RESIDUAL HERBICIDES FOR SOYBEAN WEED CONTROL

With the advent of herbicide-resistant [HR] weeds, especially those resistant to glyphosate [GR], residual herbicides applied before, at, and after planting have become increasingly important as a necessary component of a complete weed control program for soybeans. This has added an additional layer of complexity since available residual herbicides should be chosen on the basis of 1) their mode of action [MOA], and 2) how their MOA's should be selected to complement later-applied postemergence [POST] herbicides to manage HR weeds that are present.

GR soybean varieties are now the ones used in most soybean production systems. However, GR weeds have tilted the playing field so that other weed control measures in addition to glyphosate must be inserted into producers' weed management programs. These include auxin herbicide-resistant [AR] soybean varieties and the aforementioned residual herbicides that have been available for decades.

The following articles provide guidance for using residual herbicides in weed management programs for soybeans.

MSU Info. Sheet 1352 titled "Herbicide Programs for Managing Glyphosate- and ALS-resistant Palmer amaranth in Miss. Soybean" [Apr. 2013 by Dr. Thomas Eubank] precedes the availability of AR soybean varieties and the development of Palmer amaranth populations that are resistant to other herbicides. Thus, it provides suggested herbicide programs for Conventional, Roundup Ready, and Liberty Link varieties that are not infested with weeds that are resistant to classes of herbicides other than those listed in the article's title.

Lists of herbicides that can be applied preplant incorporated [PPI], preplant/preemergence [PRE], and POST are given. Major points to consider when using any of the herbicide programs follow.

- Use of residual herbicides at full label rates is imperative in managing HR weeds.
- Efficacious residual herbicides can provide 2-3 weeks of pigweed control.
- Timely POST herbicide applications when weeds are no more than 2-3 in. tall are critical for controlling escaped pigweeds following application of PPI and PRE herbicides.
- Remember that some residual herbicides can be applied in-season for additional residual control of pigweed. See product label for guidance.

MCS blog titled "Choices of Residual Herbicides in Miss. Soybeans" [Apr. 2015 by Dr. Jason Bond] also precedes the availability of AR soybean varieties. Major points from the article follow.

- Most weed management decisions for soybean production are based on managing GR Palmer amaranth.
- Herbicide programs designed to manage GR pigweed should include herbicides with multiple modes of action [MOA] that are effective for controlling this and other HR weeds. This is a critical step in developing such programs.
- A system developed by the WSSA to designate a herbicide's MOA allows devising herbicide programs that avoid sequential applications of herbicides with the same MOA.
- Diverse herbicide programs that are designed to control GR Palmer amaranth and other HR weeds begin with the inclusion of residual herbicides that are applied PRE.
- A list of the most effective PRE herbicides and herbicide mixtures is provided in the article.
- No PRE herbicide is likely to provide complete control of GR pigweed, so a POST herbicide application will be required to control escapes.

MSU Info. Sheet 2022 titled "Programs for Managing HR Palmer amaranth in Miss. Soybean [Apr. 2015 by Drs. Bond, Irby, and Reynolds] provides information that can be used for herbicide programs that are designed for overall Palmer amaranth management regardless of which HR weed population(s) may be present. The listed recommendations were developed after confirmation of PPO resistance in Palmer amaranth in Mississippi.

Lists of herbicides that can be applied PRE and POST

are given. Major points to consider when using any of the listed herbicide programs follow.

- Use of residual herbicides at full label rates is imperative in managing HR weeds.
- Efficacious residual herbicides can provide 2-3 weeks of pigweed control.
- Preplant applications of residual herbicides should be made 14-21 days before planting and after beds [if used] are prepared. Do not disturb beds after application.
- All listed herbicides for PRE application contain metribuzin. Since some soybean varieties are susceptible to injury from metribuzin, company information should be consulted for tolerance level of selected varieties. Click here for ratings of current varieties for sensitivity to metribuzin.
- Spray coverage is critical for the contact herbicides in the POST list, so nozzles that will ensure thorough coverage should be selected. These are indicated in the label for each product.

A UTcrops blog article titled "Soybean Residual Herbicide Consideration" [April 2018 by Dr. Larry Steckel] provides the following points.

- Growers must now be aware more than ever of herbicide MOA since they can no longer depend solely on a residual herbicide to provide consistent long-lasting control of Palmer amaranth.
- On sites where Palmer amaranth has not yet selected for PPO resistance, PPO residual herbicides will provide 100% control of this weed for 3 to 4 weeks.
- In order to provide complete or near-complete residual control of PPO-resistant as well as PPO-susceptible pigweed, growers are advised to apply a mixture of herbicides with 2 effective MOA's [e.g. Authority MTZ (PPO inhibitor Group 14) and metribuzin (Group 5)] against pigweed.

"Economics of reducing Palmer amaranth seed production in dicamba/glufosinate/glyphoste-resistant soybean" is a 2022 article by Striegel and Jhala of the Univ. of Nebraska. Major points from that article follow.

- The objective of the research was to evaluate the effect of herbicide programs that were applied to dicamba/glufosinate/glyphosate-resistant [DGGR] soybean.
- Field experiments were conducted in 2019-2020 on a site with silt loam soil near Clay Center, Neb.
- Corn preceded soybean at the irrigated study site each year.
- Herbicides consisted of 15 standalone herbicides or mixtures of herbicides that included acetachlor [Warrant], metribuzin, flumioxazon [Valor], dicamba, glyphosate, glufosinate [Liberty], and imazethapyr/pyroxasulfone/saflufenacil [Zidua PRO], plus a nontreated control.
- Herbicide treatments included PRE followed by [fb] Early Post [EPOST], PRE fb Late Post [LPOST], PRE fb EPOST and LPOST, EPOST, and EPOST fb LPOST.
- Results from this study indicate that use of PRE herbicides with multiple MOA's fb POST herbicides provided better weed control in and higher gross profits from DGGR soybean than applications of only POST herbicides.
- Weed control programs that included dicamba in POST applications resulted in reduced Palmer amaranth seed production.
- Glyphosate applied POST was highly efficacious against non-GR weeds.
- Glufosinate applied POST provided effective control of GR Palmer amaranth. However, the authors caution that herbicide programs that include multiple effective MOA's in both PRE and POST applications should be used to prevent overuse of this herbicide that will likely result in the development of glufosinate-resistant Palmer amaranth.

The bottom line from all of the above is 1) a weed control program for soybeans should include both PRE and POST herbicides to control/manage the increasing occurrence of HR weeds, and 2) it is mandatory that the selection of herbicides and herbicide mixtures to use in these programs be selected based on their MOA's so that multiple MOA's that are effective against both HR and susceptible targeted weed biotypes are used.

The era of using only POST glyphosate for weed control in soybean has long-since come and gone. Thus, producers are left with devising weed control

programs similar to those that preceded HR weeds, with one difference. They now have to contend with HR weeds that will require a more integrated approach that includes consideration of herbicide MOA in the selection and use of both PRE and POST herbicides that are required to achieve acceptable control of problematic weeds in soybeans.

The integrated approach referred to above now includes the addition of residual herbicides being applied with POST herbicides to aid in controlling problematic HR weeds even when residual herbicides were applied PRE. This recommendation is being made to reduce the number of weeds that are exposed to foliar-applied herbicides to help reduce the selection pressure for weeds becoming resistant to them. As with a PRE application of residual herbicide(s), a subsequent activating precipitation or irrigation event of at least 0.5 in. of water is required to realize their maximum effectiveness against targeted weeds when applied POST.

Results from research conducted in Wisconsin and reported in an article titled "Control of common weeds in Wisconsin soybean cropping systems with pre-emergence herbicides" by Ribeiro et al. provides the following information.

- In 2 years of field studies conducted at two locations, PRE herbicide treatments consisting of ALS inhibitors [Group 2], a PSII inhibitor [Group 5], PPO inhibitors [Group 14], and VLCFA inhibitors [Group 15] were evaluated for their efficacy when applied alone as single active ingredients.
- PRE herbicide efficacy varied according to the weed species present at each site.
- The results indicate that it is important that growers be aware of the weed species typically present in a field so that the appropriate PRE herbicide or herbicide mixes can be applied to control those weeds.
- Even though the results from this research focus on the efficacy of herbicides with single active ingredients, they are valuable to those making weed control decisions regarding tank mixes or premixes of PRE herbicides with more than one active ingredient that will be selected to control site-specific weed infestations.

There is another point to be aware of when applying residual herbicides in POST applications, and that is the latest these herbicides can be applied as POST treatments. This information is stated on labels of all residual herbicides, and is indicated for the residual herbicides shown in the following table.

Maximum soybean growth stage and/or cutoff before harvest [PHI] for application of shown residual herbicides to soybeans [from "Residual Soybean Herbicides Applied Postemergence" by Aaron Hager, and product label]. MOA is shown in brackets after each herbicide name.

Anthem, Anthem Maxx [14, 15]	Through stage V6 or 6th trifoliate; 60-day PHI*
Dual Magnum [15]	75-day PHI
Dual II Magnum [15]	Through stage V3 or 3rd trifoliate; 75-day PHI
FirstRate [2]	Up to stage V2 or 2nd trifoliate; 70-day PHI
Metribuzin [5]	70-day PHI
Outlook [15]	Up to stage V5 or 5th trifoliate
Pummel [2,15]	Up to stage V5 or 5th trifoliate
Prefix [14,15]	75-day PHI
Sequence** [9,15]	75-day PHI
Warrant [15]	Up to stage V2 or 2nd trifoliate
Warrant Ultra [14,15]	Up to stage V2 or 2nd trifoliate
Zidua [15]	Up to stage V3 or 3rd trifoliate
Zidua Pro [2,14,15]	85-day PHI

*Pre-harvest interval.
**Apply only to GR soybean varieties.
Some of the above-shown residual herbicides should only be applied as a directed spray underneath the soybean canopy in a POST application. Check label for this restriction.

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