Weed Resistance Risk Management in Glyphosate-Resistant Cotton

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Abstract

The introduction of glyphosate tolerance into Australian cotton systems will have an effect on conventional weed management practices, the weed species present and the risk of resistance to glyphosate evolving in weed species. It is therefore important that the effects of these management practices, particularly a potential reduction in Integrated Weed Management (IWM) practices be examined to determine their impact on weed population dynamics and resistance selection.

The study started with a survey of 40 growers in four major cotton growing regions in Australia in 2003, to gain an understanding of how glyphosate tolerance had affected the weed spectrum, weed management practices and herbicide use after three years of glyphosate tolerance being available. The 10 most common weeds reported on cotton fields were the same in glyphosate tolerant and conventional fields in this survey Herbicide use patterns were altered by the adoption of glyphosate tolerant cotton with up to six times more glyphosate, but 21% fewer growers applied pre-emergence herbicides in glyphosate-tolerant fields. Other weed control practices such as the use of post-emergence herbicides, inter-row cultivation and hand hoeing were only reduced marginally.

A systems experiment was conducted to determine the population dynamics of barnyardgrass and liverseed grass under a range of weed management regimes in a glyphosate tolerant system. These treatments ranged from a fully IWM system to using glyphosate only. The experiment investigated the effect of the treatments on the soil seedbank, germinations and weed numbers in the field. All treatments resulted in commercially acceptable control of the two grass weeds. However the soil applied

residual herbicides proved to be more effective over the period of the experiment. The treatment with a reduced residual herbicide program with glyphosate had a similar level of control to the full IWM treatments with less input, providing a more economic option. The effectiveness these treatments in the long-term were examined in a simulation model to determine the likelihood of glyphosate resistance evolving using barnyardgrass and liverseed grass as model weeds.

The seed producing capabilities and above ground biomass of barnyardgrass and liverseed grass were examined. In all experiments seed production and biomass plant^{-1} decreased as weed density increased while seed production and biomass m^{-1} tended to increase. Seed production m^{-1} reached 40,000 and 60,000 for barnyardgrass and liverseed grass, respectively. In 2004-05 weeds were also planted 6 weeks and 12 weeks after the cotton was planted. The later planting date significantly reduced biomass and seed production of the two weeds with seed production declining to 12,000 and 2,500 seeds m^{-1} row for barnyardgrass and liverseed grass. Weeds planted 12 weeks after cotton planting failed to germinate. This experiment highlighted the importance of early season weed control and effective management of weeds that are able to produce high seed numbers.

A glyphosate dose-mortality experiment was conducted to determine levels of control on barnyardgrass and liverseed grass. Glyphosate provided effective control of both species with over 85% control when the rate applied was above 690 g ae ha^{-1}. Dose-mortality curves for both species were obtained for use in the glyphosate resistance model.

Data from experiment was combined to develop a glyphosate resistance model. Outputs from this model show that if glyphosate was used alone, resistance would occur after 12-17 years, depending on the characteristics of the weed species, initial resistance gene frequencies and any associated fitness penalties. If glyphosate was used in conjunction with one other weed control method, resistance was delayed, but not prevented. The simulations showed that when a combination of weed control options was employed in addition to glyphosate, resistance would not evolve over the 30-year period of the

simulation. These simulations underline the importance of an integrated strategy in weed management to prevent glyphosate resistance evolving from the use of glyphosate tolerant cotton. Current management conditions of growing Roundup Ready® cotton crops should therefore prevent glyphosate resistance evolution.