

An Effective Mode of Action to Get TOUGH on Weeds

Facilitated discussions were held with professionals in the ag retail industry across the U.S. Corn Belt, bringing renowned university weed experts, a Belchim technical representative, and a retailer with trial experience together to talk about managing resistant weeds and a new option for enhancing weed control.



Sharpening Control of Tough Weeds is Essential

With herbicide resistance on the rise in broadleaf weed populations across the U.S., a top priority for corn growers is finding new options to control tough and resistant weeds. Later emerging weeds like Palmer amaranth and Common waterhemp are posing significant challenges for weed control programs.



Palmer amaranth shows resistance to 7 WSSA groups and is a fierce competitor, growing 2-3 inches per day, with **each plant producing up to 100,000 seeds** when competing with a crop.



Common waterhemp also shows resistance to 7 WSSA groups and can grow 1 to 1.25 inches per day, **producing up to 400,000 seeds per plant** with 68% shade.

If a postemergence product alone provides 95% control, but still leaves 50 common waterhemp plants per acre, these could quickly escalate and impact yield. At up to 400,000 seeds per plant, 50 uncontrolled waterhemp plants could mean 20 million seeds per acre and 460 new weeds per square foot.

Integrated Weed Management Program is Critical to Fight Resistance

University and industry experts emphasize the importance of an integrated system of multiple modes of action with overlapping soil residuals. Additionally, management practices are needed to control tough and resistant weeds and protect existing herbicide technologies.

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The number of cases of herbicide resistance keep rising in a linear fashion and are showing no signs of slowing down. We're also seeing an increase in cases of multiple resistance in our weed populations and that's really the challenge. It's leaving farmers with very limited options of effective control herbicides, especially for postemergence activity.”

Dr. Pat Tranel, Associate Head, Crop Sciences, University of Illinois

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One of the major considerations is the extended emergence period of some of these really big weeds like waterhemp and Palmer amaranth. With resistance to PSII inhibitors, glyphosate and other chemistries, it is very important that we are integrating different chemical practices as well as some cultural practices into an integrated weed management system to fight resistance.”

Dr. Prashant Jha, Associate Professor, Extension Weed Specialist, Iowa State University

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*You can go from one seed to a hundred thousand or more. When you think about weed management, you really need two perspectives: **short-term** where the goal is to prevent yield loss this year, but also **long-term** to get that seed bank under control and strive to be smaller every year. When you are dealing with an enemy weed that's able to produce thousands upon thousands of seed, 95% control is nowhere near close enough. You have to be above 99% control in order to have a sustainable year after year system.”*

Dr. Pat Tranel, University of Illinois



TOUGH® 5EC Enhances Control of Tough-to-Kill Broadleaf Weeds

TOUGH 5EC provides a unique tool for growers to control the most challenging weeds, especially when herbicide resistance is present in the weed population. The active ingredient in TOUGH 5EC is pyridate, which is an underutilized chemistry in the U.S. Researchers have recently explored renewed applications for this mode of action.

Research has shown increased weed control of 5% to 29% with addition of TOUGH 5EC.

TOUGH 5EC Maximizes Control of Key Weeds in Existing Weed Management Programs

TOUGH 5EC works by blocking a weed's photosystem II process, triggering the release of toxic forms of oxygen, and causing rapid cell wall degradation. Research and field trials are showing extremely positive results when TOUGH 5EC is added to an existing weed management program.

TOUGH 5EC Enhances Atrazine Control

Atrazine is another photosystem II inhibitor, with a different mode of action, that binds to a different site on the D-1 protein than TOUGH 5EC. While atrazine is primarily absorbed through the root, TOUGH 5EC enters the plant system more quickly through faster foliar absorption. Together, it results in faster kill, multiple keys to PSII target site and better residual control.

“Pyridate enters into the plant system much faster compared to atrazine. We have seen an enhancement in control because now we are talking about two different products that are working together in a synergistic way.”

Dr. Prashant Jha, Iowa State University

“Pyridate and TOUGH 5EC is a new tool in the toolbox to fight herbicide resistant weeds in corn. It is a complementary strategy and an additional tool to manage glyphosate-resistant and HPPD-resistant waterhemp and Palmer Amaranth.”

Dr. Prashant Jha, Iowa State University

“We're not looking to replace products currently in the tank, but we're trying to provide a different mode of action in a different site to prevent the selection for resistance, preserve the chemistries we have, and prevent seeds from going into the seed bank.”

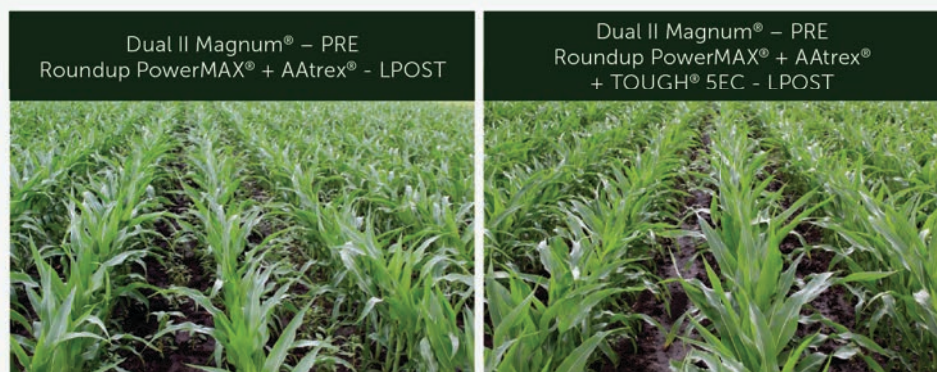
Dennis Long, National Technical Service and Development Manager, Belchim Crop Protection USA

TOUGH 5EC provides control of:

- > *Palmer amaranth*
- > *Kochia*
- > *Common waterhemp*
- > *Common lambsquarters*
- > *Black nightshade*

Glyphosate Resistant Common Waterhemp | 10 Days After Application

University of Illinois | Urbana 2018



Glyphosate Resistant Common Waterhemp

Running Check

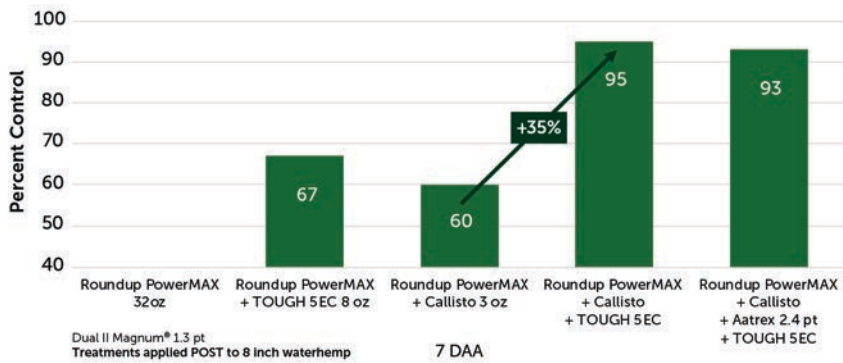
15 to 30% extra control can be significant

TOUGH 5EC Synergizes HPPD Herbicides

Pyridate also improves control when combined with HPPD inhibitor herbicides, such as mesotrione. When combined, the amount of toxic oxygen produced is increased, and the plants ability to detoxify these oxygen molecules is reduced, which increases the speed of kill and reduces the competitive effect of growing weeds in crops.

Common Waterhemp in Corn

Chris Weed, Kova Fertilizer | Crothersville, Indiana - 2020



TOUGH is definitely going to be an effective strategy paired in a tank mix with HPPD inhibitors or Group 27 herbicides. When they are mixed together, like Callisto and TOUGH, we are achieving that 90 to 95% control with rapid necrosis and kill of plants within seven days after application."

Dr. Prashant Jha, Iowa State University



With the addition of TOUGH into this mix of Roundup PowerMax and mesotrione, this was a very short period of time and you evolve from 60 to 67% control to 95%. I'm not easily impressed, and this was very impressive to me to see this activity so quickly."

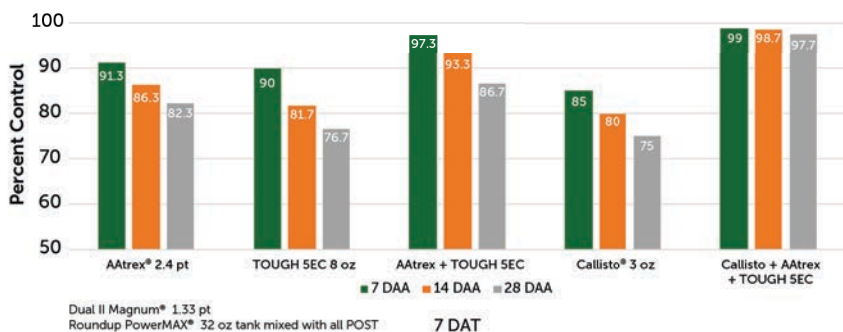
Chris Weed, Kova Fertilizer

Putting It Together: TOUGH 5EC Enhances Atrazine and HPPD Tank Mix

The combination of three effective modes of action – atrazine, HPPD inhibitor herbicides, and pyridate – is showing impressive results in field trials and research. When only atrazine and HPPD inhibitors are combined, the metabolic pathway in HPPD resistant weeds also degrades atrazine, and the plant metabolizes atrazine before it can assist the HPPDs. However, pyridate moves into the leaf quickly along with the HPPD herbicide to reach the target sites before they can be degraded.

Glyphosate Resistant Palmer Amaranth

University of Illinois - 2019



Now we have three multiple modes of action, which is one of the best management practices. Pyridate is available faster to assist that HPPD ahead of the metabolic degradation process in HPPD resistant weeds, and that's how it is a game changer."

Dr. Prashant Jha, Iowa State University



When I look at three products together – Callisto, Aatrex and TOUGH – and almost 30 days later you're seeing 98% control, that's outstanding. I'm not only thinking about corn, I'm also thinking about the soybean crop that will probably follow this corn. The better weed control I have in corn, the more benefit I'm going to see in the following crop the next year."

Chris Weed, Kova Fertilizer

Wide Application Window Provides Weed Control Flexibility

As part of an integrated weed management program, TOUGH 5EC provides flexibility and control to manage late emerging weeds like Palmer amaranth and waterhemp.

Application of a pre-emergent program provides a good foundation, but as soon as they are applied, they start to degrade and level of activity declines. TOUGH 5EC can be tank mixed with post emergent programs and can be applied up to 8 leaf stage to allow late emerging weeds to come through before application.

Flexible Application with Lower Chemical Profile:

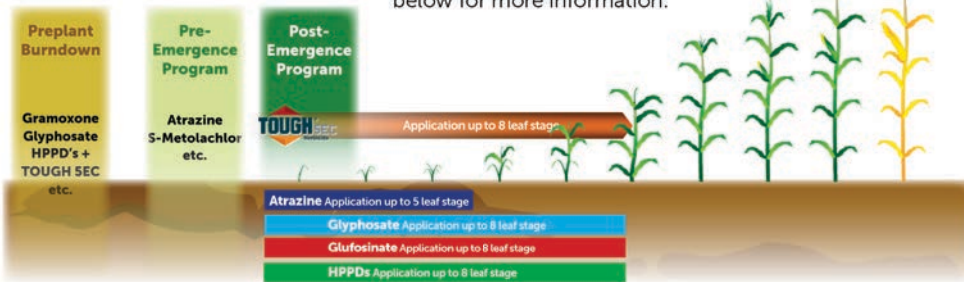
- > Wide window of application
- > No antagonism to commonly used herbicides on corn (glyphosate, HPPD's)
- > Rainfast within 1 hour
- > Post-emergent, contact activity only
- > No residual activity or concerns
- > No plant back restrictions
- > No environmental concerns
- > No crop injury to corn
- > Application flexibility to help control rapidly growing weeds such as pigweeds



Over the past several years, we've conducted more than a hundred trials across the Corn Belt with key universities like Iowa State University, University of Illinois, Purdue and more, and we see the increased weed control with synergy to complement other products. The data set is there."

Dennis Long, Belchim

Apply TOUGH® 5 EC at 8 oz per acre in tank mixture with other products effective on the target weeds. See below for more information.



RECOMMENDED RATE Apply TOUGH® 5 EC at 8 oz per acre in tank mixture with other products effective on the target weeds.

RECOMMENDED APPLICATION Apply TOUGH® 5 EC in sufficient water (15 gal per acre minimum; 20-30 gal per acre recommended), at a pressure of 30- 40 psi to ensure proper coverage. Thorough coverage of target weeds is required for optimum results. Adjuvants (nonionic surfactants, crop oil concentrate or liquid fertilizers) may be used with TOUGH® 5 EC.

RECOMMENDED TIMING Can be applied from emergence to 8 leaf stage. For optimum control, apply on small weeds (fewer than 4 leaves) 3 - 5 inches in size.

See product label for complete use instructions.

TOUGH 5EC is a Reliable Option to Enhance Integrated Weed Management Programs



Scan this QR Code to view a digital recap with audio clips and more.

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