LEARNINGS FROM SIMULATION MODELS FOR GLYPHOSATE-RESISTANCE MANAGEMENT IN MIDSOUTH COTTON-BASED PRODUCTION SYSTEMS

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Abstract

Glyphosate resistance is a serious threat confronting the sustainability of Misouth cotton-based production systems. Glyphosate-resistant Palmer amaranth populations are already widespread in this region, and barnyardgrass, an important grass weed in this system, is considered to be a high risk species for evolving glyphosate resistance. Simulation models were developed to understand glyphosate resistance in Palmer amaranth and barnyardgrass to address these issues. The model outputs are used to illustrate some important principles for preventing, delaying, or managing resistance. The key principles include, but are not limited to, a) minimize soil seedbank, b) understand seedling recruitment, c) reduce weed escapes, d) diversify management approaches, and e) consider evolutionary implications. The risk of resistance is low when initial seedbank densities are low, because the number of resistant mutants in a population is directly proportional to the seedbank size. Model outputs show that the risk of resistance is low with high post-dispersal seed loss and with high annual seedbank loss. Growers should employ at-harvest and post-harvest management practices to prevent seed return to the seedbank. The risk of resistance is high with high seedling recruitment proportion. Weeds that exhibit extended emergence pattern particularly pose greater threats; high recruitment favors resistant individuals to germinate and reproduce, rather than being lost due to seedbank mortality processes. Growers should consider adopting deep tillage, cover crops, or establish plant residue cover to suppress weed seedling recruitment. Preventing weed escapes is crucial to preventing herbicide resistance evolution. Early-season weed escapes, particularly escapes prior to crop canopy formation, greatly contribute to resistance evolution due to high levels of fecundity. Overlaying soil residual herbicides are highly valuable in minimizing weed escapes, but application timing and timely activation are critical. Rotation of herbicides/herbicide traits can tremendously delay resistance, but they may not be sufficient or desirable in every situation. Employ all possible weed management tools to reduce selection for a given management option. Herbicide resistance in an evolutionary process and the evolutionary implications should be considered at a production system level. For instance, crop rotation is an important tactic and growers should effectively utilize the opportunities provided by the rotational crop(s) in minimizing the seedbank population of resistant individuals through employment of alternative herbicide mechanisms of actions and other non-chemical tactics. More importantly, growers should also aim at preventing propagule (seed/pollen/vegetative parts) immigration from other populations, because immigration of resistance alleles can greatly favor rapid evolution of resistance.