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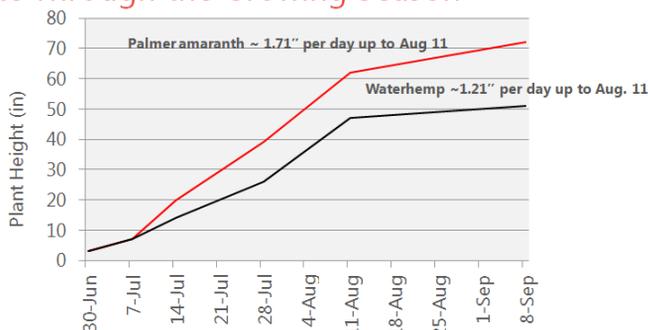


A – Start Clean - The value of a two-pass weed control system with a residual herbicide as part of the system has been demonstrated for years and repeated by numerous university weed scientists, as well as, industry representatives. Weed control strategies evolve and new technology is changing but the old adage of “**start clean and stay clean**” can’t be reinforced enough !!! Everyone is always talking about weed resistance these days, and don’t get me wrong it is a growing problem, but if we utilize an effective residual herbicide and start clean through tillage or effective burndown program in no-till systems we have started on the right foot. Not only is the residual important to fight weed resistance, **but it’s value is also for reducing weed competition allowing for better yields.**

B – Stay Clean – Timely postemergence applications are more important than ever. With the increasing rate of glyphosate resistance to weeds like waterhemp, we now must add tank-mix partners that are most effective when species like waterhemp are less than 4 inches. When weeds such as waterhemp (~1.2” growth per day) and palmer amaranth (~1.7” growth per day) as seen in the graph below are allowed to reach 4” in height or greater, effective options to control resistant biotypes of these species are limited. Many growers have added a residual herbicide to their post herbicides to extend or overlap their residual control. This make sense under heavy populations or areas needing extended residual control, **but don’t risk displacing optimal preemergence herbicide programs with POST plus residual options**, as it will likely lead to season-long problems if the applications do not occur timely. Utilizing Authority® Brand herbicides will provide a foundation for sound waterhemp and palmer amaranth management and a consistent first step in the “start clean stay clean strategy”.

C – Scout – Proper follow up and evaluation’s of herbicide performance is critical. We need to determine if escaped weeds were the result of incorrect herbicide timing, environmental conditions, weed resistance, weeds emerging after herbicide application, etc.

Palmer Amaranth and Waterhemp Growth Rate Through the Growing Season



©Dr. Kevin Bradley University of Missouri

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Soybean Weed Management

Preemergence residual herbicides are the foundation for all good weed control in soybeans. As we start the 2017 season, putting together a good preemergence residual and post program is critical for the weed control needed for maximum yields. Authority[®] Elite herbicide is the newest product in the Authority[®] Brand herbicide family and provides a strong waterhemp/pigweed option with durable grass control. It combines sulfentrazone + s-metolachlor for 2 effective modes of action on waterhemp. It can be used alone or it can be combined with another Authority Brand herbicide premix to provide a strong 3-way combination for grass and broadleaves.

Authority Brand Herbicide Treatment Options

Base Residual

1. Authority Elite herbicide: 25 - 32 oz/acre

- Strength of small seeded broadleaves (kochia, lambsquarters, nightshade, waterhemp) & excellent grass performance.
- No pH or geographical restrictions. Good conventional till product and/or as tank-mix partner.

2. Authority[®] Assist herbicide: 8 - 12 oz/acre

- Strength of small seeded broadleaves (kochia, lambsquarters, nightshade, velvetleaf, waterhemp) & added grass performance.
- No pH or geographical restrictions. Good for both conventional & no till.

3. Authority[®] First DF herbicide: 5.0 - 6.4 oz/acre

- Strength of small seeded broadleaves plus marehail, giant ragweed, sunflowers, and cocklebur.
- No pH or geographical restrictions. Good no-till / reduce-till product.

4. Authority[®] XL herbicide: 4.0 - 6.5 oz/acre

- Strength of small seeded broadleaves plus marehail, sunflower, and cocklebur w/good cost position.
- For soils below pH 7.6. Refer to the label for geographical restrictions.

5. Authority[®] MAXX herbicide: 5.5 - 7.5 oz/acre

- Same components as Authority XL herbicide but with half the amount of chlorimuron ethyl per rate for better rotational safety.
- For soils below pH 7.6. Refer to the label for geographical restrictions.

6. Authority[®] MTZ DF herbicide: 14 - 18 oz/acre

- Strength of small seeded broadleaves. Non-ALS option to help combat herbicide resistance.
- For soils with pH 7.5 and lower due to injury risk of metribuzin.

Post Sequential with Glyphosate

1. Anthem[®] MAXX herbicide (through V3): 2.5 - 4 oz/acre

- Enhance post broadleaf (Cadet[®] herbicide) plus extended grass / small seeded broadleaf residual control well into season.
- Cadillac program, great residual addition to grass/waterhemp/nightshade programs.

2. Marvel[™] herbicide (prior to R3): 6.0 - 7.25 oz/acre

- Broad post broadleaf control w/residual. Focus weeds of waterhemp, velvetleaf, lambsquarters, morningglory, nightshade.
- Geographical restrictions and rotational restrictions: See label for specific restrictions.

3. Cadet herbicide (through full flower): 0.60 - 0.90 oz/acre

- Enhance post broadleaf w/crop flexibility of soybeans or corn. Lambsquarters, velvetleaf, nightshade, waterhemp.
- No pH or geographical restrictions w/application time flexibility.

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Herbicide Resistance

How many of you have seen the herbicide mode of action charts ? If you haven't please visit the following website : www.TakeActionOnWeeds.com to see an excellent reference guide. Some key points to emphasize are:

- 1) There are basically 16 sites of action in use for corn and soybean weed control. The last new site of action discovered was the HPPD inhibitors (early 1980's), with mesotrione now off patent. It doesn't appear there are any new sites of action coming in the near future so we need to utilize what we have to the best of our abilities.
- 2) We have switched a lot of our weed control methods to postemergence programs and consequently this is where most of the weed resistance issues are appearing. We presently have resistant weed species to ALS Inhibitors (site 2), to EPSP Synthase Inhibitors (site 9) glyphosate, (site 4) – (dicamba, 2,4-D), we have Photosystem II Inhibitors (site 5) triazines that show resistance along with PPO Inhibitors (site 14), and Pigment Inhibitors – HPPD (site 27) that are all documented. As a weed scientist I can't stress enough the value of using preemergence herbicides to control resistant weeds. The preemergence herbicide while not expected to provide 100% control, do have great value because they will reduce the number of weeds subjected to the postemergence herbicides, and the selection pressure of those post herbicides where the greatest incidence of resistance has developed. **Another way to look at it is a weed that never emerges will never have a chance to develop resistance to a postemergence herbicide.** In the example below the untreated plot on the left has 60 waterhemp/sq.ft. or roughly 2.6 million plants that will be exposed to a post herbicide for resistance to develop or increase. Now if we take that to an 80 acre field then there would be about 209 million chances that some of those plants have a mutation that will lead to resistance developing to your postemergence herbicide.

Plants/Ft ²	Plants/Acre Exposed to POST Herbicide Treatment
60 Plants/Ft ²	2,613,600 Plants/A



Plants/Ft ²	Plants/Acre Exposed to POST Herbicide Treatment
0.1 Plants/Ft ²	4,356 Plants/A





PPO-resistant waterhemp is a growing concern in the Midwest. I saw and heard of several fields in Iowa that had issues in 2016. Multiple reports of failed postemergence PPO herbicide treatments have been recorded over the last few years especially in Missouri and southern Illinois. As we know, contact herbicides, especially post applied PPO inhibitors must be applied prior to waterhemp reaching 4" in height. In many cases last year, field conditions did not allow applications until waterhemp was larger than 4", thus escapes from these situations were probably not due to resistant biotypes.

However, field visits / leaf assays confirming PPO-resistance identified several problem fields in Iowa. I wanted to talk about the article below from Dr. Bob Hartzler, professor of agronomy and extension weed specialist from Iowa State University. While Iowa samples showed a high incidence of resistance to both glyphosate and PPO inhibitor herbicides these samples came from fields that had control issues thus biasing the samples. However the concern is real and information on the next page is very important as we look at weed control strategies for 2017 and beyond.

Is 80% of Iowa waterhemp really resistant to Group 14 herbicides? Blog Post

February 12, 2017 9:47 AM

The University of Illinois Plant Clinic recently published results of their 2016 herbicide resistance screening program. For a \$50 fee the Clinic analyzes waterhemp for resistance to both Group 9 (glyphosate) and Group 14 (PPO inhibitor) herbicides. Unfortunately, samples from Iowa displayed a high frequency of resistance to both herbicides (Table 1).

Table 1. Results of IL herbicide resistance screening program.

State	No. of samples	% resistant to HG9	% resistant to HG 14	% resistant to both HG 9 and 14
IA	87	89	80	75
IL	378	74	65	48
MN	78	74	44	35
MO	11	91	91	82
NE	8	63	13	0

A colleague recently asked me if I trusted the molecular tests used by the Clinic, and therefore the results of the program. My response was yes to both questions, but it is important to recognize the sampling method. Selecting a random sample is a guiding principle of scientific research, and the samples submitted to the Plant Clinic are far from a random sample. Samples are sent to the Clinic because people suspect the weeds are resistant to the herbicides, therefore creating a biased sample.

I suspect most people are comfortable identifying glyphosate resistance, but not quite so sure with Group 14 herbicides due to their less consistent performance. A high percentage of the samples were probably submitted from fields with known glyphosate resistant waterhemp and where a Group 14 herbicide failed to provide effective control in 2016. This bias results in a much higher frequency of resistance than if waterhemp was collected from randomly selected fields.

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Prior to the onset of Roundup Ready[®] technology PPO herbicides were frequently relied upon for broadleaf weed control in soybeans, resistance was already suspected in Illinois. Glyphosate was very effective on pigweeds when Roundup[®] Ready cropping systems were first adopted, which allowed weed management practitioners to neglect diverse herbicide programs. As waterhemp evolved resistance to glyphosate due to overuse, a common tactic was to include a PPO-inhibitor with the post glyphosate application in order to control glyphosate-resistant waterhemp biotypes. Tank mixtures of glyphosate + a PPO inhibitor postemergence on glyphosate-resistant biotypes only employed 1 effective site of action. This practice selected for glyphosate + PPO-resistant individuals over time. Female plants conferring resistance to both glyphosate and PPO-inhibiting herbicides were then able to escape treatment and produce in excess of 200,000 seeds, of which a portion contained multiple resistance to both herbicides.

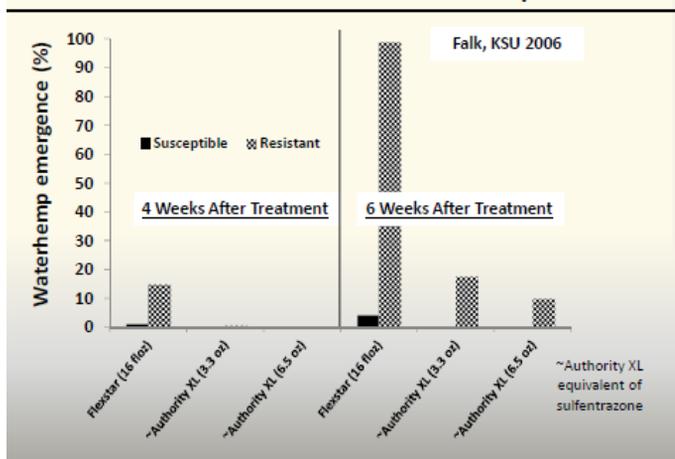
Tank mixing foliar applied PPO-inhibitors with glyphosate has been a standard procedure over the past 5 years. Each year this program has been implemented, glyphosate and PPO-resistant individuals have been selected to escape the treatment which eventually shifted the population and here we are today! In glyphosate tolerant cropping systems if waterhemp plants conferring resistance to both glyphosate and PPO-inhibiting herbicides are allowed to emerge with the crop there are no options to control them postemergence. The standard tank mixture including glyphosate plus Marvel[™] herbicide, Cobra[®] herbicide or Flexstar[®] herbicide will no longer be effective on these biotypes.

What about soil applied PPO-herbicides?

Often the question arises, is there a difference between soil applied and foliar applied PPO-resistance? If we only consider the resistance mechanism the answer is no, there is no difference. The resistant plant encompasses a codon deletion that confers resistance to PPO herbicides from seed formation throughout the plants lifecycle. However, research has indicated that soil applications of PPO herbicides provide control comparable to that of susceptible populations. How could this be? It is related to herbicide dose, the mutation facilitating PPO-resistance confers low level resistance. When foliar applied PPO-herbicides such as those mentioned above are applied, they are intended to control what is present at the time of application.

Applications of soil applied PPO-inhibitors including Authority[®] Brand herbicides are employed at rates to control what is present at the time of application in addition to what might emerge several weeks after treatment. A higher dose overcomes the low level resistance mechanism sustaining residual activity. Even though applications of soil applied PPO herbicides are implemented at higher doses, degradation begins to occur after the treatment occurs. As the dose diminishes over time, PPO-resistant individuals are more likely to emerge first as the concentration in the soil becomes lower than levels capable of overcoming the resistance mechanism. This could also be why we are noticing an increase in PPO-resistance. If the only effective mode of action employed in the soil is a PPO-inhibitor and over time the dose diminishes enough to select for resistant individuals to emerge, this followed by a post treatment of glyphosate + a foliar PPO herbicide has placed tremendous selection pressure on populations resulting in glyphosate and PPO-resistant weed escapes.

PPO Resistant Waterhemp



Data from Kansas State University indicates that at 4 weeks after treatment Authority[®] XL herbicide was providing residual activity on both susceptible and resistant waterhemp biotypes. However, at 6 weeks after treatment the dose diminished to a level that allowed a small percentage of resistant individual plants to emerge. Note that 6 weeks of residual activity on a resistant biotype still represents an effective treatment. Therefore, we must manage PPO herbicides correctly to keep them viable long term.

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Always read and follow label directions. NOTE REGARDING RESTRICTED USE PESTICIDES: Anthem ATZ herbicide; Athena insecticide, Brigade 2EC Insecticide/Miticide, Brigade WSB Insecticide/Miticide, Brigadier Insecticide Capture 3RIVE 3D insecticide, Capture LFR Insecticide, Declare insecticide, Hero Insecticide, Mustang Insecticide, Mustang Maxx Insecticide, Pounce 25WP Insecticide, Stallion Brand Insecticide, Temity LFR Insecticide/Fungicide, Triple Crown Insecticide, Ethos XB Insecticide/Fungicide and Gladiator Insecticide/Miticide are **Restricted Use Pesticides**. NOTE FOR CALIFORNIA: Accurate Extra herbicide, Aim herbicide, Aim EC herbicide, Aim EW herbicide, Anthem herbicide, Anthem ATZ herbicide, Anthem Flex herbicide, Anthem MAXX herbicide, Authority Assist herbicide, Authority Elite herbicide, Authority First DF herbicide, Authority MAXX herbicide, Authority MTZ DF herbicide, Authority XL herbicide, Cadet herbicide, Chisum Herbicide, Command 3ME microencapsulated herbicide, Crusher Herbicide, Edition Broadspec herbicide, Edition Tankmix Herbicide, Marvel herbicide, Nimble Herbicide, Nuance Herbicide, Preemptor SC fungicide, Report Extra Herbicide, Solstice herbicide, Spartan 4F herbicide, Spartan Charge herbicide, Spartan Elite herbicide, Temity LFR Insecticide/Fungicide, Topguard EQ fungicide, Zeus Prime XC herbicide, Zeus XC herbicide, Capture 3RIVE 3D insecticide, Ethos XB Insecticide/Fungicide, Hero Insecticide, Mustang Maxx Insecticide, Display cotton harvest aid, Zoro Miticide and VGR Soil Amendment **are not registered for sale or use in California**. VGR Soil Amendment is not a pesticide. Beleaf and Carbine are trademarks of Ishihara Sangyo Kaisha, Ltd. Cercobin is a trademark of Nippon Soda Co., LTD. Sovran is a registered trademark of BASF. FMC, 3RIVE 3D, Accurate, Aim, Anthem, Athena, Authority, Brigade, Brigadier, Cadet, Capture, Chisum, Command, Crusher, Declare, Display, Edition, Ethos, Preemptor, Fracture, Fyfanon, Gladiator, Hero, Koverall, LFR, Marvel, Mustang, Nimble, Obey, Pounce, Report, Rhyme, Rovral, Shark, Solida, Solstice, Spartan, Stallion, Temity, Topguard, Topguard Terra, VGR and Zeus are trademarks and HatchTrak and Investing in farming's future are service marks of FMC Corporation or an affiliate. ©2016 FMC Corporation. All rights reserved. 11/16

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