

New Herbicide Technology Session

LACA Meeting February 12, 2015

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Consultants - Harold Lambert and Ray Young

LDAF - Kevin Wofford

Industry Reps - Jonathan Siebert, Fran Deville, Brad Guice



Current Situation in Weed Management

“The chemical companies are not developing new herbicides with new modes of action, but rather are developing new technologies for use with old herbicides.”

Dr. Stephen O. Duke, USDA

Why? Herbicide-resistant weeds





Major Culprit

Glyphosate-resistant Palmer amaranth verified in Louisiana by Dr. Daniel Stephenson in 2010

New Weed Management Systems

Enlist Weed Control System

- Dow AgroSciences
- Use of 2,4-D herbicide



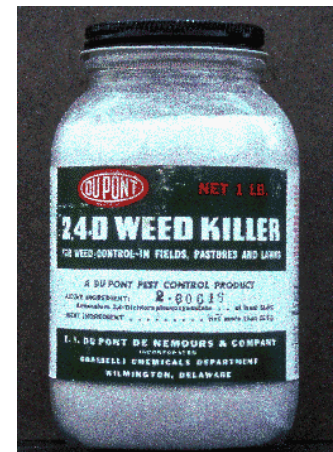
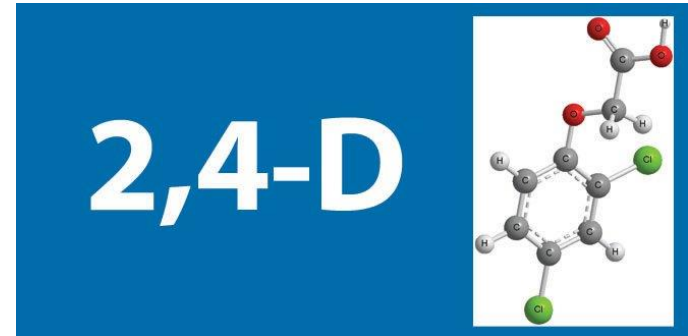
Roundup Ready Xtend Crop System

- Monsanto Company
- Use of dicamba herbicide



2,4-D Herbicide

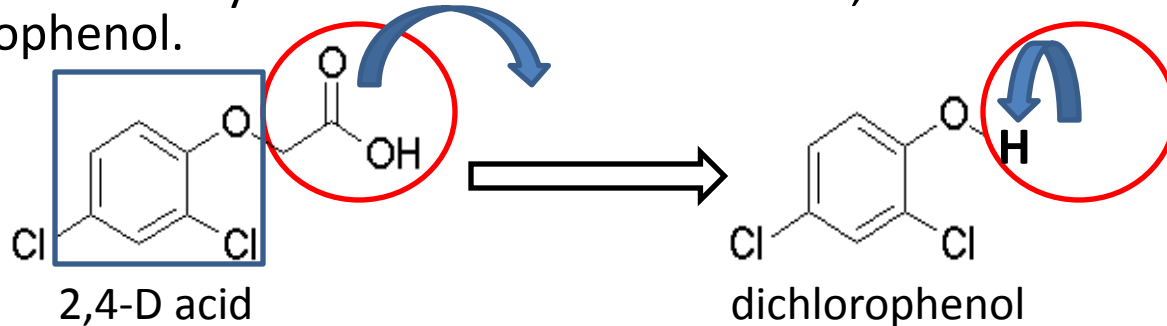
- Synthetic auxin herbicide in the phenoxy chemical family
- First used in the U.S. in the 1940s and marked the beginning of the selective chemical weed control era
- One of the most widely used herbicides worldwide
- Controls annual and perennial broadleaf weeds in grass crops
- Would offer a different mode of action for control of broadleaf weeds and glyphosate-resistant Palmer amaranth in row crops



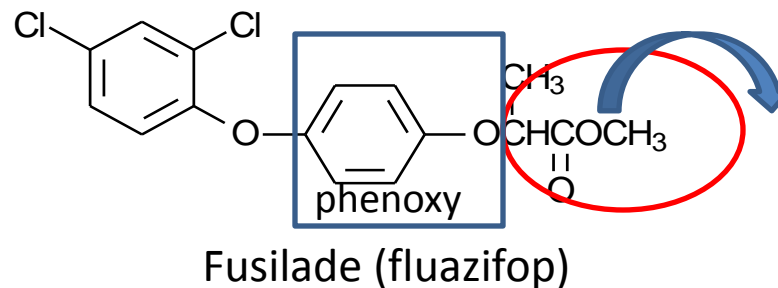
Enlist Weed Control System

2,4-D Tolerant Crops (Dow AgroSciences)

- Crop tolerance in transgenic plants achieved through insertion of the aad-12 gene that encodes for a bacterial aryloxyalkanoate dioxygenase enzyme (metabolism/deactivation gene)
- Production of enzyme leads to breakdown of 2,4-D to the non-herbicidal dichlorophenol.



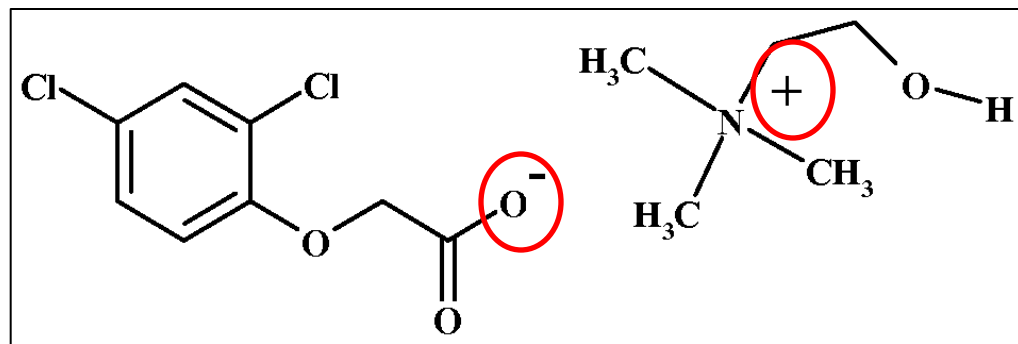
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- In corn, the enzyme will also lead to the breakdown of the aryloxyphenoxy propionate (fop) herbicides: flazifop (Fusilade), quizalofop (Assure)



Enlist Weed Control System 2,4-D Salt Formulation


Dow AgroSciences

- A herbicide premix will be marketed that contains glyphosate and 2,4-D choline, a quaternary ammonium salt with reduced volatility



Choline salt of 2,4-D

Enlist Weed Control System Herbicide to be Marketed

Technology	Tolerance to:	Product/Rate
Enlist™ Corn	Glyphosate, 2,4-D (<u>greater tolerance</u>), fop herbicides	<p>Dow AgroSciences - Enlist Duo™ 3.33 lb ai/gal = 1.63 lb of 2,4-D-choline salt + 1.71 lb of glyphosate DMA salt</p> <p>Use rate of 3.5 pt/A = 1.5 pt 2,4-D 3.8S + 22 fl oz glyphosate potassium salt</p> 
Enlist™ Soybeans	Glyphosate, 2,4-D	Enlist Duo™
Enlist™ E3 Soybeans	Glyphosate, 2,4-D, glufosinate	Enlist Duo™ plus Liberty
Enlist™ Cotton	Glyphosate, 2,4-D, glufosinate	Enlist Duo™ plus Liberty

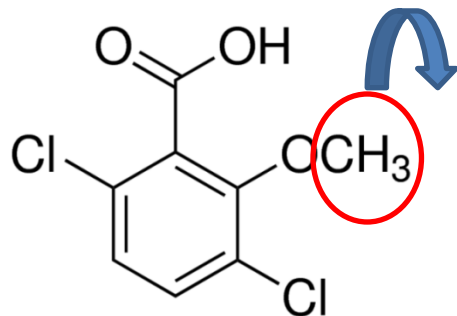
Dicamba Herbicide

- Synthetic auxin herbicide in the benzoic acid chemical family
- Discovered in 1958 and first marketed in 1964 as Banvel DMA salt
- Clarity DGA salt marketed in 1992
- Sixth most widely used herbicide in the U.S., with more than 25 million acres of farmland treated annually
- Controls annual and perennial broadleaf weeds in grass crops
- Would offer a different mode of action for control of broadleaf weeds and glyphosate-resistant Palmer amaranth in row crops

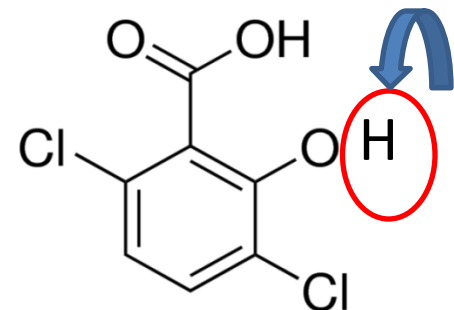
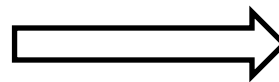


Roundup Ready Xtend Crop System Dicamba Tolerant Crops (Monsanto)

- Discovery at University of Nebraska of soil bacterium (*Pseudomonas maltophilia*) that metabolizes dicamba to a non-herbicidal/inactive active form (*Science* 2007)
- Crop tolerance in transgenic plants achieved through insertion of a gene that encodes for a bacterial DMO (dicamba monooxygenase) enzyme (metabolism/deactivation gene)
- Production of DMO leads to breakdown of dicamba to the non-herbicidal 3,6-dichlorosalicylic acid



3,6-dichloro-o-anisic acid (dicamba acid)



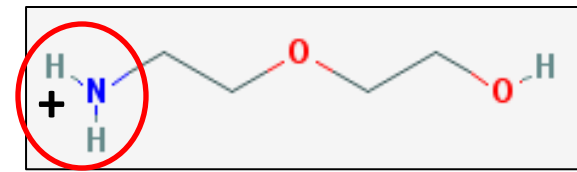
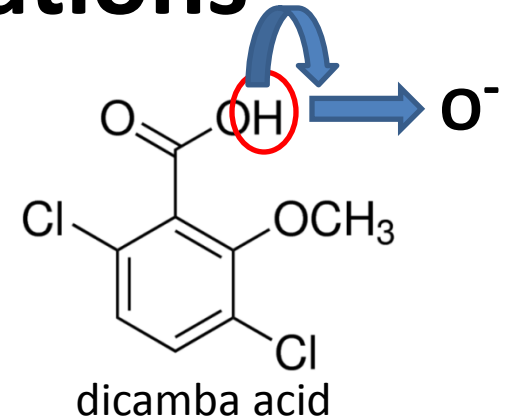
3,6-dichlorosalicylic acid (non-herbicidal)

Roundup Ready Xtend Crop System

Dicamba Salt Formulations

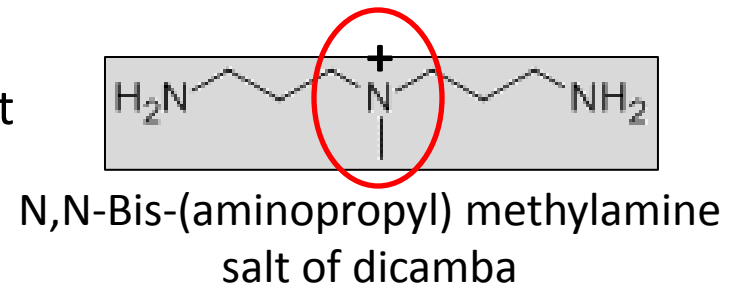
Monsanto

- A diglycolamine (DGA) salt of dicamba plus a monoethanolamine salt of glyphosate which includes VaporGrip technology to reduce volatility of dicamba
- A diglycolamine (DGA) salt of dicamba which includes VaporGrip technology, a special adjuvant to help reduce drift of dicamba








BASF

- A BAPMA (N,N-Bis-(aminopropyl) methylamine), a tridentate amine salt, that provides strong and effective binding of dicamba spray residues to suppress volatilization






Roundup Ready Xtend Crop System Herbicides to be Marketed

Technology	Tolerance to:	Product/Rate
<p>Roundup Ready 2 Xtend™ Soybeans</p> 	<p>Glyphosate, dicamba</p>	<p><u>Monsanto</u> - Roundup Xtend™ 3L with VaporGrip™ technology; Roundup Xtend™ @ 64 fl oz /A equivalent to 1 lb/A monoethanolamine glyphosate + 1 pt/A Clarity (dicamba-diglycolamine)</p> 
		<p><u>Monsanto</u> - Xtendimax™ 4L (dicamba diglycolamine salt) with VaporGrip™ technology; Xtendimax™ @ 16 fl oz/A equivalent to 0.5 lb/A Clarity (dicamba-diglycolamine)</p> 
		<p><u>BASF</u> - Engenia 5SL (dicamba BAPMA salt) Rate 12.8 oz/A (equivalent to 1 pt/A Clarity) 1 gallon Engenia per 10 acres)</p> 
<p>Bollgard II® XtendFlex™ Cotton</p> 	<p>Glyphosate, dicamba, glufosinate</p>	<p><u>Monsanto</u> - Roundup Xtend™ 3L with VaporGrip™ technology; Roundup Xtend™ @ 64 fl oz /A equivalent to 1 lb/A monoethanolamine glyphosate + 1 pt/A Clarity (dicamba-diglycolamine)</p>

Weed Control with 2,4-D and Dicamba

Effectiveness of 2,4-D and dicamba on broadleaf weeds 4 weeks after application.

Herbicide	Palmer amaranth	prickly sida	hemp sesbania	morningglory	cocklebur	sicklepod	hophornbeam copperleaf	smellmelon
2,4-D Amine 1.0-2.0 pt/A	8	8	8	9	9	8	8	8
Clarity/Banvel 8 oz/A 	8	9	9	9	9	7	8	8
2,4-D Amine 1.0 pt/A	8	8	-	9	9	8	-	-
Clarity/Banvel 8 oz/A 	9	-	-	9	8	8	-	-
2,4-D Amine 0.5-1.5 pt/A	8	8	8	9	8	8	-	-
Clarity/Banvel 8-16 oz/A 	8	8	9	9	9	8	-	-
Average 2,4-D (0 to 100%)	80	80	80	90	87	80	80	80
Average Clarity/Banvel (0 to 100%)	83	85	90	90	87	77	80	80

Current Regulatory Status

Dow AgroSciences

Technology/ Herbicide	USDA	EPA
Enlist™ Corn	Submitted August 2009 Deregulated September 2014	N/A
Enlist™ Soybeans	Submitted December 2009 Deregulated September 2014	N/A
Enlist™ E3 Soybeans	Submitted August 2011 Deregulated September 2014	N/A
Enlist™ Cotton	Anticipated 2015	N/A
Enlist™ Duo herbicide	N/A	Submitted December 2012 Final Registration October 2014 (includes corn and soybeans in 6 states at this time)

Note: Awaiting global import approval of 2,4-D-resistant seed.

Current Regulatory Status

Monsanto/BASF

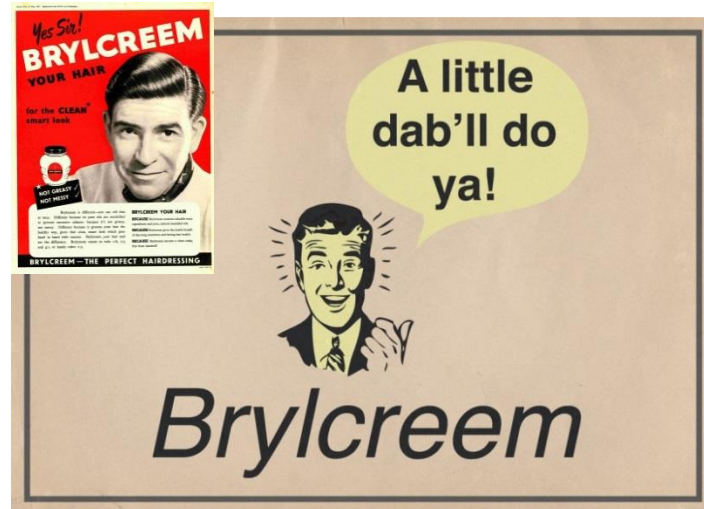
Technology/ Herbicide	USDA	EPA
Roundup Ready 2 Xtend™ Soybeans	USDA approval for dicamba-resistant soybean technology	N/A
Bollgard II® XtendFlex™ Cotton	USDA approval for dicamba-resistant cotton technology	N/A
RoundupXtend™, Xtendimax™, and Engenia™ herbicides	N/A	Awaiting EPA approval for dicamba that will be used in the crops.

Note: Awaiting global import approval of dicamba-resistant seed.

Concerns/Issues

Dicamba and 2,4-D Technologies

- Labels will be very specific and restrictive; Enforcement?
- Crop sensitivity
 - 2,4-D on cotton and dicamba on soybeans
 - Like Brylcreem, “a little dab’ll do ya!”
 - These herbicides “will tell on you!”
- Off-target movement
 - Volatility not likely to be major contributor; companies have developed “low volatile” formulations
 - Physical drift – affected by droplet size, spray pressure, nozzle type, boom height, wind speed, etc.
 - Spray tank contamination/sprayer clean-out



Soybean Yield Reduction Associated with Dicamba Off-Target Movement (M. Foster Thesis Research)

Dicamba Rate (oz/A)	Dicamba rate (fraction of use rate)	Height reduction	Overall visual injury	Yield reduction
		% 14 DAT	% 14 DAT	%
0	--	--	--	--
0.02	1/1024 x	16	42	2 (NS)
0.03	1/512 x	19	49	2 (NS)
0.06	1/256 x	29	56	7 (NS)
0.13	1/128 x	29	57	10
0.25	1/64 x	31	62	18
0.50	1/32 x	40	75	27
1	1/16 x	50	81	55
2	1/8 x	80	88	83
4	¼ x	86	94	100
8	½ x	88	98	100

Volatility
1/1000th x

Spray tank
contamination
1/50th - 1/400th x

Physical
drift
1/10th -
1/100th x

Roundup Xtend, Xtendimax, Engenia Labels

- No aerial application allowed
- Use nozzles that deliver extremely coarse to ultra coarse droplets - TTI, TDXL-D, ULD, etc.
- Boom height no more than 24 inches above the canopy
- Spray when wind is 0 to 10 mph; 3 to 10 mph when a temperature inversion exists
- Spray volume minimum of 10 GPA
- Buffer (set back) defined by rate and wind speed/direction
- Sprayer cleanout – use commercial cleaner followed by triple rinse??
- Restricted additives - No ammonium sulfate (e.g., AMS, UAN) containing materials or acidifying water conditioners
- Use drift reduction agents
- Ground speed no more than 15 MPH
- Enforcement?



Enlist Duo Label

- No aerial application allowed
- Use of non-choline formulations of 2,4-D not authorized for use in Enlist crops
- Nozzles
 - Label will include a chart listing allowable nozzles and spray pressure
 - Use of any nozzle not listed is a label violation.
- Tank Mixing
 - Dow to maintain website of acceptable tank mix partners (<http://EnlistTankMix.com>)
 - Label prohibits tank mixing with any product not listed
- Susceptible plant buffers
 - Maintain a 30 foot downwind buffer to protect sensitive areas; application not allowed if wind blowing toward adjacent fruiting vegetables, cucurbits, grapes, cotton
- Wind speed restriction (<15 mph)
- Sprayer cleanout specified on label – triple rinse procedure??
- Enforcement?



Comments

Dr. Donnie Miller, LSU AgCenter



- Control of weeds in NE Louisiana will be fairly similar between 2,4-D and dicamba. Dicamba is better on large sesbania, smartweed, and resistant marehail. Both herbicides are good on small morningglory and pigweed. 2,4-D in burndown is better on primrose.
- Both weed control systems will be a good call where hot spots of glyphosate-resistant Palmer are present but would not be head and shoulders above what we now have.
- The deciding factor between the two will have little to do with efficacy from a weed management standpoint.
- Varieties available with the technologies will drive the decision and farmers may select varieties as a self defense response.
- It does not appear that the companies are positioning the technologies as replacing anything, so residuals at planting and at layby will continue to be beneficial. I do not see wholesale changes occurring over what growers are currently doing.
- Bottom line, complimentary preemergence, at planting, and layby programs currently used will continue to be used with the new systems.

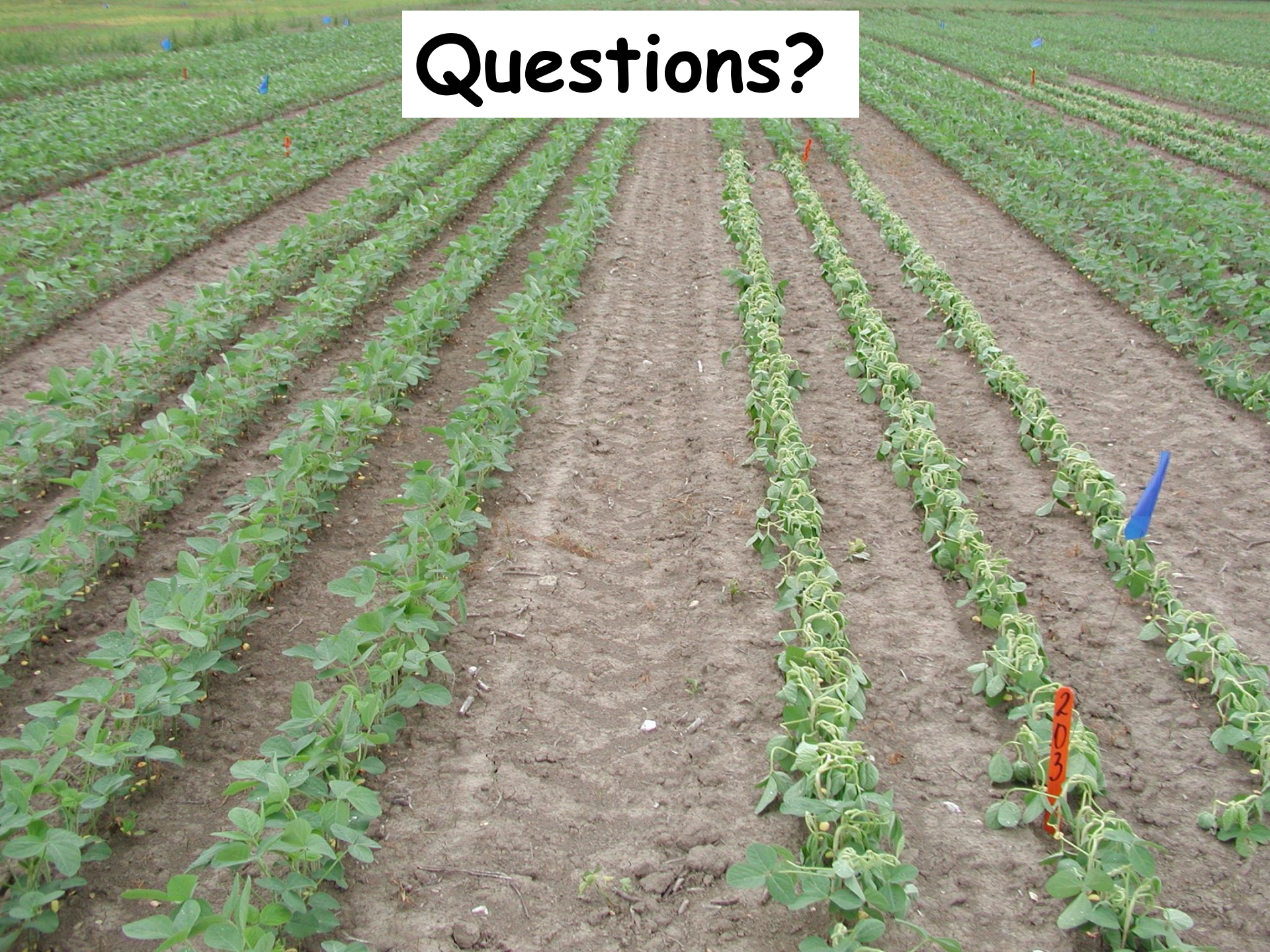
Comments

Dr. Daniel Stephenson IV, LSU AgCenter



- I see both weed control systems as another tool in the toolbox but neither is a "silver bullet".
- Comparing 2,4-D and dicamba:
 - 2,4-D is a better burndown herbicide for winter weeds and is more effective on morningglory; 2,4-D and dicamba provide little if any residual control.
 - Liberty plus 2,4-D choline is outstanding, but Dow will not sell 2,4-D choline alone. Liberty could hamper the inherent drift reduction properties in Enlist Duo.
 - With more than 1 million acres of soybean, it is scary when I consider the potential physical drift and misapplication of dicamba on non-Xtend soybeans.
- Weeds should be 4-inches or less at application for maximum efficacy. Control can be greatly reduced if weeds are large, especially glyphosate-resistant Palmer amaranth.
- My fear is that producers will shift to a total postemergence program where two applications of Enlist Duo or glyphosate + dicamba are made. This approach would set up the technology for failure.
- Bottom line, Enlist Duo and dicamba should be part of a program that includes an effective burndown along with residual herbicide applied at planting and co-applied with Enlist Duo or glyphosate + dicamba postemergence.

Questions?



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