Recent and Future Soybean Traits That Impact Weed Management

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Abstract

The performance of glyphosate in soybean has declined in recent years as a result of weed species shifts and the progressive increase in the occurrence of glyphosate-resistant weed species. Over the next five years, several new transgenic soybean traits are planned for release that will encode for resistance to herbicides that serve as new tools for soybean weed management. The herbicide-resistant soybean traits include Liberty Link (glufosinate herbicide), Optimum GAT (certain sulfonylurea herbicides); Dow Herbicide Tolerant (2,4-D herbicide); Dicamba Tolerant (dicamba herbicide), and HPPD Tolerant (isoxaflutole herbicide). In most instances these traits represent the opportunity to utilize herbicide modes-of-action that were previously not possible in soybean; allowing for more effective control of today's problematic weed species, including glyphosate-resistant weeds. However, all of these technologies will rely on an integrated weed management strategy with a focus on residual herbicides and postemergence applications to weeds less than four inches in height to ensure robust weed control.

Introduction

The commercial popularity of glyphosate-resistant crop production and the subsequent blanketing of corn and soybean acres with glyphosate applications go without saying. Furthermore, we are all too familiar with the fact that a large portion of these fields have relied solely on glyphosate for weed management, especially in soybean, which has contributed to a shift towards more difficult-to-control weed species and glyphosate-resistant weeds species (Johnson et al. 2009). Some of the most problematic weed species in the Midwest include marestail, giant ragweed, common lambsquarters, common waterhemp, and annual morningglory species. The ineffectiveness of glyphosate compounded with the possibility of multiple resistance to other herbicide modes of action in some weed species creates an extremely challenging, time-consuming, and costly weed management scenario. In some instances where glyphosate has failed, herbicide programs have cost in excess of $70 per acre in soybean while risking a loss in soybean yield due to incomplete control throughout the growing season. No new herbicide modes of action will be on the market for use in corn or soybean in the foreseeable future. Instead, the new options for weed management will come from the commercialization of new soybean traits that allow for herbicides to be used in soybean production that were previously not possible.

Liberty Link Soybean

Soybeans resistant to glufosinate (Ignite, Liberty) herbicide were sold commercially for the first time in 2009 (Allen and Fischer 2008). The positive attributes that glufosinate brings to weed management in soybean are that the herbicide has a unique mode of action

(inhibits glutamine synthetase) compared with any other herbicide, and glufosinate provides foliar control of a wide spectrum of grass and broadleaf weed species. No weed species has evolved resistance to glufosinate to date; yet the same was true of glyphosate when RR1 soybeans were first introduced, so we must not over-rely on glufosinate if we want to preserve the herbicide as a weed management tool. Glufosinate has relatively fast activity and very little translocation within plants and, thus, should be considered largely non-systemic, which means the activity is best on annual weed species rather than perennials. Furthermore, the non-systemic activity also results in glufosinate having less effective control of large grass species and overall having optimal efficacy on weed species that are four inches in height or less. Glufosinate should prove useful for improving control of several problematic weeds species, but the strengths of glufosinate may be for controlling marestail, giant ragweed, and annual morningglory.

Roundup Ready 2 Yield Soybean

The Roundup Ready 2 Yield soybeans that were first commercialized in 2009 by Monsanto have the same gene that allows for resistance to glyphosate as the initial glyphosate-resistant soybean (RR1) sold in 1996. The only difference between the two is the actual gene insertion event, which means these new soybeans really don't contribute anything further for improved weed management beyond the previous RR1 soybeans. The new RR2Yield trait was commercialized primarily for the potential to realize greater soybean yield compared with RR1 soybeans.

Optimum GAT Soybean

Optimum GAT soybean contain genes that allow for resistance to both glyphosate and ALS-inhibiting herbicides (Green 2007) with commercial sales anticipated in 2011. In some respects, the technology is akin to current RR/STS stack soybeans with significantly greater tolerance to the ALS herbicides with Optimum GAT than in RR/STS stack. Due to the prevalence of weeds resistant to glyphosate, ALS herbicides, or both modes of action, successful utilization of Optimum GAT technology will require a diverse integration of herbicides with multiple modes of action for effective weed control. To accomplish this, DuPont has proposed some concept herbicides for use in Optimum GAT soybean, such as the herbicide Diligent, which contains chlorimuron (Classic), rimsulfuron (Resolve), and flumioxazin (Valor SX) for preplant foliar burndown and residual weed control. Regardless, some skeptics consider Optimum GAT soybean to be a relatively weak technology to improve future weed control challenges as we have widespread ALS-resistance in some weed species. However, the opportunity to include ALS-inhibiting herbicides (which have foliar and residual activity plus excellent crop safety in Optimum GAT soybean) in addition to glyphosate should provide enhanced control of some problematic weed species and help slow the evolution and spread of glyphosate-resistant weed biotypes.

Dow Herbicide Tolerant Soybean

Dow Herbicide Tolerant (DHT) soybean is anticipated for commercial sales in 2013 and allows for the use of 2,4-D in soybean with excellent crop safety in either preplant or postemergence applications (Simpson et al. 2008). The integration of 2,4-D in soybean weed management programs should provide greater flexibility in managing broadleaf weed species. Even though 2,4-D is arguably the oldest herbicide that we still currently use today, the exact application rates and timings of 2,4-D for use in soybean and the potential tank-mix partners on our most problematic weed species will need to be determined prior to the introduction of DHT soybean.

Dicamba Tolerant Soybean

The commercialization of Dicamba Tolerant soybean from Monsanto is anticipated around 2014 and will provide for safe applications of dicamba for preplant burndown or postemergence applications. Similar to 2,4-D and DHT soybean, the use of dicamba for weed management in soybeans in terms of application rates, application timings, and tank-mix partners for dicamba will need to be verified. However, the tank-mixtures of glyphosate and dicamba will be common as Monsanto currently plans to only offer the Dicamba Tolerant trait stacked with RR2Yield soybean.

HPPD Tolerant Soybean

Bayer CropScience has announced their intentions to develop soybean that will allow for applications of HPPD-inhibiting herbicides. The introduction of this trait to the soybean market will not be for several years and likely not prior to 2014. The HPPD-inhibiting herbicides currently used in corn include Balance Flexx, Callisto, Impact, and Laudis. These herbicides as a general group provide both foliar and residual weed control; have excellent activity on small-seeded, summer annual weed species such as common lambsquarters and common waterhemp; and can have good activity on annual morningglory, giant ragweed, and marestail depending on the specific herbicide's active ingredient. The primary HPPD-inhibiting herbicide targeted for use in HPPD Tolerant soybean has not been disclosed at this time as the future weed management programs in this technology are in the early stages of development.

Summary

The multitude of herbicide-resistant soybean traits to be commercialized over the next five years will provide a dramatic increase in the diversity of herbicides that can be integrated into weed management strategies for soybean, especially considering the fact that no new herbicide mode of action was introduced into soybean since the use of glyphosate in RR soybean in 1996. An increase in the complexity in how we manage weeds will be ushered in by these new traits as tracking the specific soybean traits that were planted in various fields and the associated herbicide products for use with each trait will be far-removed from the ease of management with glyphosate and the first decade of using glyphosate-resistant soybean. However, these new traits will increase our ability to control weeds effectively in soybean by allowing the use of herbicides with modes of action that were previously not possible in soybean. The common element that will be

evident in all these technologies is that the systems will rely on an integrated weed management strategy with a focus on residual herbicides and postemergence applications to weeds less than four inches in height to ensure robust weed control.

References Cited

Allen, J. and J. Fischer. 2008. Development of Liberty Link soybean trait technology. North Central Weed Science Society Proc 63:87, http://www.ncwss.org/

Green, J. M. 2007. "Review of glyphosate and ALS-inhibiting herbicide crop resistance and resistant weed management." *Weed Technol*. 21:547–558.

Johnson, W. G., V. M. Davis, G. R. Kruger, and S. C. Weller. 2009. "Influence of glyphosate-resistant cropping systems on weed species shifts and glyphosate-resistant weed populations." *Europ. J. Agronomy* 31:162–172.

Simpson, D. M., T. R. Wright, R. S. Chambers, M. A. Peterson, C. Cui, A. E. Robinson, J. S. Richburg, D. C. Ruen, S. Ferguson, B. E. Maddy, and E. F. Schreder. 2008. Dow AgroSciences herbicide tolerance traits in corn and soybean. North Central Weed Science Society Proc 63:85, http://www.ncwss.org/

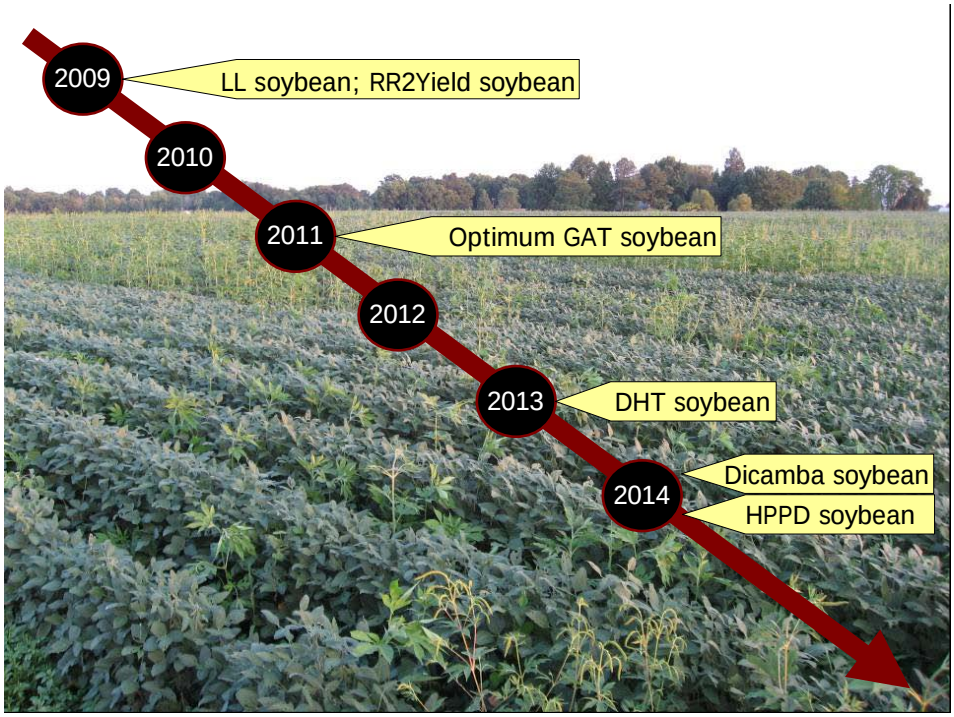

Figure 1. Recent and future commercialization of soybean traits that confer resistance to herbicides. The years indicated for traits beyond 2009 are subject to change and assume successful completion of all regulatory requirements.