Managing the Risk of Glyphosate Resistant Weeds

February 18, 2008

Glyphosate resistant (GR) weeds have been the focus of much debate since the introduction of Roundup Ready crops in the mid 1990's. Initially the questions focused on whether GR weeds would actually develop, but this quickly changed to how to prevent their selection following their rapid appearance after the introduction of Roundup Ready crops. Evaluating the relative effectiveness of different resistance management strategies is difficult due to the both the low frequency of GR within native weed populations, and the variety of selection pressures placed on weeds during the time frame required for resistance to evolve. Modeling is one way that resistance management tactics can be evaluated, and several papers have been published recently based on these research tools. This article will briefly summarize results of a few of these papers.

Dave Stoltenberg at the University of Wisconsin has run a field experiment for eight years evaluating changes in weed communities under regimes with different levels of reliance on glyphosate (Stolenberg 2008). While resistance hasn't appeared in this experiment, he was able to calculate the probability of resistance based on the number of weeds exposed to glyphosate and the biological characteristics of the different weed species found in the experimental area. It was assumed that glyphosate occurred at an initial frequency of 1×10^{-10} at the initiation of the experiment (i.e. prior to the use of glyphosate, one in every 10 billion individuals within a species would contain a trait providing resistance to glyphosate).

As expected, management systems relying only on glyphosate had higher risks of selecting GR weeds than other systems (Table 1). The relative effectiveness of the resistance management tactics {annual rotation of glyphosate and non-glyphosate herbicides vs annual inclusion of an alternative mode of action with glyphosate} varied depending upon characteristics of the weed species. Annual use of PRE applications of metolachlor in combination with POST glyphosate applications did not affect the probability of GR in velvetleaf compared to glyphosate alone since metolachlor has little

Table 1. Relative probability of appearance of GR weeds in a conventional till corn-soybean rotation with different weed management systems.

Weed management system	Redroot pigweed	Common lambsquarters	Velvetleaf
1. Glyphosate POST	21 c	5 b	2 b
2. Glyphosate Early POST + Late POST	55 d	3 ab	2 b
3. Glyphosate POST in soybean, non-glyphosate herbicides in corn	5 b	1 a	1 a
4. Metolachlor fb glyphosate POST	1 a	1 a	2 b
Means within column followed by same letter do not differ significantly.			

activity on velvetleaf. Other research has shown that alternative modes of action must provide highly effective control of a weed in order to reduce the likelihood of GR. Annual rotation away from glyphosate was equal to the use of metolachlor in managing GR risk in lambsquarters, but in pigweed rotation of herbicide chemistries resulted in five times greater risk of GR than the use of metolachlor. Thus, different tactics were better at managing GR in different weed species.

A group of Australian scientists evaluated risks of GR weeds in Roundup Ready cotton (Werth et al. 2008). As with the WI study, they found the effectiveness of adding a preemergence herbicide to a glyphosate based system varied among weed species based on the weeds sensitivity to the herbicide. They also reported that when weed pressures are low, or the initial frequency of resistance is 1×10^{-8} or less, the incorporation of a single weed control option may be suitable for resistance prevention. I believe one of the reasons that GR weeds are less of an issue in Iowa than in states to our east is that most Iowa fields have lower weed populations than those in the eastern Cornbelt. This can be attributed partially to better management by Iowa farmers and the fact that controlling weeds is easier here due to lower rainfall amounts than in the eastern Cornbelt (*I'd like to say that Iowa has better Extension Weed Scientists that Ohio and Indiana, but I know better than that*).

Finally, a scientist from Monsanto reported results of the HERMES model in predicting GR evolution (Gustafason, 2008). The relative benefit of including a resistance management tactic every third year of a cropping system relying on glyphosate resistant crops was evaluated. Rotating away from glyphosate every third year was slightly more effective (~2 to 8 years) than including an alternative herbicide in delaying the onset of resistance in two different weed species. Gustafson stressed that glyphosate has a lower potential for resistance evolution than other herbicides due to both its low initial frequency within weed populations and also the relatively low level of resistance provided by the GR mechanisms compared to resistance mechanisms to other herbicides (e.g. triazines and ALS inhibitors).

In summary, while the likelihood of GR is much less likely than resistance to other commonly used herbicides, current use patterns of glyphosate are creating a real threat in terms of the appearance and spread of GR weeds. For most farmers, the resistance management tactics most likely to be incorporated into weed management systems are either herbicide rotation or inclusion of alternative modes of action. The relative value of these two tactics varies depending upon the characteristics of the specific weed species investigated and the relative effectiveness of the alternative herbicide. Alternative herbicides rarely, if ever, are as broad spectrum as glyphosate. Thus, there will be some species in which the use of alternative herbicides provides little benefit in managing resistance – this is especially true if below-label rates are used due to the planned POST application of glyphosate. For this reason, a combination of these two tactics will provide the greatest protection for preventing the appearance of glyphosate resistant weeds.

References

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