Use of HPPD-inhibiting Herbicides for Control of Troublesome Weeds in the Midsouthern United States

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Abstract

Transgenic crops provide cotton and soybean producers additional weed control options for many of the most problematic weeds in midsouthern United States (U.S.). production systems. The expected commercialization of 4-hydroxyphenylpyruvate dioxygenase (HPPD)-resistant soybean in 2017 and cotton in 2020 will provide producers the option to apply HPPD-inhibiting herbicides that will offer an alternative mechanism of action for previously hard-

herbicides applied preemergence (PRE) or postemergence (POST) for control of problematic weeds of cotton and soybean in the mid southern US. PRE experiments were conducted to understand the length and degree of control of Palmer amaranth and barnyardgrass that could be expected with HPPD-inhibiting herbicides compared with current standards on silt loam and clay soil textures. The HPPD herbicides evaluated included mesotrione,

herbicides combined with glyphosate or glufosinate were evaluated for control of Palmer amaranth, barnyardgrass, hemp sesbania, and yellow nutsedge. When herbicides were applied PRE, the HPPD-inhibiting herbicides and the current standard treatments all provided greater than 90% control of Palmer amaranth 4 weeks after treatment (WAT) on both soil textures. Barnyardgrass control with HPPD-inhibitors was generally weaker than the current

experiment, all treatments, except for glyphosate alone, provided excellent (>85%) control of Palmer amaranth less than 10-cm in height. Barnyardgrass, yellow nutsedge, and hemp sesbania were effectively controlled with HPPD-inhibiting herbicides with and without glufosinate or glyphosate.

Keywords: HPPD-inhibiting herbicides; Preemergence; Postemergence; Tank-mix

Introduction

Options for weed control in midsouthern U.S. crops were broadened with the introduction of transgenic crops, speci cally glyphosate-resistant soybean and cotton in 1996 and 1997, respectively. e adoption of glyphosate-resistant crops came with a dramatic shi in herbicide use patterns, most notably the almost sole reliance on glyphosate [1]. Glyphosate is a non-selective herbicide that inhibits the 5-enolpyruvylshikimate-3-photsphate synthase (EPSPS) within a plant. Producers were allowed to apply up to 3.3 kg ae ha^{-1} yr^{-1} over multiple application timings [2]. Due to the fact that glyphosate applications are cheap, e ective, and simple [3], applications were being made multiple times per year in cotton and soybean and thus replaced tank mixtures of herbicides, tillage, and residual herbicides in the late 1990s and early 2000s [1,4,5]. Extens(a)8.9(m)45a(a)19()4(hi5(xt ex(iminT[u)-5(h)19(n)8(s(a)8.cide u)3(s)12(n o)12(f g)-6.1(l))13minyp)7(h)4(os)-6(a)19(tc a)9(r)4(os)

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plant at application [15,16]. Applications of glufosinate on both hemp sesbania and yellow nutsedge have proven very effective [16,17].

Barnyardgrass is a problematic weed due to its ability to germinate and grow under a wide variety of conditions [18]. It has been predicted that barnyardgrass will eventually evolve resistance to glyphosate [19]. The addition of HPPD-resistant cotton and soybean could be an additional tool that can be used to combat weed resistance. The weed spectrum shift caused by glyphosate-resistant crops has affected the entire southern US. where cotton and soybean are two of the principle crops [20]. The objectives of this research were to evaluate alternative options in the use of HPPD-inhibiting herbicides for crops likely to be labeled in the near future. This research also aims to explore the most efficient method of application to control four of the most troublesome weeds in Arkansas: Palmer amaranth, barnyardgrass, hemp sesbania, and yellow nutsedge.

Materials and Methods

Length and degree of control with pre-applied HPPD-inhibiting herbicides compared to current herbicide standards

Experiments were conducted during the summers of 2010 and 2011 to determine the length of residual control with HPPD-inhibiting herbicides compared to the current PRE-applied herbicides commonly used in midsouthern US. soybean production systems. Experiments were conducted at the University of Arkansas Northeast Research and Extension Center (NEREC) in Keiser, AR in 2010 on a Sharkey (very fine, smectitic, thermic Chromic Epiaquerts, pH 6.5, OM 3.8%) and 2011 on a Sharkey-Steele (very fine, smectitic, thermic Chromic Epiaquerts, pH 6.7, OM 3.3%). Experiments were also conducted at the University of Arkansas Agricultural Research and Extension Center (AAREC) in Fayetteville, AR in 2010 on a Captina silt loam (fine-silty, siliceous, active, mesic, Typic Fragiudults, pH 6.4, OM 1.8%), in 2011 on a Johnsburg silt loam (fine-silty, mixed active, mesic, Aquic Fragiudults, pH 6.5, OM 1.4%), and in 2011 at the University of Arkansas Pine Tree Branch Experiment Station (PTBES) near Colt, AR on a Calloway silt loam (fine-silty, mixed active thermic Aquic Fraglossudalfs, pH 6.5, OM 2.2%). Soil samples from the top 10 cm were analyzed from all locations to determine soil properties on all five experimental sites (Table 1). Soil organic matter (OM) was determined using loss on ignition [21].

Experiments conducted in 2010 and 2011 at the AAREC and in with 0 being no plant injury and 100 complete control. Weed control in plots was rated weekly for 8 to 10 weeks a er application, which is the length of time generally needed for soybean and cotton to achieve a dense crop canopy [22-24]. Barnyardgrass and Palmer amaranth seedlings m^{-2}

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Results and Discussion

Length and degree of control with pre-applied HPPD-inhibiting herbicides compared to current herbicide standard

The effect of year and location and their interaction with herbicide was non significant for Palmer amaranth and barnyardgrass control

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to 7.5 cm. Reduced activity of glufosinate on small Palmer amaranth

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