

Glyphosate-Resistant Confirmed Kochia in Nebraska

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Glyphosate-resistant kochia (*Kochia scoparia*) was first reported in Kansas in 2009. In Western Kansas, resistant populations have developed into a serious problem in only a few short years. In 2011, work by UNL weed scientists confirmed a glyphosate-resistant kochia population in Keith County, Nebraska. This population has resulted in numerous weed control failures in the past two years. Based on other field reports in 2011, it is believed that there may be many populations in western Nebraska that are resistant to glyphosate. A kochia plant's ability to disseminate over large distances and the vast amount of seed produced by each kochia plant makes it one of the most threatening weeds for crop production in the High Plains region of the US.

Greenhouse studies were conducted in 2011 to determine if a population from Keith County, NE was glyphosate-resistant, and if so, to what level. Dose response studies were conducted with ten treatments of a 5 lb ae/gal glyphosate formulation (0 to 12x). A known glyphosate-susceptible population from Kansas was used with suspected susceptible and resistant populations from Nebraska. Plants were sprayed when the average height reached three inches.



Results suggest a 10 to 15 fold level of resistance in the Keith County population relative to the Nebraska susceptible population. These results also indicate that labeled glyphosate use-rates are not adequate for desired control. Producers need to use an effective burndown program that does not rely solely on glyphosate, and use effective tank mixtures to achieve acceptable control of glyphosate-resistant kochia populations. Because glyphosate is relatively cheap, producers may be tempted to manage problem populations with higher rates of glyphosate. Our results indicate this is not a viable management option and will result in greater selection pressure for higher levels of resistance in resistant populations, and a greater percentage of resistant plants within the total population.

Reports of herbicide-resistance in kochia is not a new phenomenon in the US. Triazine (1976), ALS (1987), and growth regulator (1997) resistant kochia populations have been reported on the International Survey of Herbicide Resistant Weeds website (<http://www.weedscience.org>).

Know how. Know now.



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Kochia Biology

Kochia is an early germinating summer annual broadleaf weed species. It can be found in crop fields throughout the Midwest. It is especially common in corn, soybean, wheat, pasture and right-of-way areas in the central and western parts of Nebraska. Kochia is capable of self or cross pollination, making the prospect of glyphosate resistance spreading in this species via gene flow likely. It has a unique seed dispersal mechanism. After the plant has matured, it will break off at the ground and roll in the direction of a slope or wind. As it rolls, seed is dislodged and deposited in new areas. This mechanism can disseminate the genetics from a single plant over great distances.

Integrated Weed Management is Necessary to Manage Glyphosate-Resistance in Kochia

In a multi-state study conducted by Andrew Kniss (Wyoming), Phil Stahlman (Kansas), Robert Wilson (Nebraska), Phil Westra (Colorado) and Mike Moechnig (South Dakota), crop rotation and herbicide program were evaluated for controlling kochia. Their findings showed that crop was a significant contributor to biomass reduction in kochia. Both corn and soybean were able to significantly suppress biomass regardless of herbicide management. Fallow areas and wheat were not as effective as either corn or soybean, but sugarbeet crops were completely ineffective at suppressing kochia.

In both corn and soybean, a PRE with residual activity plus a POST treatment including something other than just glyphosate were effective at suppressing kochia. POST applications of Clarity, Sharpen and Rage D-Tech all suppressed kochia greater than 80% in fallow, while Huskie, Starane NXT, and Agility SG all did the same in wheat. The three PRE followed by POST treatments in sugarbeet only provided 40-50% control of kochia. All PRE followed by POST treatments provided better control of kochia than the POST glyphosate treatments. In sugarbeet the glyphosate alone treatment was the most effective. This is an indication that glyphosate should not be over-relied upon in other crops in order to make sure that glyphosate is as effective as possible on kochia if sugarbeet is in the crop rotation.

This study provides further evidence for the need of diversified weed control programs which include crop rotation, rotating herbicide mode-of-action and utilizing tank mixtures of multiple herbicides whenever possible. The use of multiple herbicide applications with PRE herbicide that have residual activity are less likely to result in weed control failures. Whenever making herbicide applications, thorough scouting prior and following the applications is necessary to ensure satisfactory performance of herbicides in-season as well as in years to come.

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There are numerous options for effective burndown, preemergence and post emergence control of glyphosate resistant kochia in corn (Table 1), soybean (Table 2), and other areas. Refer to the *2012 Guide for Weed Management in Nebraska* (<http://www.ianrpubs.unl.edu/epublic/live/ec130/build/ec130.pdf>) for detailed information. In soybeans, preemergence herbicides are most effective on kochia. Much like glyphosate-resistant marestail, post emergence options in soybeans are limited and would be unlikely to provide greater than 85% control of glyphosate resistant kochia.

Table 1. Herbicide options to control glyphosate resistant kochia in corn.

Herbicide	Timing	Rate
Balance Flexx* + atrazine	Pre	3.0 – 6.0 oz + 1 lb
Lumax/Lexar	Pre	2.5 – 3.0 qt
Atrazine	Post	1 lb
Buctril + atrazine	Post	1.0 – 1.5 pt + 1 lb
Callisto + atrazine	Post	3.0 oz + 0.5 lb
Impact + atrazine	Post	0.75 oz + 0.5 lb
Laudis + atrazine	Post	3.0 oz + 0.5 lb
Starane Ultra + 2,4-D	Post	0.3 – 0.4 pt + 0.5 – 1.0 pt

* Do not use Balance Flexx on coarse textured soils with less than 2% organic matter if the water table is less than 25 feet. Crop response with Balance Flexx would be most likely to occur on coarse soils with organic matter less than 1.5% and the pH is greater than 7.4.

Table 2. Herbicide options to control glyphosate resistant kochia in soybeans.

Herbicide	Timing	Rate
Authority Assist	Pre	6.0 – 12.0 oz
Command	Pre	1.0 – 2.0 pt
Envive/Enlite	Pre	2.5 – 3.5 oz/2.8 oz
Optill	Pre	2.0 oz
Pursuit Plus	Pre	2.5 pt
Valor XLT	Pre	3.0 – 5.0 oz

Why Does Herbicide-Resistance Evolve?

Herbicide resistance usually results from repeated use of the same herbicide. An over-reliance on glyphosate facilitated by widespread adoption of glyphosate-tolerant crops in the Midwest (primarily corn and soybean) has resulted in the evolution of glyphosate-resistant weed populations. The selection pressure exerted on weed populations by increased glyphosate use over the last ten to fifteen years is unprecedented in the era of herbicide weed control. There were only a few weed species resistant to glyphosate

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worldwide prior to introduction of glyphosate-tolerant crops. Currently 12 weed species in the US have evolved glyphosate-resistant populations, due to repeated glyphosate use over a large land area (>300 million acres just in US). The current US list of weed species with glyphosate-resistant populations include common waterhemp, giant ragweed, common ragweed, kochia, palmer amaranth, marehail (horseweed), hairy fleabane, junglerice, goosegrass, Johnsongrass, Italian ryegrass, and annual bluegrass (source: www.weedscience.org).



Over-reliance on any one single tool for management of weeds is likely to cause inconsistent and eventually ineffective control. While weed management is not impossible in the presence of resistant species, such as glyphosate-resistant kochia, it is certainly more difficult. As new herbicides and traits reach the market, it is important to note they are in known herbicide modes-of-action classes. It has been greater than 20 years since a new herbicide mode-of-action has reached the market for row-crops and therefore it is imperative that currently used herbicides be stewarded in a way to delay the evolution of resistance for as long as possible.

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