alone treatments (Figure 1A). Consistent with visible control, tank mixture of Duplosan + Clash or Duplosan + Clash + Weedone significantly reduced shoot dry biomass of MHR kochia (Figure 1B).

Field Study

Results from the field study also indicated that control of MHR kochia with Clash, Pixxaro, Weedone, or Duplosan alone treatments was inadequate (10 to 66%) throughout the growing season (Figure 2). However, tank-mixing Clash with Duplosan or Pixxaro (two-way mixtures), and to Duplosan + Weedone, Pixxaro + Duplosan or Pixxaro + Weedone (three-way mixtures), provided an excellent control (91 to 97%) of MHR kochia at 6 and 9 weeks after treatment (WAT) (Figure 2 and 3). Control of MHR kochia with all other tank-mix combinations (both two and three ways) was moderate and ranged from 53 to 81% at 6 and 9 WAT (Figure 2).

Conclusions

Results from these studies suggest that tank-mixing Clash with Duplosan, Pixxaro, Duplosan + Pixxaro, Duplosan + Weedone, or Pixxaro + Weedone can potentially provide synergistic effects in controlling MHR kochia in fallow fields.

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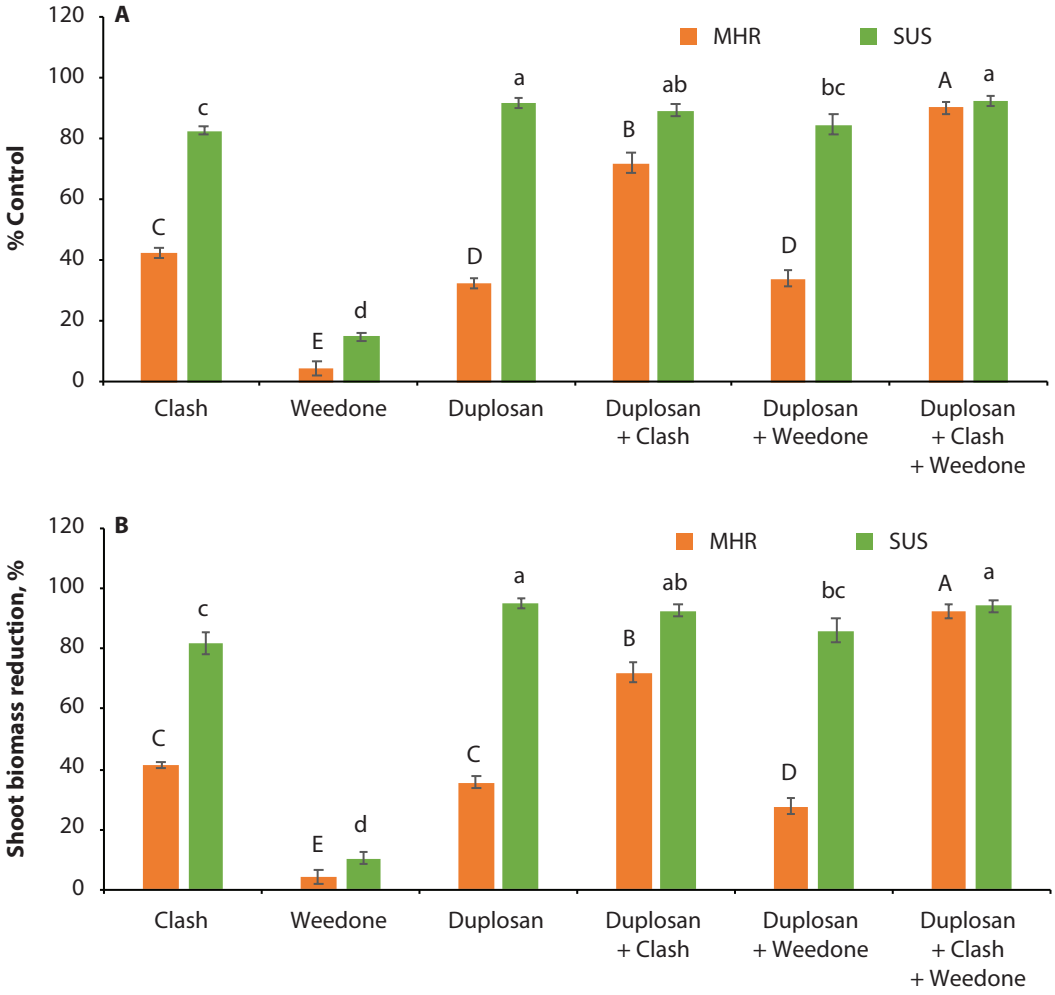

Figure 1. Multiple herbicide-resistant (MHR) and susceptible (SUS) kochia control (A) and shoot dry biomass reduction (B) 21 days after treatment with Duplosan, Clash, and Weedone alone or in tank-mix combinations at the K-State Agricultural Research Center in Hays, KS. Means for SUS population followed by similar lowercase letters are not significantly different based on Fisher's protected LSD test at $P < 0.05$; means for MHR population followed by similar uppercase letters are not significantly different based on Fisher's protected LSD test at $P < 0.05$.

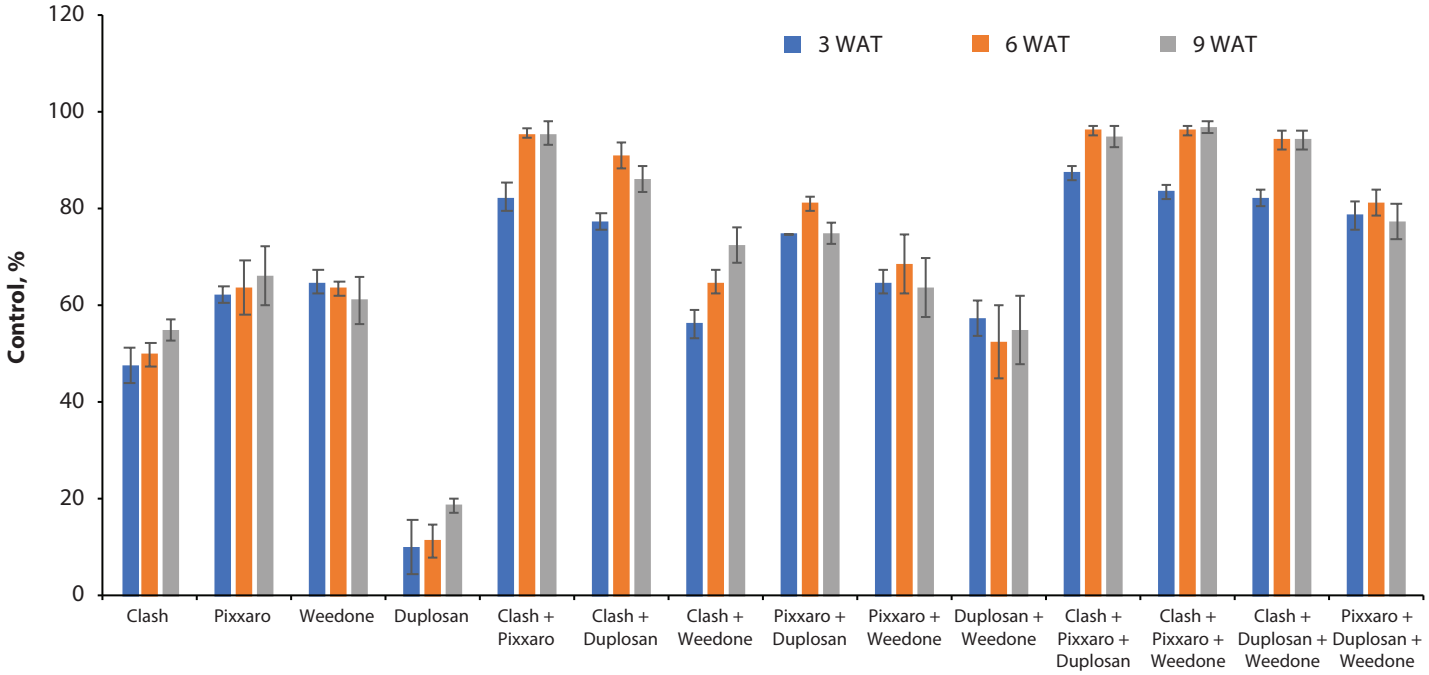

Figure 2. Multiple herbicide-resistant (MHR) kochia control with Clash, Pixxaro, Weedone, and Duplosan alone or in various tank-mix combinations at 3, 6, and 9 weeks after treatment (WAT) in fallow at K-State Agricultural Research Center in Hays, KS.

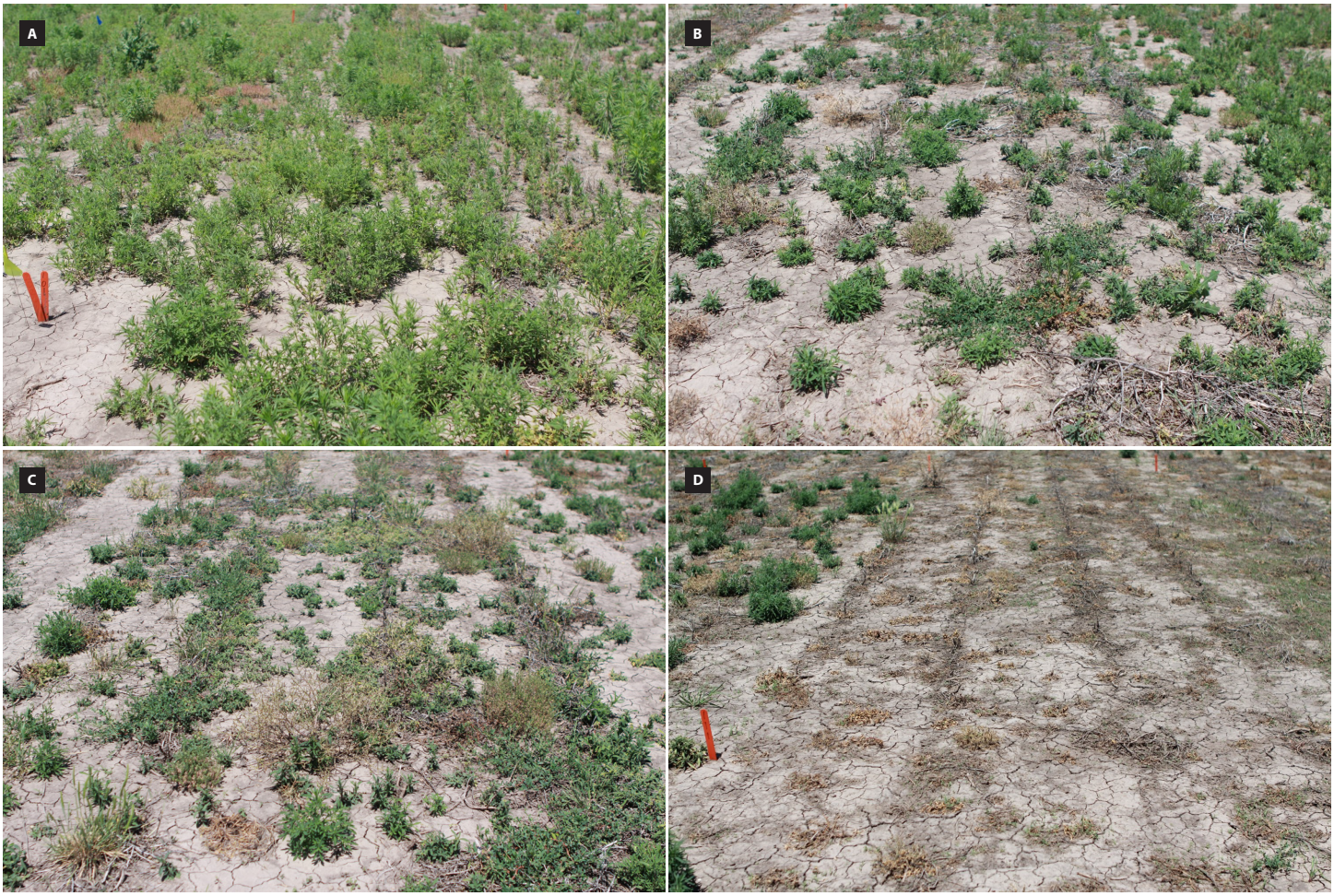

Figure 3. Multiple herbicide-resistant (MHR) kochia control at 6 weeks after treatment (WAT) in fallow field at the K-State Agricultural Research Center in Hays, KS: Nontreated weedy check (A), Duplosan (B), Pixxaro (C), and Clash + Duplosan + Weedone (D).