SIMULATING THE EVOLUTION OF GLYPHOSATE-RESISTANT BARNYARDGRASS IN MIDSOUTH COTTON: KEY MANAGEMENT CONSIDERATIONS

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Abstract

Barnyardgrass (*Echinochloa crus-galli*) is the most troublesome grass weed in Midsouth cotton fields. Historically, barnyardgrass has exhibited a high tendency for evolving herbicide resistance, and is the sixth most important herbicide-resistant weed worldwide. In Midsouth rice, resistance has been confirmed for a number of herbicides, including propanil, quinclorac, clomazone, and imazethapyr. Glyphosate-resistant barnyardgrass is likely to evolve in glyphosate-resistant cotton, and proactive measures are important to prevent such a situation. A simulation model was developed to 1) understand the risk of glyphosate resistance evolution in barnyardgrass in Midsouth cotton and 2) devise strategies for preventing/delaying resistance. The model was implemented in the visual programming language STELLA. For each management scenario, 1000 model runs were performed for a 30-year period. Resistance is considered to have evolved if >20% of the barnyardgrass seedbank is comprised of resistant individuals. The model accounts for shifts in historical weed management programs in predicting the risks of glyphosate resistance. Under a worst-case scenario of five annual glyphosate applications since the adoption of Roundup Ready™ cotton in a continuous cotton culture, resistance evolves only in nine years with a 20% risk by year 11. If POST residual herbicides were tank mixed with glyphosate for directed application in Roundup Ready™ cotton and subsequently shifted to a glyphosate-only program in Roundup Ready Flex™ cotton, there was a great reduction in resistance risk (10% by year 15) compared to the glyphosate-only program, but the risk was still substantial. A diversified herbicide rotation [fomesafen (pre-plant) fb paraquat + fluometuron (at planting) fb glyphosate +*S*-metolachlor (1st, 2nd POSTs) fb glyphosate + prometryn (3rd POST) fb MSMA + flumioxazin (layby)] was widely recommended for controlling glyphosate-resistant Palmer amaranth in Midsouth cotton. The risk of glyphosate-resistant barnyardgrass is greatly reduced if growers had adopted the diversified herbicide rotation. The model was subsequently used to perform Monte-Carlo simulations to understand how various cultural/management strategies influence the rate and risk of glyphosate resistance evolution in barnyardgrass. Advancing cotton planting is a valuable strategy because the majority of barnyardgrass recruits are affected by competition from well-established cotton crop. Where possible, inter-row cultivation is an effective option to eliminate weed escapes in the inter-row space. Rotating cotton with corn (glyphosate-resistant or glufosinate-resistant) can greatly delay resistance with a greater reduction in risk compared to monoculture cotton, but the diversity of barnyardgrass management options adopted in the rotational crop is more important than rotation *per se*. Additionally, application timing and the choice of management option are critical, because the key to preventing herbicide resistance is to prevent weed escapes. Although herbicide rotations are helpful in herbicide resistance management in a short-run, they do not address metabolism-based resistance nor are they preferable in every situation. A sustainable resistance management program will aim at utilizing every available weed management tool.