SYNTHETIC AUXIN HERBICIDE
APPLICATOR TRAINING PROGRAM

Essential Background

Module 1

In this module:

- Key differences between dicamba and 2,4-D
- Potential problems from improper application
- Impact of improper application: a look back at 2017

Key Differences between Dicamba and 2,4-D

Define It!

Synthetic Auxin Herbicide Key Terms

- **Auxin:** plant hormone that promotes growth, root formation, leaf abscission, etc.

- **Synthetic auxins:** herbicides that act similar to plant auxins

Dicamba vs. 2,4-D

Differences in Symptomology

Dicamba

2,4-D

Dicamba

Tell-tale Symptom: Leaf Cupping

2,4-D

Tell-tale Symptom: Epinasty





Dicamba vs. 2,4-D

Differences in Cropping Systems

	Xtend system		Enlist system		
Available GM Traits					
Tolerances Conferred	Soybean	Cotton	Soybean	Cotton	Corn
Dicamba	✓	✓	x	x	x
2,4-D	x	x	✓	✓	✓
Glyphosate	✓	✓	✓	✓	✓
Glufosinate	x	✓	✓	✓	✓
FOP herbicides	✓*	✓*	✓*	✓*	✓
Available Formulations	*XtendiMax, FeXapan Engenia*		*Enlist One, Enlist Duo*		

**Cotton and Soybean are inherently tolerant to FOP herbicides; tolerance is not conferred by Xtend or Enlist traits*

Potential Problems from Improper Application

Potential Problems

Improper Application Can Have Serious Consequences

- Crop injury
- Yield loss
- Damage to nearby sensitive species
- Harm to neighbor relationships
- Lawsuits and fines
- Black eye for the agriculture industry
- Improper use jeopardizes access to future traits, herbicides, and tools

Crop Injury

Potential Problems with Improper Application

- Both dicamba and 2,4-D can cause visible injury if not applied according to the label
- Each crop or plant species will differ in their sensitivity to 2,4-D and dicamba; for example
  - Non-tolerant soybean is extremely sensitive to dicamba
  - Non-tolerant cotton is extremely sensitive to 2,4-D
- The same kind of species sensitivity differences can exist with vegetables, ornamentals, and tree species

Crop Injury

Example: Potential for Injury on Non-Resistant Soybean

The Impact of Driftable Fractions of Dicamba and 2,4-D on Non-Resistant Soybean

Herbicide	Rate lbs ae/A (fraction of 1x*)	Visible Injury 2 Weeks After Trtmt V3 Drift Event	Visible Injury 2 Weeks After Trtmt R2 Drift Event
		----------%----------	
Dicamba	**0.000025 (1/20,000)**	**21**	**15**
	0.00025 (1/2,000)	**28**	**17**
	0.0025 (1/200)	**32**	**14**
	0.025 (1/20)	**44**	**18**
2,4-D	**0.000025 (1/40,000)**	**2**	**0**
	0.00025 (1/4,000)	**1**	**0**
	0.0025 (1/400)	**1**	**0**
	0.025 (1/40)	**3**	**0**
Control	**----**	**1**	**0**

**1x use rate for dicamba = 0.5 lb/A; 1x use rate for 2,4-D = 1 lb/A.*

***Numbers in red indicate significant differences from the non-treated control.*

Source: Solomon & Bradley (2014)

Crop Injury

Example: Potential for Injury on Non-Tolerant Soybean

Non-treated, Control (healthy, non-injured soybean comparison)

Dicamba
1/20,000th of the 1x Use Rate
(0.000025 lb ae/A)
14 days after V3 application

2,4-D
1/40th of the 1x Use Rate
(0.025 lb ae/A)
14 days after V3 application

Yield Loss

Potential Problems with Improper Application

- Both dicamba and 2,4-D can lead to yield loss if applied at the wrong growth stage.

Example:
Application on soybean after R2 stage can lead to yield loss.

Yield Loss

Example: Potential for Yield Loss in Non-Resistant Soybean

The Impact of Driftable Fractions of Dicamba and 2,4-D on Non-Resistant Soybean

Herbicide	Rate lbs ae/A (fraction of 1x*)	Visible Injury 2 Weeks After Trtmt		Soybean Yield	
		V3 Drift Event	R2 Drift Event	V3 Drift Event	R2 Drift Event
		----------%----------		------Bu/A------	
Dicamba	0.000025 (1/20,000)	21	15	62	63
	0.00025 (1/2,000)	28	17	64	61
	0.0025 (1/200)	32	14	63	56
	0.025 (1/20)	44	18	62	21
2,4-D	0.000025 (1/40,000)	2	0	65	65
	0.00025 (1/4,000)	1	0	65	66
	0.0025 (1/400)	1	0	67	65
	0.025 (1/40)	3	0	65	66
Control	----	1	0	65	65

**1x use rate for dicamba = 0.5 lb/A; 1x use rate for 2,4-D = 1 lb/A.*

***Numbers in red indicate significant differences from the non-treated control.*

Source: Solomon & Bradley (2014)

Yield Loss

Example: Potential for Yield Loss in Non-Resistant Soybean

Non-treated Control (healthy, non-injured soybean comparison)	Dicamba 1/200th of 1x Rate (0.0025 lb ae/A) 14 days after R2 application	Dicamba 1/20th of 1x Rate (0.025 lb ae/A) 14 days after R2 application
		
Source: Solomon & Bradley (2014)	*14% yield loss*	*68% yield loss*

Another Consideration

Dicamba Injury this Year Can Affect Seed Next Year

- Soybean seed emergence was reduced by 50% when parent soybean plants were exposed to a 1/20x use rate of dicamba (0.025 lb/A) at flowering or pod filling
- Progeny from plants treated at R1-R6 growth stages exhibited significant dicamba symptomology 14 days after planting

Sources: Thompson & Egli (1973); Barber et al. (2015)

Crop Injury and Yield Loss

Potential for Injury and Yield Loss in Non-Tolerant Cotton

Cotton injured by 1/500th of the 1X rate of 2,4-D. 2,4-D resulted in higher visual injury and yield loss to cotton than dicamba or 5 other synthetic auxin herbicides.

Source: Marple et al. (2007)

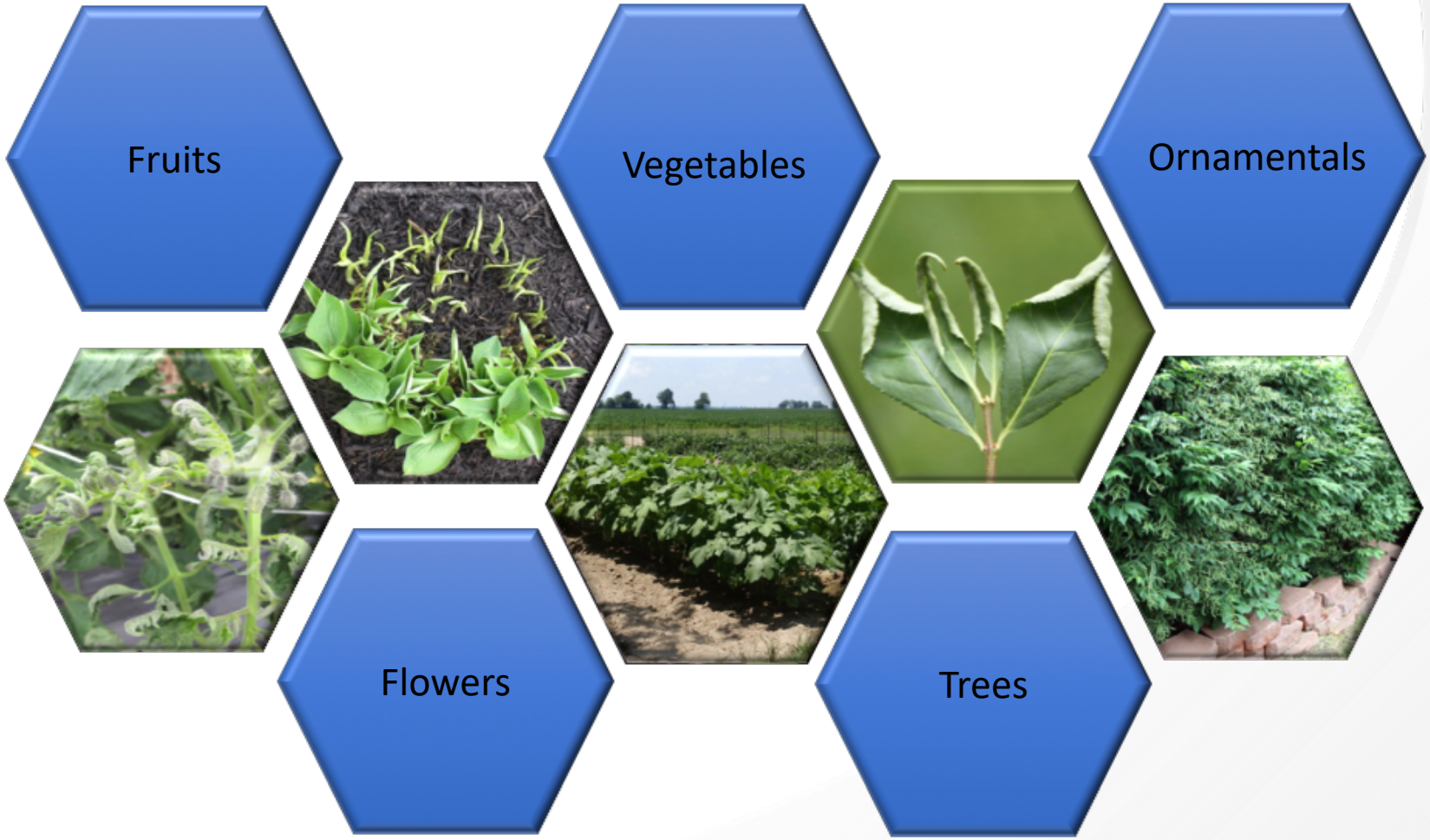
2,4-D at 1/40th the labeled use rate caused a 45-50% cotton yield reduction when applied at early growth stages, and a 68% yield loss when applied at the pinhead square growth stage.

Source: Everitt & Keeling (2009)

Photo courtesy of Dr. Stanley Culpepper, University of Georgia

Damage to Other Sensitive Species

Potential Problems with Improper Application



Damage to Other Sensitive Species

Sensitivity of Various Crop and Vegetable Species to 2,4-D

Lower	Moderate	Severe	Extreme
Broccoli Cabbage Kale Mustard Onions Peanut Turnip	Cantaloupe Canola Cucumber Pecan Squash	Pepper Pumpkin Tomato Watermelon	Cotton Grapes* Tobacco*
>1/75X	1/75-1/300X	1/300-1/800X	< 1/800X

Herbicide Rate of Detectable Injury

**Data from literature; all other data generated in GA field studies.*

Slide courtesy of Dr. Stanley Culpepper, University of Georgia

Damage to Other Sensitive Species

Sensitivity of Various Crop and Vegetable Species to Dicamba

Lower	Moderate	Severe	Extreme
Broccoli Cabbage Kale Mustard Turnip	Cantaloupe Cucumber Squash	Cotton Pepper Tomato Watermelon	Grapes* Lima bean Southern pea Snap bean Soybean Tobacco*
>1/75X	1/75-1/300X	1/300-1/800X	< 1/800X

Herbicide Rate of Detectable Injury

**Data from literature; all other data generated in GA field studies.*

Slide courtesy of Dr. Stanley Culpepper, University of Georgia

Damage to Other Sensitive Species

Sensitivity of Various Tree and Ornamental Species to Dicamba

Lower	Moderate	Extreme
Walnut	Pecan	Apple
Raspberry	Elm	Peach
Crabapple	Redbud	Grape
Hydrangea	Rose	Elderberry
Sweetgum		Dogwood
		Maple
		Oak

*Results based on a 2017 experiment conducted in Columbia, Missouri

Damage to Other Sensitive Species

Sensitivity of Various Tree and Ornamental Species to 2,4-D

Lower	Moderate	Extreme
Maple	Peach	Grape
Raspberry	Elm	Apple
Crabapple	Walnut	Dogwood
Hydrangea	Pecan	Oak
Sweetgum		Redbud
Rose		
Elderberry		

*Results based on a 2017 experiment conducted in Columbia, Missouri

A Black Eye for the Ag Industry

Potential Problems with Improper Application

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EPA executes search warrants related to Dicamba

Saturday, October 22, 2016

Cody Tucker

Daily Dunklin Democrat

According to a news release obtained by the DDD Friday from the Environment
Protection Agency, EPA has executed federal search warrants at several locatio
southeastern Missouri as part of an investigation into alleged misuse or misapp
herbicide products containing Dicamba. EPA's investigation is ongoing and sten
widespread complaints of damage to various crops across Missouri and several
states in the Midwest and Southeast.

Southern Illinois farmer's grapevines destroyed by dicamba; four years of work lost

Sunday, October 29, 2017

By T

MENU ST. LOUIS POST-DISPATCH News Sports Business Go! Life Buy/Sell

Law and order

Bootheel man arrested following fatal shooting allegedly sparked by dicamba dispute

By Bryce Gray St. Louis Post-Dispatch Oct 28, 2016 (2)

Jerry Thurston, left, and his wife Lisa Thurston stand in their vineyard of about 12 acres on Thursday, Oct. 26, 2017 at Spring Valley Farm & Vineyard in Pulaski, Illinois. Jerry said about 4 acres of his crops from the vineyard along with 40 acres of soybeans where damaged from the herbicide, Dicamba, that drifted to his fields killing his crops.
Andrew J. Whitaker

Impact of Improper Application:
A look back at 2017

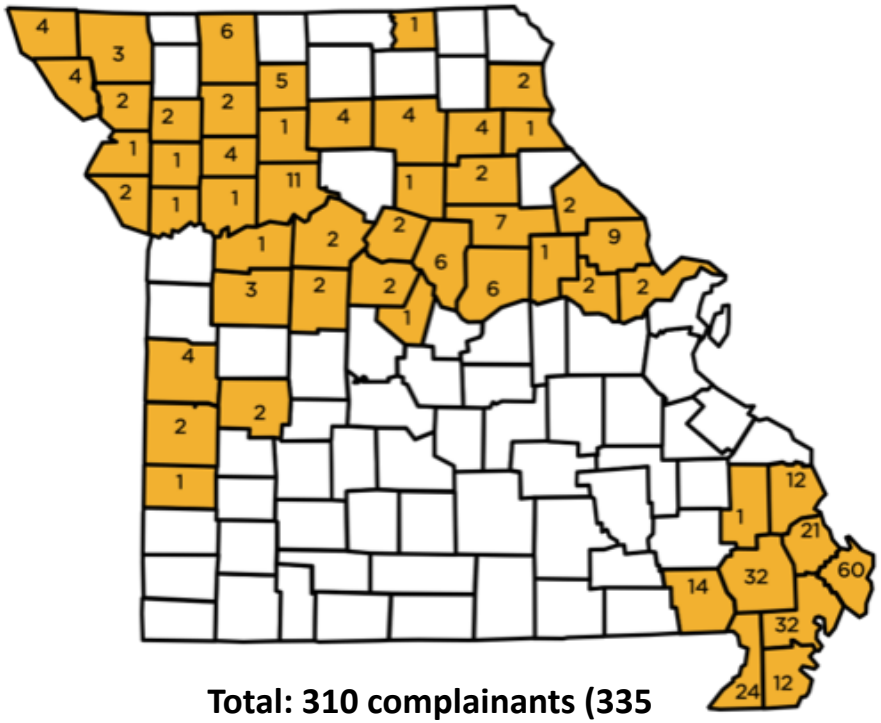
Improper Application of Dicamba

A Look Back at 2017

In 2017, **thousands of acres were damaged in Missouri.**

Dicamba Complaints in Missouri

Number of Complaints and Reports of Crop Damage* in 2017



Total: 310 complainants (335 complaints) across 52 counties

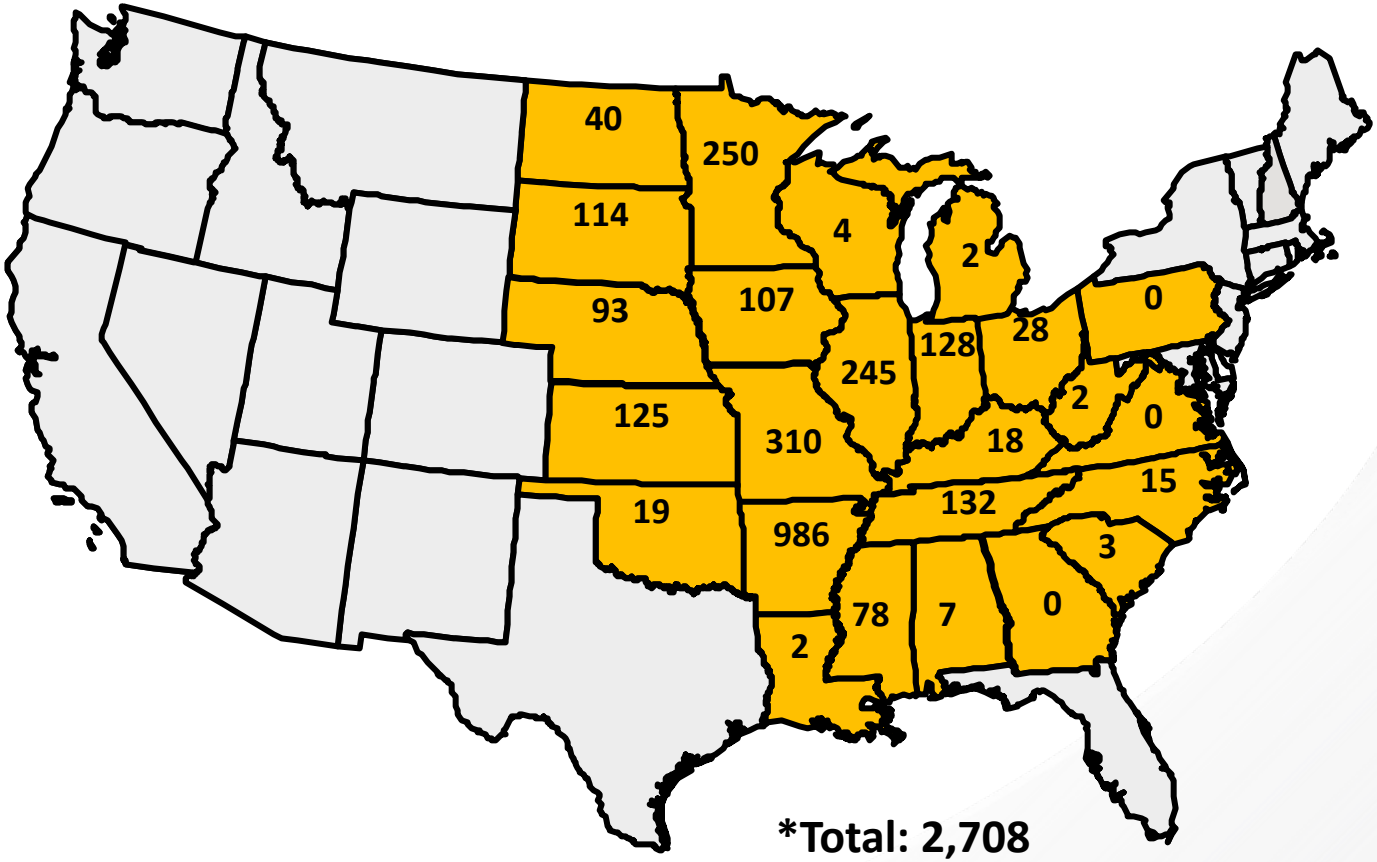
(as of 10/26/2017)

- 108,758 acres of soybean
- 18,904 tomato plants
- 758 acres of peaches
- 132 acres of vineyards
- 130 acres rice
- 122 acres of watermelons
- 35 acres of alfalfa
- 24 acres certified organic vegetables
- 15 acres of pecan trees
- 12 acres of apple trees
- 11 commercial gardens
- 10 acres of cantaloupes
- 2 acres of pumpkins
- 900 mums
- 40 residential properties (gardens/trees/shrubs)

*Crops damaged as identified by complainants: (as of 10/26/2017)

U.S. Injury Investigations

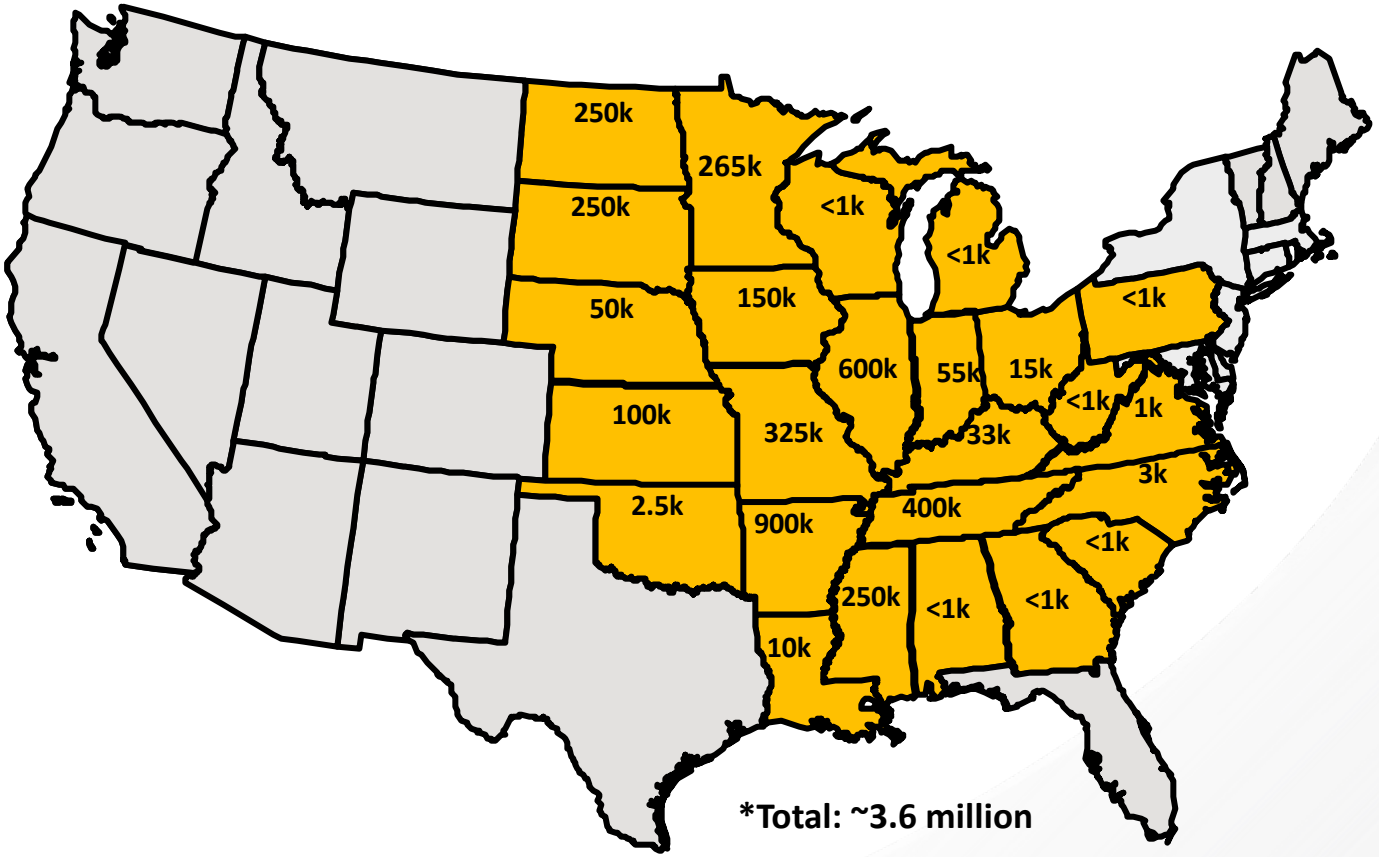
Dicamba-related Injury Investigations as Reported by State Departments of Agriculture



(*as of October 15, 2017)

Injured U.S. Acreage

Estimates of Dicamba-injured Soybean Acreage in the U.S. Reported by State Extension Scientists



(*as of October 15, 2017)

Key Reminders:

- Synthetic auxin herbicides can be an effective tool for the management of troublesome broadleaf weed species.
- Dicamba and 2,4-D have the potential to cause a variety of issues when the herbicides contact sensitive plant species.
- The movement of dicamba caused significant damage in 2017 in Missouri and across the U.S.
- Misapplication contributed to the problems observed in 2017.

Acknowledgements

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Sources

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