

Glyphosate-Resistant Lambsquarters Threat on the Horizon

Common lambsquarters has increasingly caused headaches for many growers across the United States. As more and more escapes appear in fields, frustrations grow and yields drop. Not only is lambsquarters a competitive weed, it is persistent and has shown resilience to glyphosate herbicides in recent years. This weed has already exhibited resistance to other herbicide modes of action, such as ALS and PSII inhibitors. If glyphosate herbicide options are also thrown out, what is left to control this difficult weed?

The threat of multiple-resistance also looms. In areas of the northern Corn Belt, where lambsquarters remains the biggest weed

menace, growers have already experienced waterhemp populations resistant to multiple modes of action (University of Illinois, *Multiple Herbicide Resistance in Waterhemp: Can It Get Any Worse?* Tranel, et. al. 2003.). Should the same obstacle happen in lambsquarters, growers would be left with very few solutions.

As no new herbicide modes of action are currently in development, it is critical that practices are adopted to preserve glyphosate technology. Utilizing proper cultural and chemical management practices that reduce selection pressure placed on resistant biotypes can help delay resistance.

Management Options

Preserving herbicides, particularly glyphosate, involves a well-rounded management program. Rotating modes of action and limiting the frequency of glyphosate applications are key to preserving this intricate part of modern agriculture. Syngenta recommends using no more than **two** applications of glyphosate on **one** field over a **two**-year period (**2-1-2**). Using cultural and chemical management practices helps to incorporate other modes of action into a program.

Weed resistance management is the first step in controlling lambsquarters and other weeds. Syngenta recommends the following:

- Scout fields
- Use effective herbicides with different modes of action
- Use full rates
- Apply when weeds are small (less than 6 inches)
- Control weed escapes
- Avoid spreading seed through machinery or persons by thoroughly cleaning machinery and clothing between fields
- Control weeds in fence rows and ditches

For specific control options, Syngenta recommends a variety of choices to fit individual needs. Always read and follow label instructions before using these products.

(See charts on following page.)

Corn

*(Numbers) = product Mode of Action (MOA)
For example: LUMAX® (27, 15, 5)
See page 3 for MOA numerical reference

Weed control plan	Program (rate/A)	Modes of action per product*	Glyphosate-resistant weed control?	Number of glyphosate applications reserved for soybeans the following season
One-pass conventional or GT system	LUMAX® (2.5-3 qt.) or Lexar® (3-3.5 qt.)	3 (27, 15, 5) 3 (27, 15, 5)	Yes	2 applications
Two-pass conventional system	Bicep II MAGNUM® (1.6-2.1 qt.) followed by Callisto® (3 oz.)	2 (5, 15) 1 (27)	Yes	2 applications
	LUMAX (2 qt.) or Lexar (2.5 qt.) followed by Northstar® (5 oz.)	3 (27, 15, 5) 3 (27, 15, 5) 2 (2, 4)		
Two-pass GT system	LUMAX (2 qt.) or Lexar (2.5 qt.) followed by Touchdown Total™ (24 oz.)	3 (27, 15, 5) 3 (27, 15, 5) 1 (9)	Yes	1 application
Two-pass conventional or GT system	LUMAX (2 qt.) or Lexar (2.5 qt.) at planting, followed by LUMAX (1 qt.) or Lexar (1 qt.) at 2-inch weed height	3 (27, 15, 5) 3 (27, 15, 5) 3 (27, 15, 5) 3 (27, 15, 5)	Yes	2 applications

Note: Use GRAMOXONE Inteon™²² tankmixed with phenoxy (such as 2,4-D) or residual herbicides as a glyphosate alternative burndown.

Soybean

Weed control plan	Program (rate/A)	Modes of action per product*	In addition to lambsquarters, program controls	Considerations
Conventional system	Dual MAGNUM® PRE (1-2 pt.) followed by Fusion® (8-10 oz.) plus Flexstar® (16-20 oz.)	1 (15) 1 (1) 1 (14)	—	For growers who use more than one application of glyphosate in GT corn program
GT system	Sequence (2.5-3.5 pt. applied at V1-3), followed by Flexstar (16-20 oz. as needed)	2 (9, 15) 1 (14)	Glyphosate-resistant pigweed and common ragweed	Flexstar controls late-emerging resistant pigweed
	Prefix™ followed by Touchdown Total (24 oz.)	2 (9, 15) 1 (9)	Glyphosate-resistant pigweed	Flexible POST application; early season weed control
	Boundary® 6.5EC (1.5-2.25 pt.) followed by Touchdown Total (24 oz.)	2 (5, 15) 1 (9)	Glyphosate-resistant pigweed	Flexible POST application; early season weed control
	Dual MAGNUM (1-2 pt.) followed by Touchdown Total (24 oz.)	1 (15) 1 (9)	Glyphosate-resistant pigweed	Flexible POST application; early season weed control

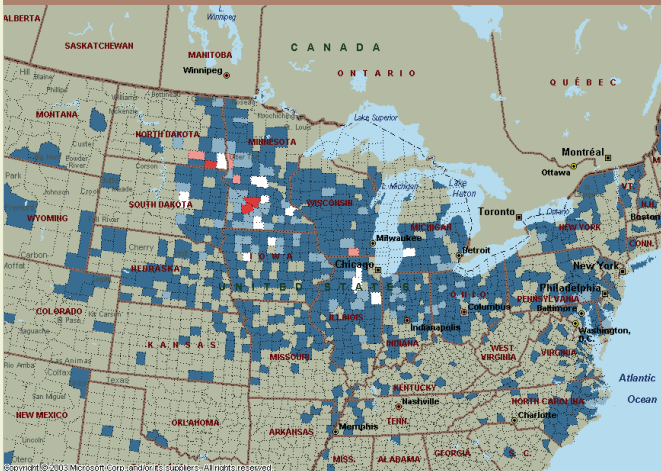
Note: Use GRAMOXONE Inteon™²² tankmixed with phenoxy (such as 2,4-D) or residual herbicides as a glyphosate alternative burndown.

Lambsquarters Resistance

Weed resistance is the inherited ability of a plant to survive and reproduce following exposure to a dose of herbicide that would normally be lethal to the wild type. Resistance occurs when a particular mutation is selected and enriched in a particular population. Rotating herbicide modes of action helps to prevent resistance from developing. There are several modes of action throughout the United States and the world to which lambsquarters is resistant.

Lambsquarters resistance has been well documented across the United States. Not only have populations exhibited resistance to ALS and PSII chemistries in some states, but lambsquarters is also being carefully monitored for resistance to glyphosate herbicides. Lambsquarters populations are being observed due to the great amount of genetic diversity, its widespread geography and the tremendous amount of seed it produces.

Lambsquarters Base Acres 2004 Corn, Cotton and Soybeans Combined



As the map denotes, there are several areas throughout the Midwest that are battling lambsquarters. When you throw herbicide-resistant populations into the mix, this competitive weed can be even more challenging. The widespread distribution and densities of this weed reinforce the number of field investigations Syngenta received in the past year—or how often growers cited poor control of lambsquarters. With the risk of glyphosate-resistant populations increasing, it becomes even more important to carefully monitor fields and be aware of escapes.

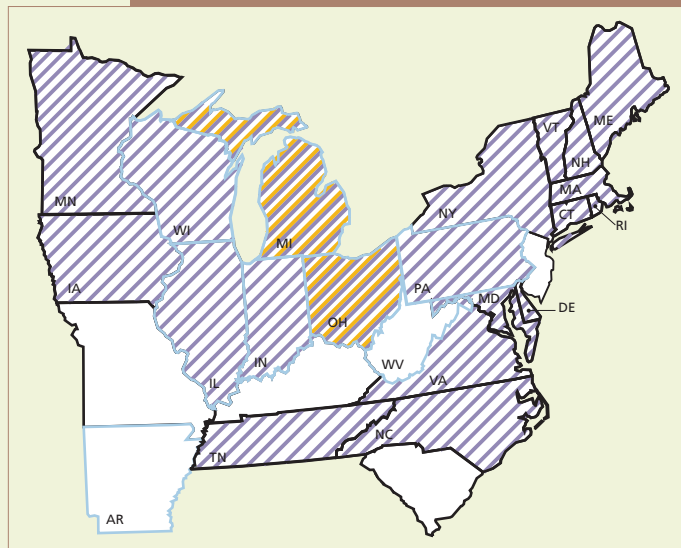
Lambsquarters

- 400,000 to 500,000
- 300,000 to 399,999
- 200,000 to 299,999
- 100,000 to 199,999
- 1 to 99,999

- Known research areas for glyphosate resistance
- ALS resistance*
- PSII resistance*

*Source: I. Heap. International Survey of Herbicide Resistant Weeds. Internet. Feb. 2006. www.weedresistance.org.

Resistance to modes of action per state



Numerical system to describe modes of action as designated by the Weed Science Society of America:

- | | |
|---|--|
| 1 – ACCase inhibition | 10 – Glutamine synthetase inhibition |
| 2 – ALS inhibition | 12 – Inhibition of carotenoid biosynthesis at PDS |
| 3 – Microtubule assembly inhibition | 13 – Inhibition of carotenoid biosynthesis, unknown target |
| 4 – Synthetic auxin | 14 – PPO inhibition |
| 5 – Photosystem II (PSII), different binding behavior than groups 6 & 7 | 15 – Inhibition of a very long-chain fatty acid |
| 6 – Photosystem II, different binding behavior than groups 5 & 7 | 17 – Unknown mode of action |
| 7 – Photosystem II, different binding behavior than groups 5 & 6 | 19 – Auxin transport inhibition |
| 8 – Inhibition of lipid synthesis (not ACCase inhibition) | 22 – Photosystem I electron diversion |
| 9 – EPSPS synthase inhibition (glyphosate) | 27 – Inhibition of HPPD |

Biology

Lambsquarters *Chenopodium album*



Flower or Seed Head

- Irregular spikes, clustered in flower heads at the ends of branches
- Flowers are perfect, small and usually green

Leaves

- Alternate to simple, egg-shaped to lance-shaped without base appendages
- Usually white, mealy-coated on the underside

Stem

- Erect, much branched above
- Smooth or hairless, with grooves
- Often streaked with red or light green
- 1'-6' tall

Roots

- Taproot, short and much branched

- Life cycle—Annual

Common lambsquarters, also known as green pigweed and white goosefoot, is a summer annual that is most often a concern in the northern Corn Belt. This broadleaf weed prefers rich soils and can be found any place that the soil has been disturbed. Depending on its habitat, common lambsquarters can grow up to 6 feet tall. It is a very competitive weed with corn and soybean crops. For instance, the University of Wisconsin reports that at a density of just two weeds per foot of row, corn yield was reduced 11 percent due to common lambsquarters. In soybeans, at a density of 75 plants per square yard, yield was reduced by 50 percent.

Lambsquarters reproduces by seeds, producing 72,000 seeds per plant, and can persist in the soil for years. Seeds germinate early in the season, from March until May. They can be spread through harvest equipment, clothing and livestock. Lambsquarters is a monoecious, or self-pollinating, plant. Therefore it may be less likely to develop herbicide resistance than a dioecious species.

Common lambsquarters may appear similar to redroot pigweed. However, redroot pigweed leaves have a prominent midvein, while lambsquarters do not. Lambsquarters has opposite leaves at the first true leaf stage, while pigweed is alternate.

For more information, please call the Syngenta Customer Resource Center at 866-3-DO-U-212 or log on to resistancefighter.com

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