THE UNIVERSITY OF ARIZONA

COLLEGE OF AGRICULTURE AND LIFE SCIENCES

COOPERATIVE EXTENSION

School of Plant Sciences

2020 Cotton Chemical Weed Control Review

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The Past – Cotton Chemical Weed Control

- Started in Extension - 1991
  - Reviewed past PowerPoint presentations
  - Topics discussed
    - Weeds
    - Herbicides
    - Issues

Past Chemical Weed Control in Cotton

- Early 1990s
  - No truly selective “over-the-top” (topical) BROADLEAF herbicides
  - Focus on preemergence herbicides: pendimethalin, trifluralin
    - Used with diuron or prometryn or cyanazine (Bladex)
  - Grass herbicides were more widely used
    - Fusilade 2000, Poast Plus, and Select 2EC
  - Purple & Yellow nutsedges ranked as the worst weeds in cotton
    - Eptam, MSMA, Dual (yellow nutsedge only)
    - Zorial Rapid 80 (norflurazon – now marketed as Solicam)
  - Other problem weeds: e.g., morningglories, pigweeds
  - Herbicide resistant weeds NOT on growers minds

Past Chemical Weed Control in Cotton

- Late 1990s
  - BXN Cotton resistant to Buctril (bromoxynil)
  - Roundup Ready Cotton resistant to glyphosate
    - Tolerance issue – Topical only to 4th true leaf
    - Labelled rate was 0.75 lb ae/A (equivalent to 22 oz/A Roundup PowerMAX)

Tolerance of DP5690RR to Topical Roundup Ultra

Treatment	Seed Cotton Yield (kg/plot)
Roundup Ultra -1 qt/A, 4 leaf	11.2 ± 2.3 a
Roundup Ultra -1 qt/A, 4 leaf + 6 node	10.6 ± 1.0 ab
Roundup Ultra -1 qt/A, 4 leaf + 10 node	4.5 ± 0.5 c
Roundup Ultra -1 qt/A, 4 leaf + 14 node	9.0 ± 1.5 b
No Roundup Ultra	11.3 ± 2.0 a

- Yield effect was not consistent
- Spray topical glyphosate up to 4th true leaf.

All treatments received Treflan @ 0.5 lb. a.i./A PPI and were hand weeded

Past Chemical Weed Control in Cotton

- Late 1990s
  - BXN Cotton resistant to Buctril (bromoxynil)
  - Roundup Ready Cotton resistant to glyphosate
    - Tolerance issue – Topical only to 4th true leaf
  - Staple herbicide – selective topically
  - Increase in off-target drift issues and application errors
  - Preemergence herbicides
    - pendimethalin, trifluralin + diuron or prometryn or cyanazine (Bladex)
  - Other herbicides & weeds similar as in early 1990s.

Past Chemical Weed Control in Cotton

- 1990s Trends (570,000 acres of cotton at start of decade)
  - Preplant Incorporated (PPI) herbicides used extensively
  - Cultivation was common, routine
  - Post-directed herbicides sprayers were commonly used
    - Shields and hoods to protect cotton (prometryn, diuron, etc.)
    - 6 row equipment for accurate placement of herbicide
  - Hand weeding was common
  - Growers made an effort to spray small weeds
    - Herbicide options did not perform well on large weeds

Early 2000s

- Precision cultivation
- Development of Roundup Ready Flex Cotton
- Development of Liberty Link Cotton (glufosinate)
- Herbicide registrations
  - Aim (carfentrazone)
  - ET (pyraflufen)
  - Chateau (flumioxazon)
  - Envoke (trifloxysulfuron)
- Herbicide resistant weed concerns were minimal

Tools – 2006 Cotton Herbicides by Target Weed

Grasses

Preemergence: Pendimax, Prowl, Prowl H_2O, Treflan, trifluralin

Postemergence: Poast, Fusilade, Select, glyphosate, DSMA, Ignite280, MSMA

Broadleaves

Preemergence: Prowl, Treflan, diuron* (Karmex), prometryn (Caparol), Zorial* Rapid 80 (*do not use PPI if dry planting cotton)

Postemergence: Aim, Chateau, Cotoran (fluometuron), diuron, DSMA, Envoke, ET, glyphosate herbicides-RR Flex (e.g., Glyphomax, Glyphos, Glyphosate Original, Roundup WeatherMax, Touchdown IQ), Goal, Ignite280, MSMA, prometryn, Staple, Suprend

Nutsedges

Preemergence: Zorial Rapid 80, Dual Magnum (yellow only)

Postemergence: DSMA, Envoke, glyphosate herbicides, Ignite280 (suppression), MSMA

Post-directed and Layby Herbicide Options: Cotton 12 to 24 Inches Tall or Greater

- Herbicide (add adjuvants) — Soil Texture
- Aim – 1 to 1.6 oz/A — no soil activity
- Chateau – 2 oz/A — all, soil activity
- Diuron – 0.8 to 1.6 qt/A — coarse and medium
- ET – 0.5 to 1 oz/A — no soil activity
- Prometryn - 0.8 to 1.6 qt/A — coarse and medium
- Goal – 0.5 lb ai/A — all soil types
- Layby Pro (linuron, diuron) – 1.6 to 2.4 pt/A — all soil types
- Tank mixes
  - PPO inhibitors (Aim, ET) + either prometryn or diuron
  - RR/glyphosate (e.g. grasses, nutsedges or large weeds) or Liberty cotton/Ignite
- Consider layby herbicide-crop rotation restrictions

Past Chemical Weed Control in Cotton

- Early 2010s Trends
  - Preplant Incorporated (PPI) herbicides NOT always used
    - Pendimethalin, trifluralin remain very effective against Palmer amaranth
  - Cultivation for weed control NOT often used
  - Post-directed spraying using shields or hood was NOT common.
  - Layby herbicide treatments often not used.
  - Total postemergence chemical weed control programs common
    - Large broadcast spray booms and topical sprays
  - Hand weeding NOT common, labor shortages

* July 2012: field after 3 sprays of 44 oz/A (1.5 lb ae glyphosate/A). Grower admitted having difficulty controlling Palmer amaranth in 2011.

* Second GR Palmer amaranth field in Buckeye with patchy distribution

* Plants sprayed with 5% solution 7/11; no symptoms 7/17

Herbicide Resistant Weeds

- Buckeye Palmer Amaranth population Resistant to:
  - Glyphosate
  - ALS inhibitors: Staple, Envoke, Sandea, Raptor, Pursuit,
- Glyphosate resistance in Palmer amaranth developed once (Georgia).
- Transported across the county on equipment
  - Illustrates the need for sanitation
- Common across Arizona

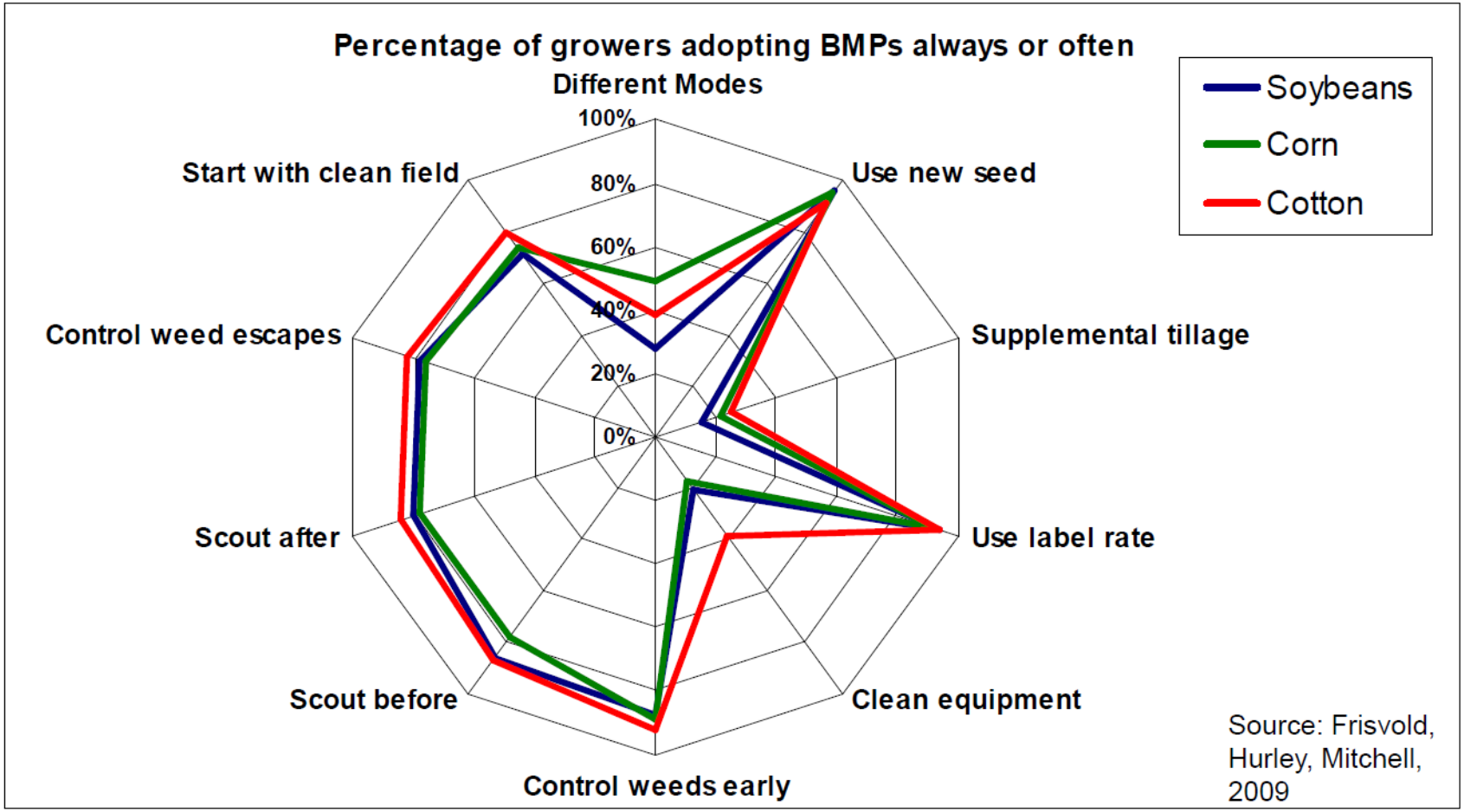
Glyphosate Resistant Palmer amaranth Coolidge – August 24, 2016

Glyphosate Resistant Palmer Amaranth in Marana

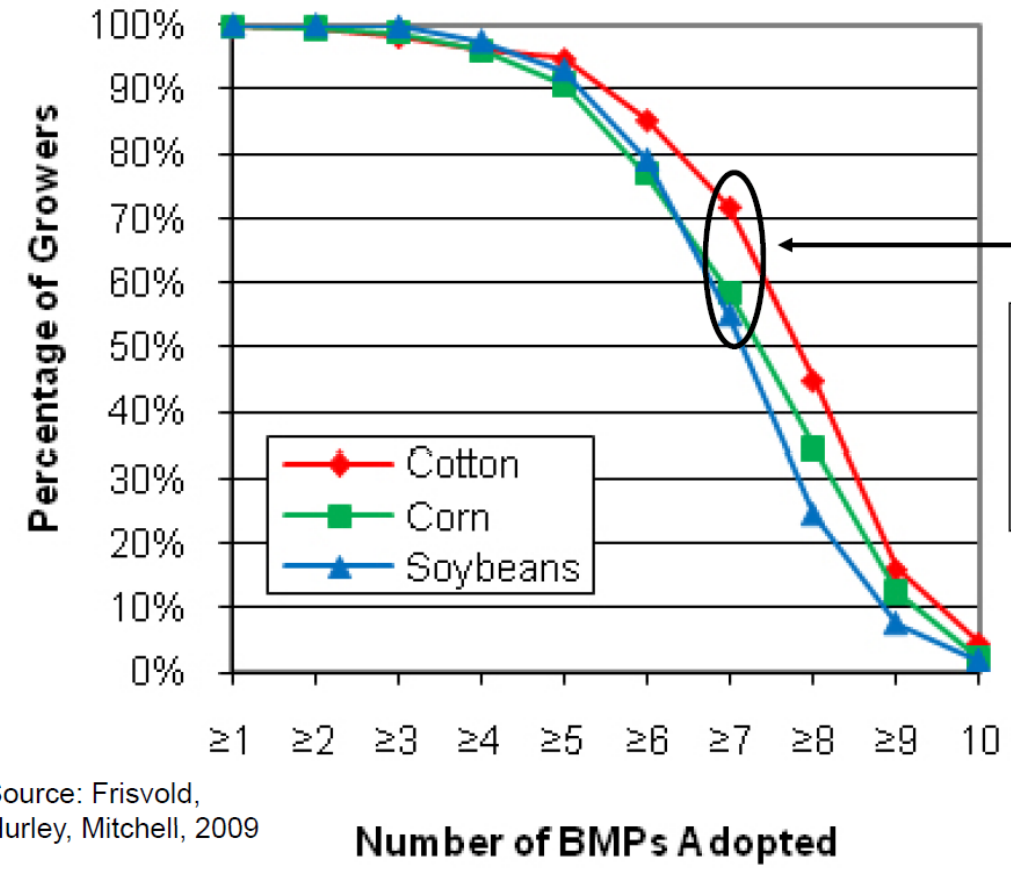
Risks of over reliance on chemical weed control

- Herbicide Resistance
  - Glyphosate resistant Palmer amaranth (also ALS resistant)
  - Glyphosate resistant hairy fleabane
  - Atrazine resistance in Palmer amaranth reported

BMP adoption varies more across practices than crops



Growers often or always adopting BMPs by total number of BMPs adopted



Most growers adopting 7 or more BMPs often or always

Source: Frisvold, Hurley, Mitchell, 2009

Risks of over reliance on chemical weed control

- Herbicide Resistance
  - Glyphosate resistant Palmer amaranth (also ALS resistant)
  - Glyphosate resistant hairy fleabane
  - Atrazine resistance in Palmer amaranth reported
- Off target movement or drift
  - Volatility or movement of herbicide in gaseous form
  - Spray droplet movement
- Sprayer contamination
- Application error
  - Spraying the wrong field

Proactive Management Tactics that delay herbicide resistance can include one or more of the following tactics:

Herbicides
Multiple herbicides each with different mechanisms of action
– Mixes
– Sequences
– Across seasons

Mechanical
Tillage
– Pre-plant
– In-crop cultivation
– Mowing
– In-row weeding
– Post-harvest
Hand-rogueing before seed set

Cultural
Crop rotation
Plant population
Row spacing
Planting date
Fertilizer placement
Cover crops

PREE- & POST-Emergence Selective Cotton Herbicides (use with appropriate traits)

Preplant – Residual Herbicides	Early POST – Mid POST (sequential sprays) Selective Chemistries (with appropriate varieties)
Pendimethalin	Dual Magnum (metolachlor) Warrant (acetochlor) Outlook (dimethenamid-P)
Trifluralin	Pendimethalin (Prowl H_20)
Prometryn	Glyphosate
Diuron	Glufosinate (Liberty, Interline)
Solicam	2,4-D-choline (Enlist One) 2,4-D-choline+glyphosate (Enlist Duo)
	Dicamba (Engenia, Xtendimax)
	Pyrithiobac (Staple LX), Trifloxysulfuron (Envoke)
	Graminicides: fluazifop, sethoxydim, clethodim (Fusilade, Poast, Select)

Cotton Post-Direct and Layby Herbicides

Layby PD broadcast	PREE soil activity	Foliar Herbicide type/activity	General Crop Rotation intervals
Prowl H_2O (pendimethalin)	Yes	None	Medium-Long
Prometryn	Yes	Contact	Short
Diuron	Yes	Contact	Long
Goal, GoalTender (oxyfluorfen)	Yes	Contact	Long-small grains, Short labeled crops
Chateau (flumioxazin)	YES	Contact	Short with tillage
Fierce (flumioxazin + pyroxasulfone)	YES	Contact	Long
Aim (carfentrazone)	NO	Contact	None-registered crops
ET (pyraflufen)	NO	Contact	Short (30 days)

New Cotton Herbicides

- Dicamba resistant cotton – Bayer (formerly Monsanto)
  - Engenia (BASF) – dicamba (BAPMA, tridentate amine salt*)
  - XtendiMax (Bayer) – dicamba (DG or diglycolamine salt*)
  - *All include proprietary technology to reduce volatility
- 2,4-D resistant cotton – Corteva (formerly Dow)
  - Enlist One – 2,4-D:choline formulation (best seller in 2018)
    - Do not use in Yuma, La Paz, Maricopa, Pinal, Pima & Santa Cruz Co. AZ SLN label expected in 2020
  - Enlist Duo – 2,4-D:choline + glyphosate
    - Do not use south of I-8 or west of Highway 85 (AZ SLN)
  - Stacked with glyphosate and glufosinate
- No cross-resistance

Nozzle Selection

First & most important decision made by an applicator

NOZZLES

Allowed Nozzles

Enlist One

Manufacturer	Model	Maximum-Operating Pressure (psi)
		10 20 30 40 50 60 70 80 90 100 110
AlbuZ	AVI110025	MAX 60
	AVI11003	MAX 80
	AVI11004	MAX 90
	AVI11005	MAX 90
	AVI11006	MAX 90
GreenLeaf	TADF025-D	MAX 90
	TADF03-D	MAX 90
	TADF04-D	MAX 90
	TADF05-D	MAX 90
	TADF06-D	MAX 90
	TDXL11003	MAX 80
	TDXL11004	MAX 80
	TDXL11006	MAX 90
	TDXL11008	MAX 90
	TDXL-D11002	MAX 90
	TDXL-D110025	MAX 90
	TDXL-D11003	MAX 70
	TDXL-D11004	MAX 90
	TDXL-D11006	MAX 90
	TDXL-D11008	MAX 100
	TDXL-D025	MAX 80
Hypro	ULD12004	MAX 80
	ULD12005	MAX 70
	ULD12006	MAX 65
Lechler	ID11003	MAX 60
	ID11004	MAX 80
	ID11005	MAX 60
TeeJet	AI11002	MAX 80
	AI110025	MAX 80
	AI11003	MAX 80
	AI11004	MAX 80
	AI11005	MAX 80
	AI11006	MAX 80
	AI11008	MAX 80
	AITTJ11004	MAX 50
	AITTJ11006	MAX 60
	AIXR11004	MAX 60
	AIXR11005	MAX 60
	AIXR11006	MAX 60
	TTI11002	MAX 80
	TTI110025	MAX 80
TeeJet (Cont.)	TTI11003	MAX 80
	TTI11004	MAX 80
	TTI11005	MAX 80
	TTI11006	MAX 80
Wilger	MR11006	MAX 60
	MR11008	MAX 70
	MR11010	MAX 70

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Xtendimax

Nozzles

Last Updated on 10/16/2017

			Operating Pressure (psi)						
Manufacturer	Nozzle Type	Part Number	10	20	30	40	50	60	70
Greenleaf Technologies	TADF03-D	TADF03-D		Min 20		Max 40			
	TADF06-D	TADF06-D		Min 20			Max 50		
	TDXL 11003-D	TDXL 11003-D		Min 20		Max 40			
	TDXL 11004-D	TDXL 11004-D		Min 20			Max 50		
	TDXL 11005-D	TDXL 11005-D		Min 20				Max 60	
	TDXL 11006-D	TDXL 11006-D		Min 20				Max 60	
Hypro	ULD120-04	ULD120-04 / FC-ULD120-04		Min 20		Max 40			
	ULD120-05	ULD120-05 / FC-ULD120-05		Min 20		Max 40			
John Deere	ULD120-04	PSULD2004 / PSULDQ2004		Min 20		Max 40			
	ULD120-05	PSULD2005 / PSULDQ2005		Min 20		Max 40			
Lechler	ID 110-03	ID 110-03 / ID 110-03C			Min 30	Max 40			
	ID 110-04	ID 110-04 / ID 110-04C			Min 30	Max 40			
	ID 110-05	ID 110-05 / ID 110-05C			Min 30	Max 40			
	ID 80-04	ID 80-04 / ID 80-04C			Min 30	Max 40			
TeeJet® Technologies	AI11003	AI11003-VS / AIC1103-VS			Min 30	Max 40			
	AI8003	AI8003-VS / AIC8003-VS			Min 30	Max 40			
	AI8005	AI8005-VS / AIC8005-VS			Min 30	Max 40			
	TTI11003	TTI11003-VP		Min 20				Max 60	
	TTI11004	TTI11004-VP		Min 20				Max 63	
	TTI11005	TTI11005-VP		Min 20				Max 60	
	TTI11006	TTI11006-VP		Min 20			Max 50		
Wilger	DR110-10	40286-10			Min 30	Max 40			
	UR110-05	40292-05			Min 30		Max 50		
	UR110-06	40292-06			Min 30			Max 60	
	UR110-08	40292-08			Min 30				Max 70
	UR110-10	40292-10			Min 30				Max 70

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Nozzle Selection

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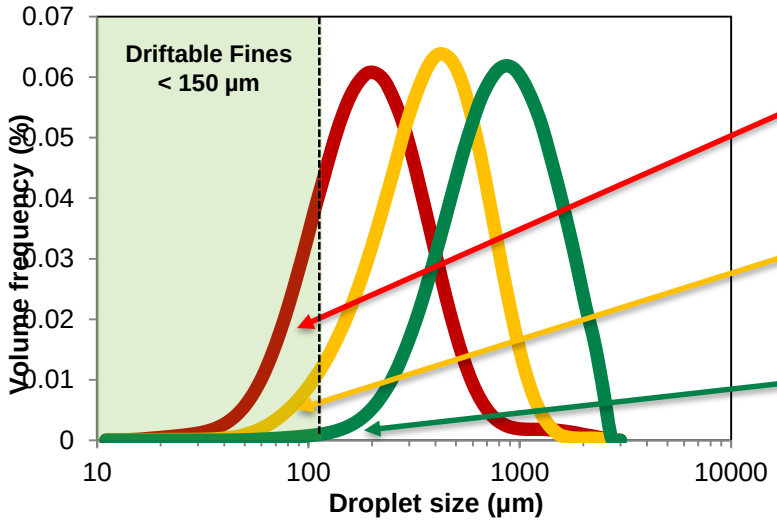
dicamba + glyphosate



Driftable Fines	Nozzle Type
35%	XR 11004
7%	AIXR 11004
<1%	TTI 11004

Go to registrant websites for list of approved nozzles

Boom Height Requirement

Key for consistency of nozzle performance

24” **Maximum Boom Height Above Target**

48” height can increase drift potential by 5.6 times*

*Based on AGDISP modelling comparing 24” vs. 48” above target with approved TTI 11004 at 60 PSI

Application Parameters

Parameter	Enlist One & Duo	Xtendimax, Engenia
Boom height	24 inches maximum above target canopy	
Sprayer speed	15 MPH maximum	
Wind speed *(Measure repeatedly)*	3 to 10 MPH recommended, 3 to 15 MPH allowed	3 to 10 MPH
Temp. Inversions	Do not spray	Do not spray; spray only 1 hour after sunrise to 2 hours before sunset
Buffer requirement	30 feet	110 ft (220 ft if > 22 oz/A)
Susceptible crops in downwind field	Do NOT spray; Applicator must verify downwind crop is not susceptible	
Sprayer clean out	Clean every day, use triple rinse procedure; ***Do NOT leave spray mix in tank overnight!***	

PROTECTION OF ADJACENT SUSCEPTIBLE/SENSITIVE CROPS:

DO NOT APPLY this product when the wind is blowing toward adjacent non-dicamba tolerant susceptible crops;

this includes NON-DICAMBA TOLERANT SOYBEAN AND COTTON.

- Susceptible crops include but are not limited to tomatoes and other fruiting vegetables (EPA crop group 8), fruit trees, cucurbits (EPA crop group 9), grapes, beans, flowers, ornamentals, peas, potatoes, sunflower, tobacco, other broadleaf plants, and including plants in a greenhouse.

- Problem of wind direction changes during spraying

Dicamba Visual Sensitivity Scale for GA - 2018

S. Culpepper, J. Smith, E. Prostko; University of Georgia at Tifton

Lower	Moderate	Severe	Extreme
Broccoli	Cantaloupe	Cotton	Grapes*
Cabbage	Canola*	Pepper	Lima Bean
Kale	Cucumber	Tomato	Snap Bean
Mustard	Peach	Watermelon	Southern Pea
Pecan	Peanut		Soybean
Turnip	Squash		Sweet potato*
			Tobacco*
>1/75X	1/75-1/300X	1/300-1/800X	< 1/800X

Herbicide Rate of Visually Detectable Injury

For relative comparison: tomato, squash, and watermelon response to Roundup for visual damage would be in the "lower" category.

*Asterisk notes data from literature; all other data generated in over 70 UGA field experiments.

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2,4-D Visual Sensitivity Scale for GA - 2018

S. Culpepper, J. Smith, E. Prostko; University of Georgia at Tifton

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

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A Meta-Analysis on the Effects of 2,4-D and Dicamba Drift on Soybean and Cotton

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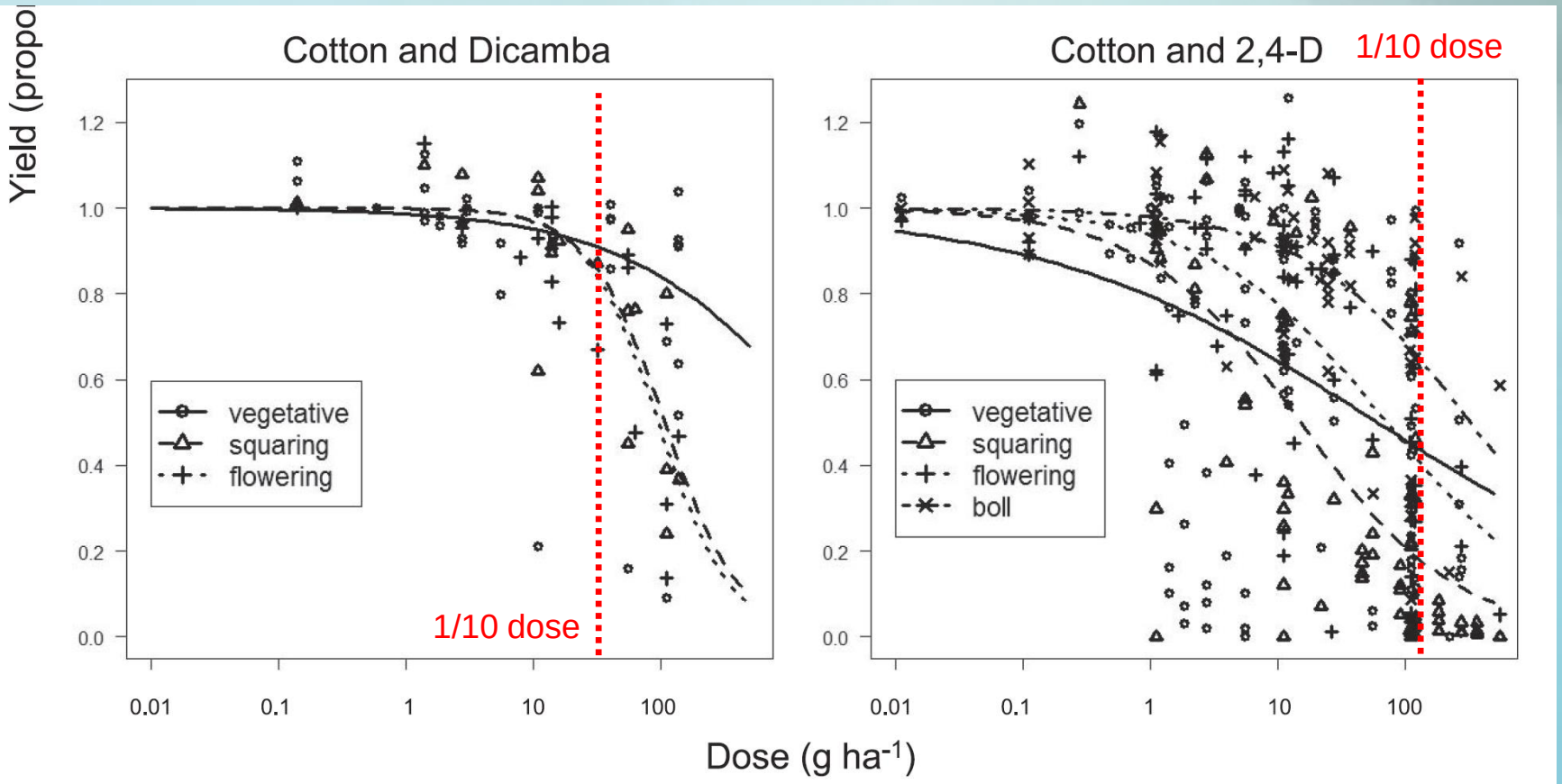
Weed Science 2014 62:193–206



Dicamba *n* = 42, 18, 19

2,4-D *n* = 117, 76, 75, 64

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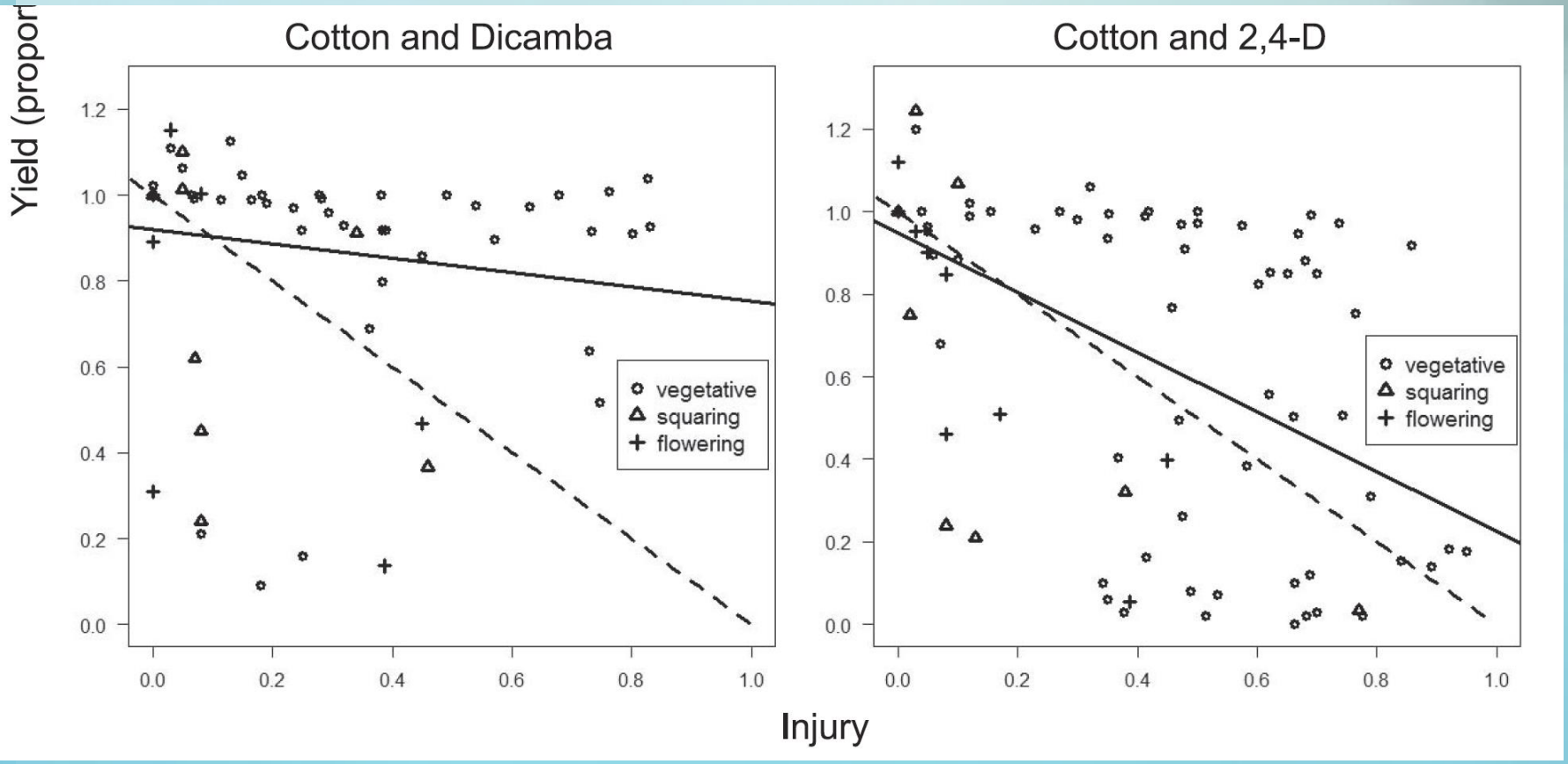
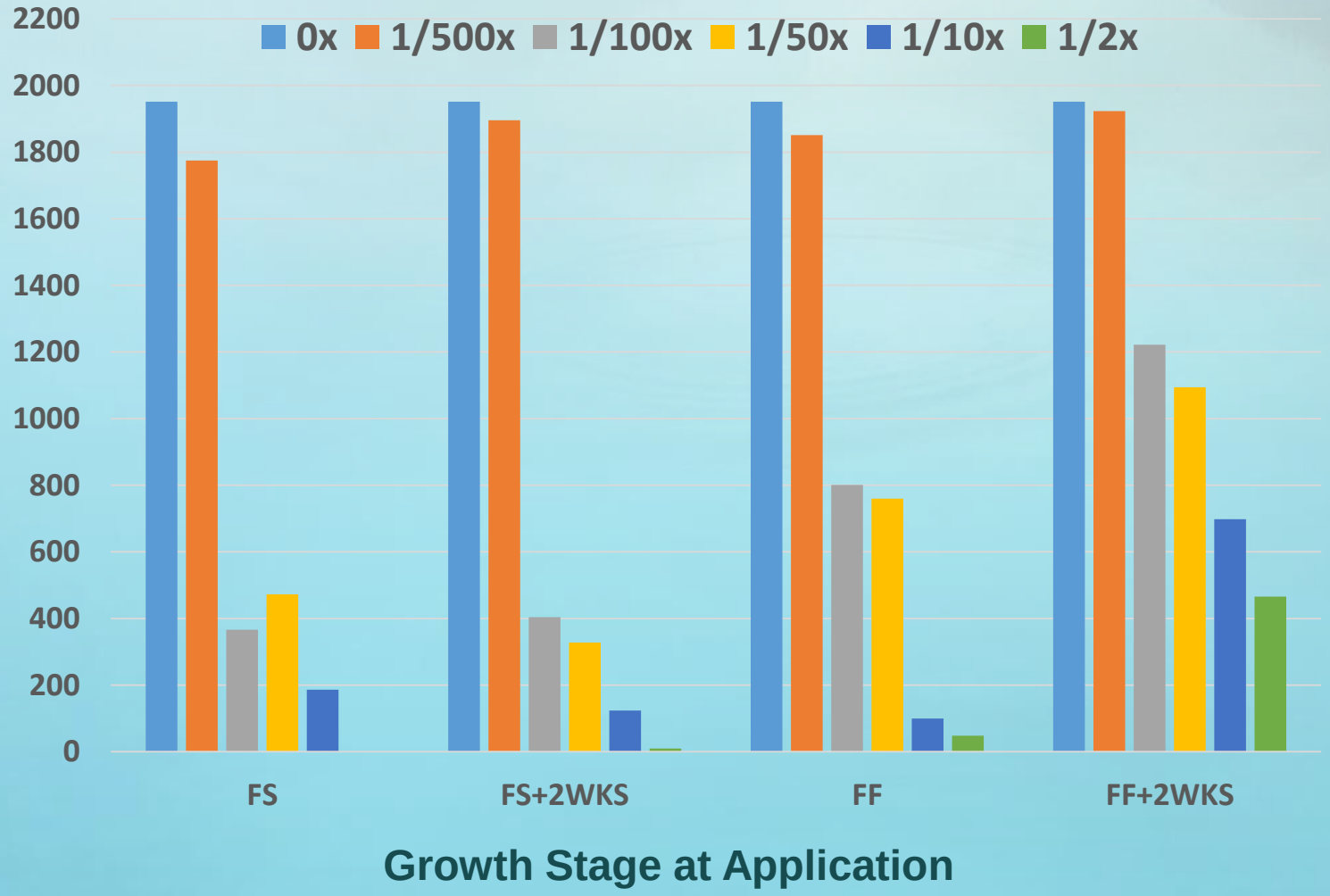


2,4-D (1x = 0.95 lb. ae/A) Effects on Susceptible Cotton Lint Yield (lb/A) [RRACenter 2017]



Dicamba (1x = 0.5 lb. ae/A) effect on Susceptible Cotton Lint Yield (lb/A) [RRAC 2016]