

Detecting Dicamba & 2,4-D in Plant Tissue: What Are the Possibilities

Row Crop Short Course

Daniel B. Reynolds

December 3, 2018



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Why All the Fuss Over Auxin Training

- Auxins are a class of plant hormones that control plant growth
 - Cell division
 - Cellular expansion
 - Root growth
 - Leaf development
- Auxins are very active at low concentrations.
- Thousands of acres were adversely affected in 2017 and 2018
- EPA now requires yearly mandatory training for those who will be applying dicamba.



2018 Complaints in Mississippi

- 135 Total OTM Complaints
 - 4 for 2,4-D
 - 9 aminopyralid
 - 68 for dicamba
 - 24 glyphosate
 - 6 paraquat
 - 15 other
 - 9 unknown
- Dicamba
 - 4 yard
 - 3 garden
 - 2 cotton
 - 59 soybean
 - ~ 36,421 acres

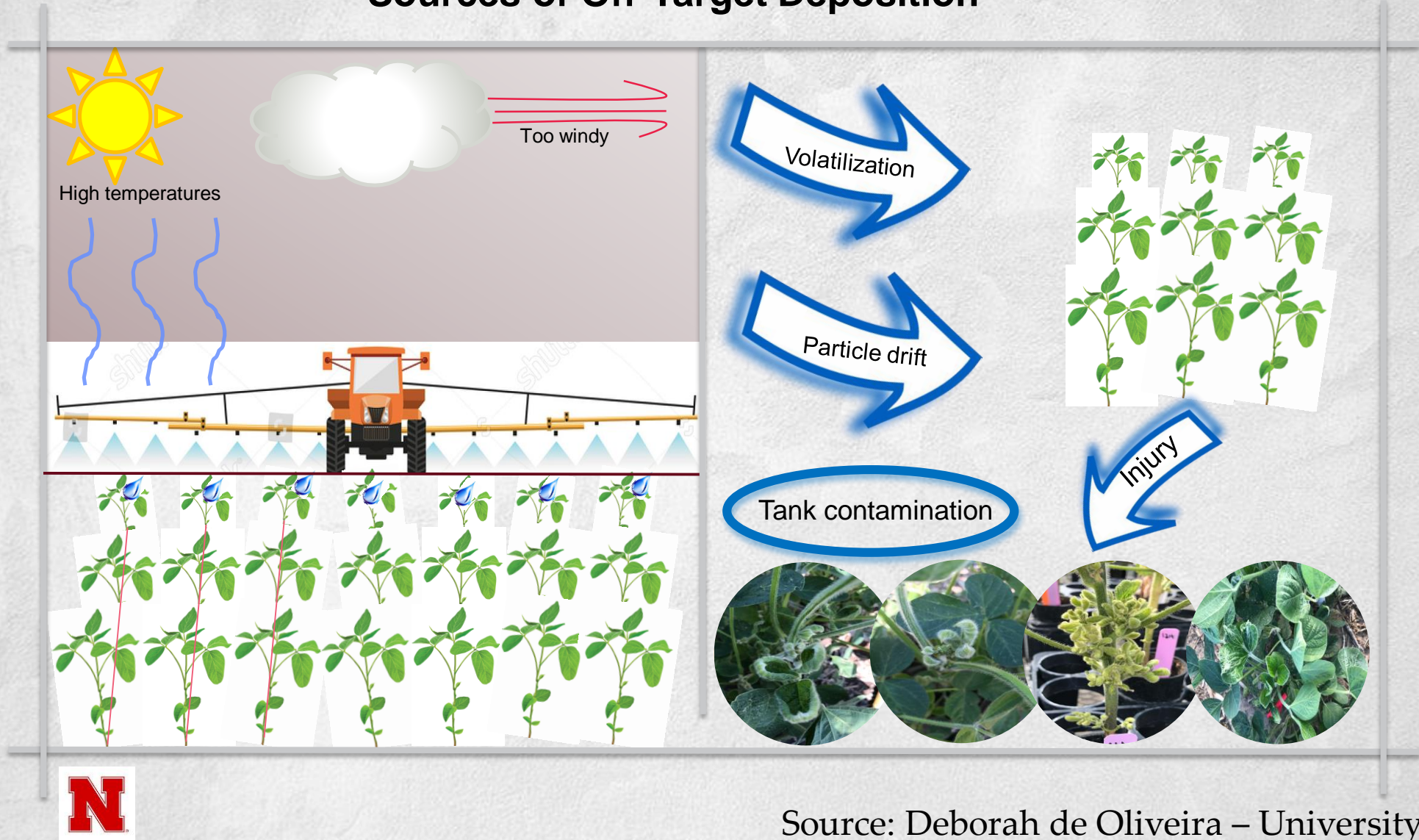
Last updated 10-30-2018



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Sources of Off-Target Deposition



Source: Deborah de Oliveira – University of Nebraska



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Sources of Off-Target Movement

- Drift
 - Particle Drift - movement of spray particles during or shortly after the spray application
(May be called “Near Drift”)
- Volatility
 - movement of pesticide vapors (gas, fumes).
 - Volatilization is the physical change of a liquid or a solid to a gas
(May be called “Far Drift”)
- Contaminated Equipment
- Misapplication



Wind From Right to Left





5 feet



65 feet



195 feet

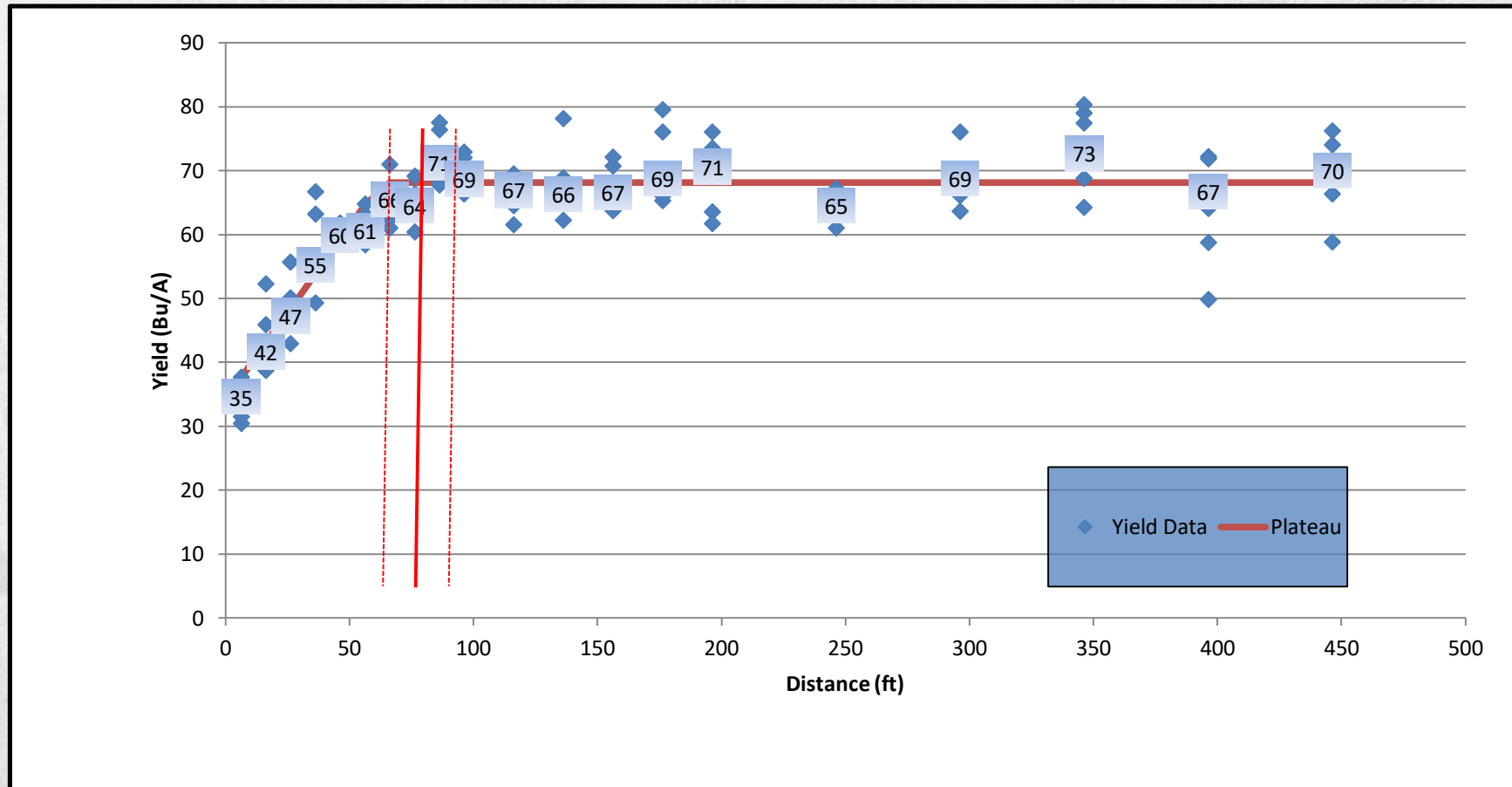


395 feet



Yield Reduction Plateau

Plateau Distance: 63 feet



Open Boom and Hooded Boom

**Redball Hooded
Boom Sprayer**

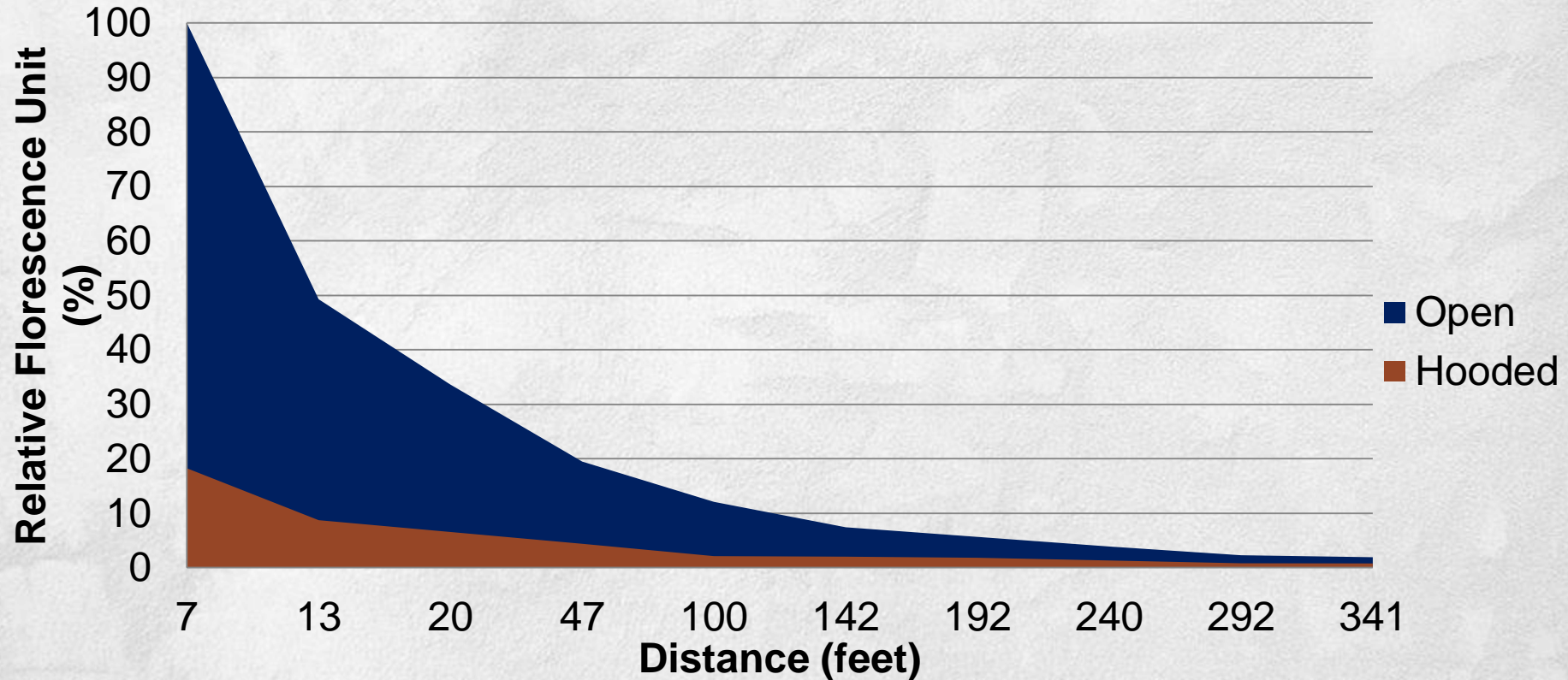


Open Boom Sprayer



Fine Droplets (XR11002)

Open – 7.5 mph Redball Hooded – 8.2 mph



Things to Consider About Drift

Nozzle selection has the greatest impact on spray particle size

Hooded spray booms aid in the reduction of off-target movement but do not eliminate it

Applications must be made under favorable application conditions

New formulations, improved nozzles, and hooded sprayers are no substitute for common sense and will not overcome poor judgement

Drift is inevitable and mitigation is needed!



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Low Tunnel Research



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Materials & Methods

- ◎ Each treatment was applied to 2 flats (60 x 30 cm) of soil
- ◎ Soil was treated at a remote location and transported to the test site



Low Tunnel Research



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Low Tunnel Research



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Materials & Methods

- Treatments applied at 4x rates to assure symptomology
- Soil flats wetted to field capacity the night before the trial
- Flats exposed to the crop for 48 hours
 - Crop injury ratings taken 14 and 28 DAT
- Temperature under the hoop house monitored with a weather station
 - In many cases, air temperature was 100-120 degrees





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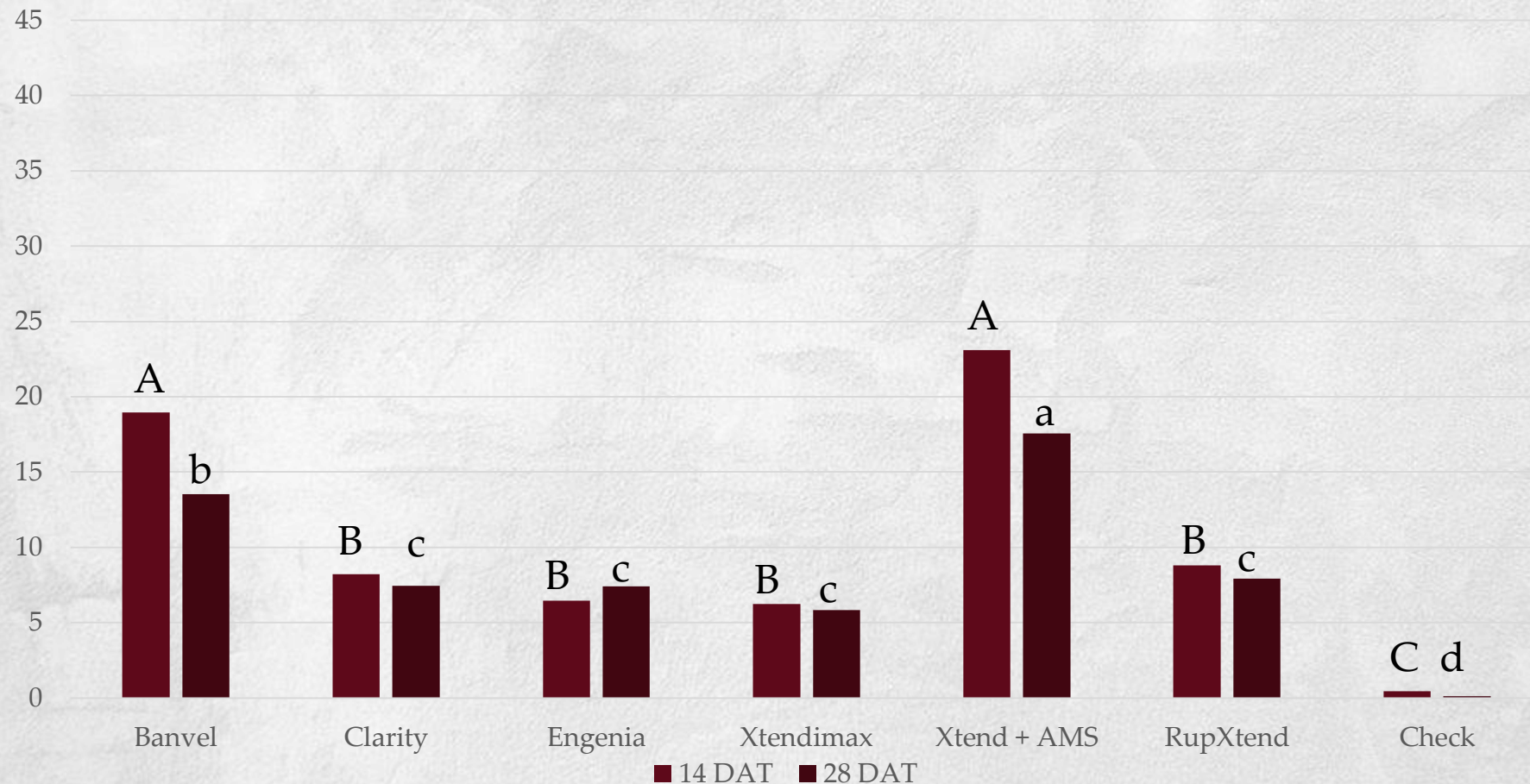
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Cooperators for 2017 Trials

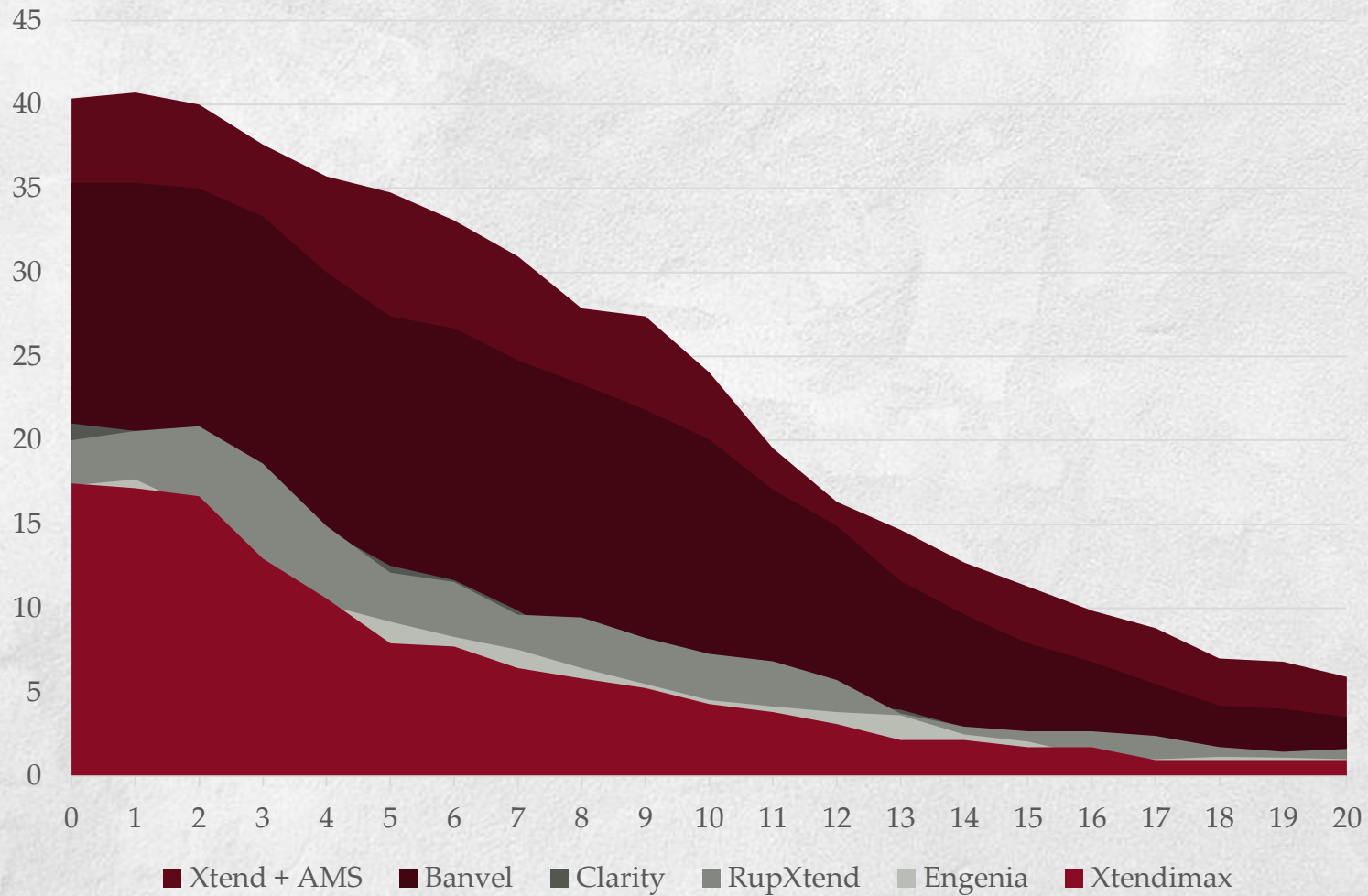
Location	Cooperator
Arkansas	Jason Norsworthy
Georgia	Stanley Culpepper
Indiana	Bryan Young
Louisiana	Daniel Stephenson
Mississippi	Dan Reynolds
Nebraska	Greg Kruger



Visual Injury Across All Locations



Injury 14 DAT By Distance



Cooperators for 2018 Trials

Location	Cooperator
Arkansas	Jason Norsworthy
Canada	Peter Silkkema
Georgia	Stanley Culpepper
Illinois	Mark Bernards
Indiana	Bryan Young
Louisiana	Daniel Stephenson
Michigan	Christy Sprague
Mississippi	Dan Reynolds
Nebraska	Greg Kruger
Texas	Scott Nolte
Wisconsin	Rodrigo Werle

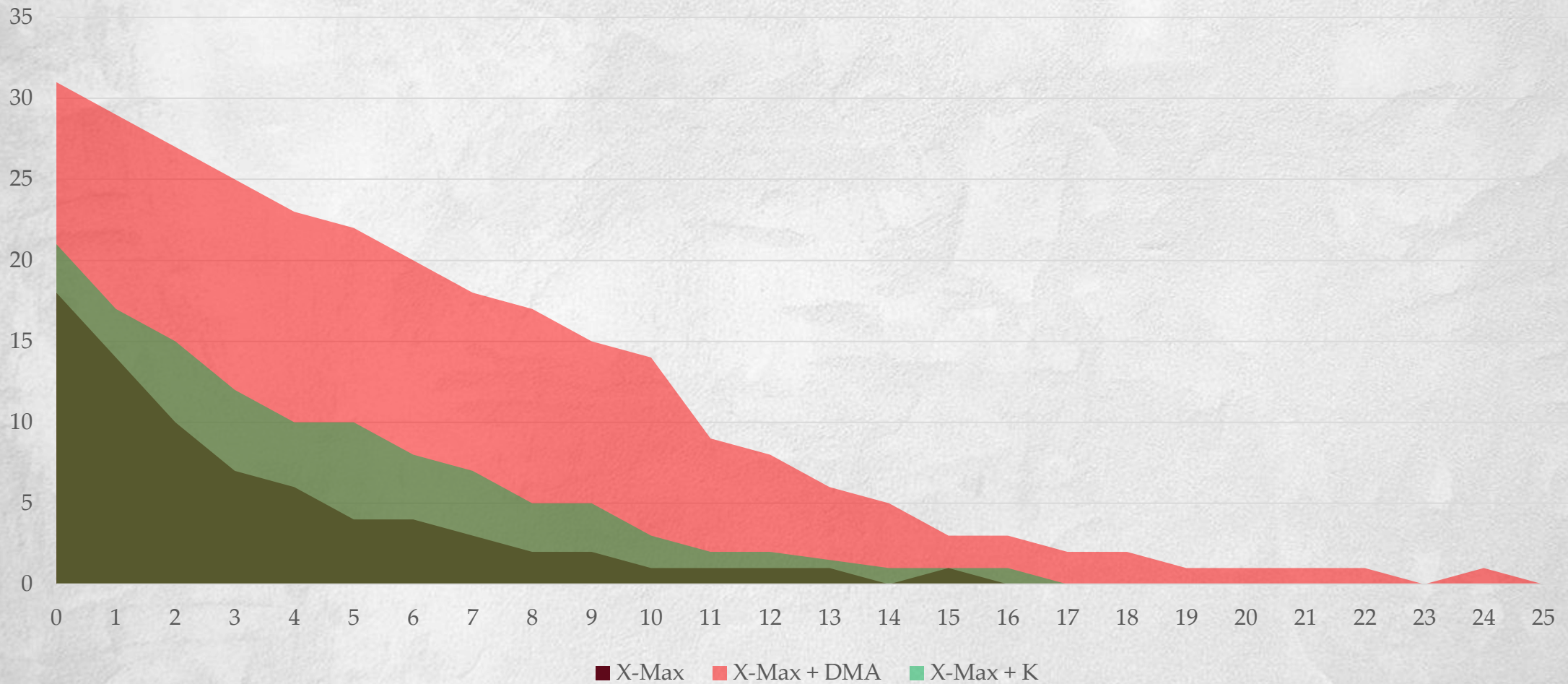


The Effect of Various Tank Mix Partners on Dicamba Volatility with XtendiMax and Roundup Xtend

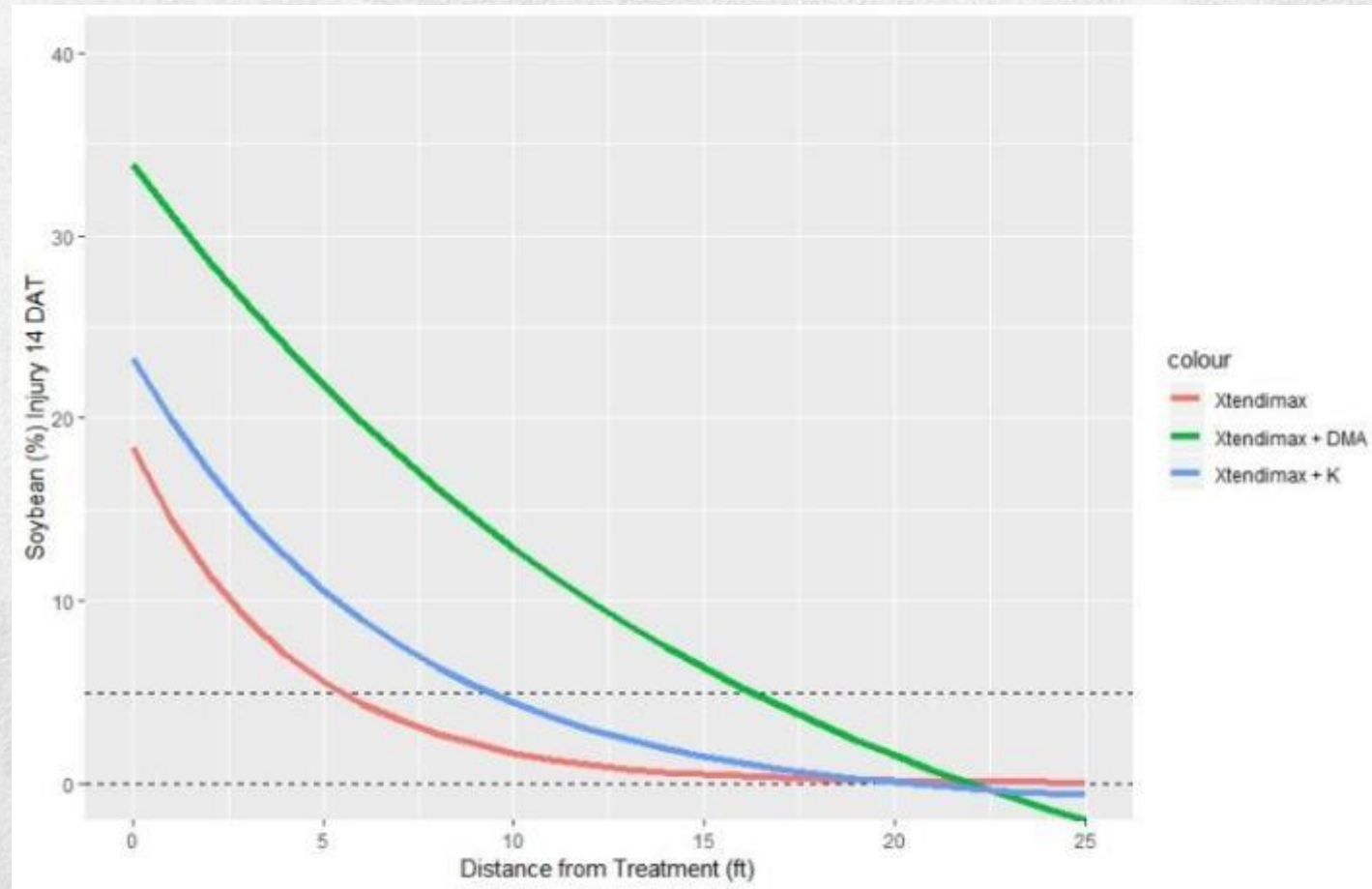
Treatment (Protocol 2018-01-B7-16)	Rate (lbs ae/A)
Xtendimax	2.0
Xtendimax + Durango (DMA)	2.0 + 4.0
Xtendimax + PowerMax (K)	2.0 + 4.0
Xtendimax + PowerMax + Intact	2.0 + 4.0 + 2% v/v
Xtendimax + PowerMax + Intact + Mon 10	2.0 + 4.0 + 2% + 4% v/v
RoundupXtend (MON 301110)	6.0
RoundupXtend + Liberty	6.0 + 116 floz
Untreated Check	



The Effect of Glyphosate Salt on Xtendimax

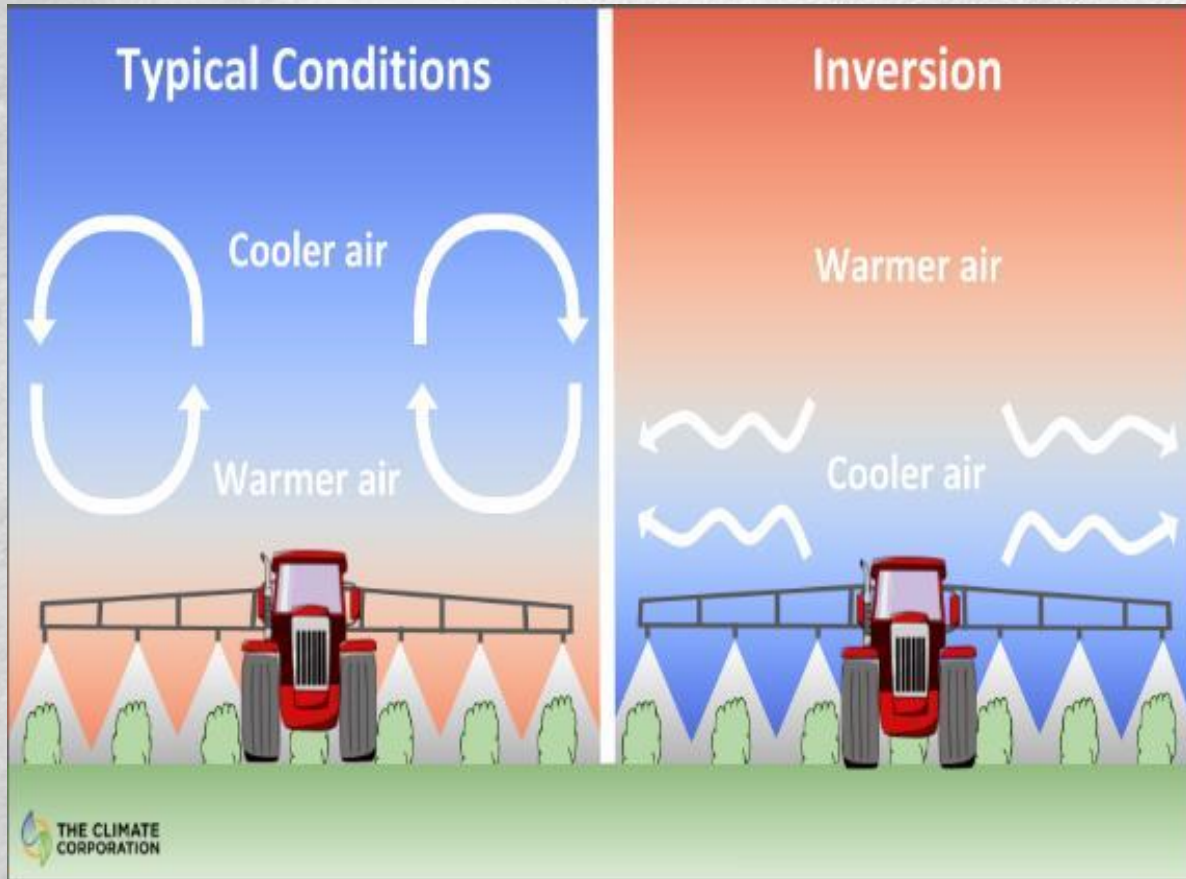


The Effect of Glyphosate Salt on XtendiMax Volatility



TEMPERATURE INVERSIONS

A layer of cool air trapped below a layer of warmer air



- During a temperature inversion, the atmosphere is very stable and vertical air mixing is restricted, which can cause small, suspended droplets to remain in a concentrated cloud
- The inversion will typically dissipate with increased winds (>3 mph) or at sunrise when the surface air begins to warm (~3°F from morning low)
- Do not apply this product between sunset and sunrise.
- Inversions can also be identified by the movement of smoke from a ground source or an aircraft smoke generator.
- Smoke that layers and moves laterally in a concentrated cloud (under low wind conditions) indicates an inversion, while smoke that moves upward and rapidly dissipates indicates good vertical air mixing.



Things to Consider About Volatility

Use only approved formulations!

The approved formulations are less volatile!

Do not use AMS in spray mixture

Only use approved tank mix partners



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Dicamba Injury to Soybean Applied at First Bloom

1/4 X Rate



1/1024 X Rate



The Effect of Growth Stage on Susceptibility





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Booms



Injection Point & Eductor System



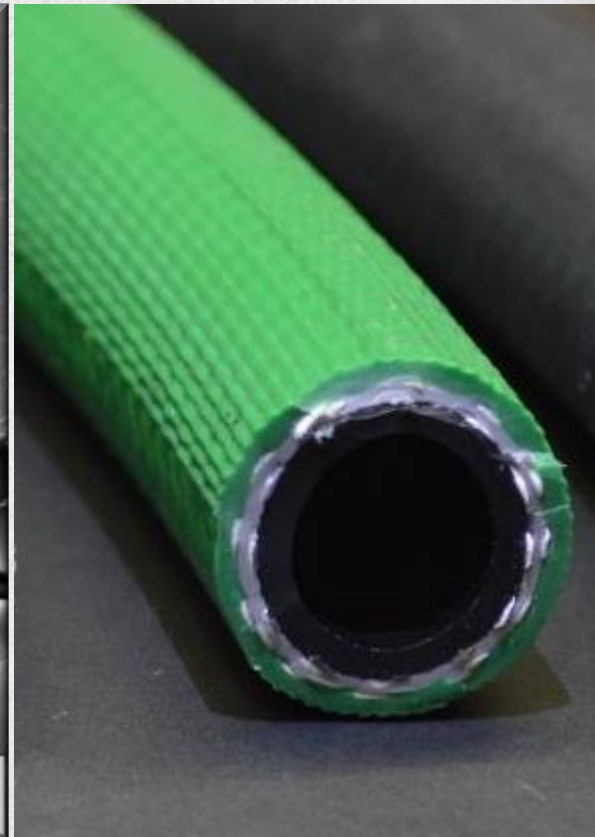
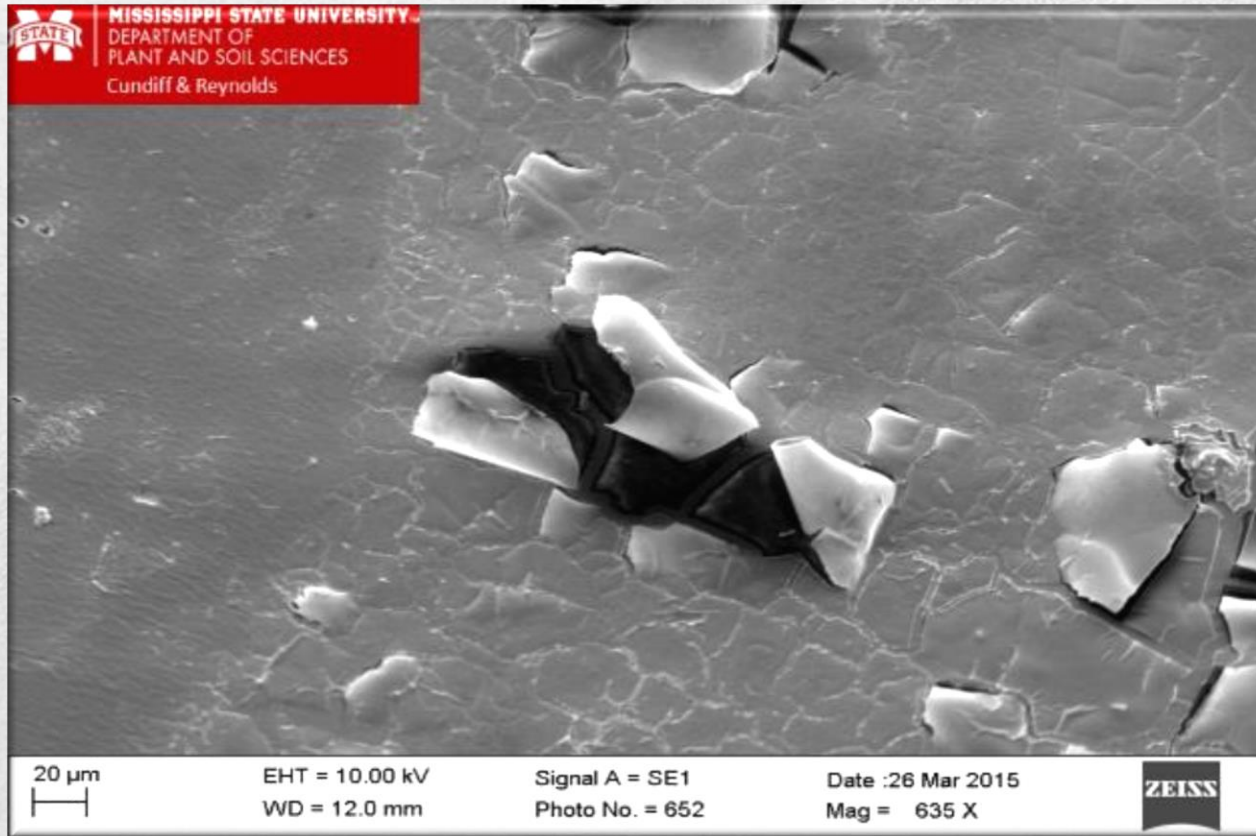
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Strainers, screens, and tips



Scanning electron micrograph of a John Deere PMA 1687-08
(Green/PVC/polyurethane-high tensile-strength yarn-2 ply)
hose used eight times





Deactivation of Dicamba Using Soybean as a Bio-indicator



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Dicamba 0X 28 DAT

No Deactivation

Deactivated



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Dicamba 1/1024X 28 DAT

No Deactivation

Deactivated



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Dicamba 1/256X 28 DAT

No Deactivation

Deactivated



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Dicamba 1/64X 28 DAT

No Deactivation

Deactivated



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Dicamba 1/16X 28 DAT

No Deactivation

Deactivated



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Dicamba 1/4X 28 DAT

No Deactivation

Deactivated



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Dicamba 1X 28 DAT

No Deactivation

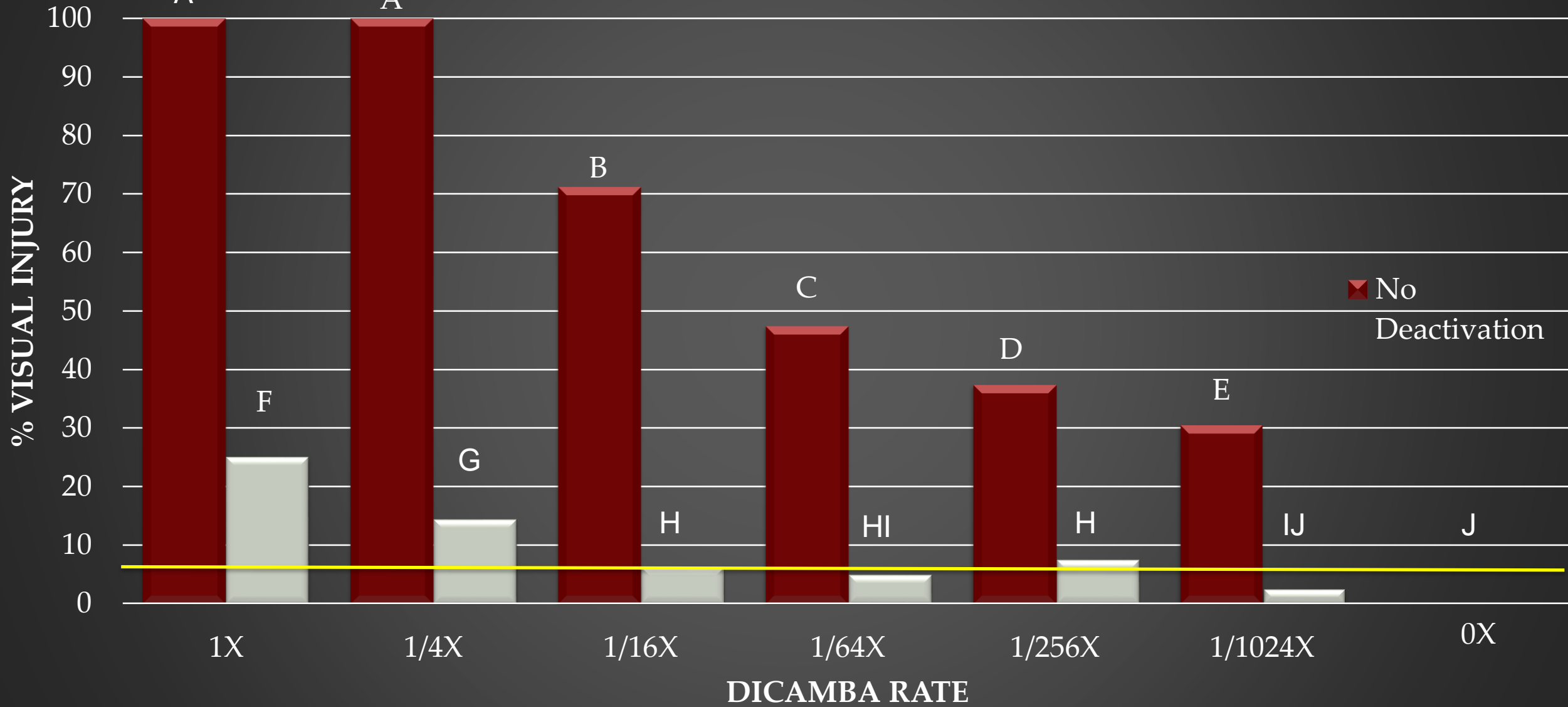
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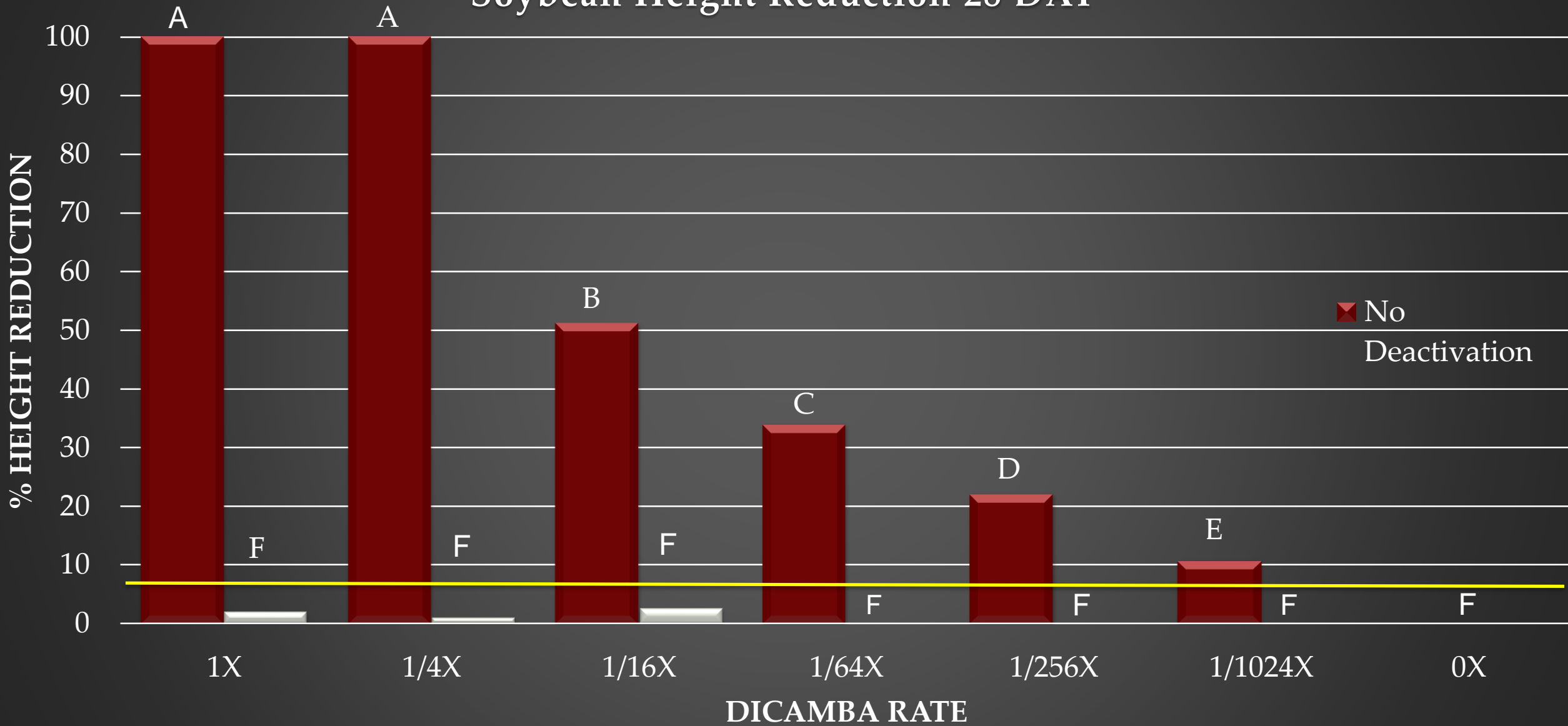
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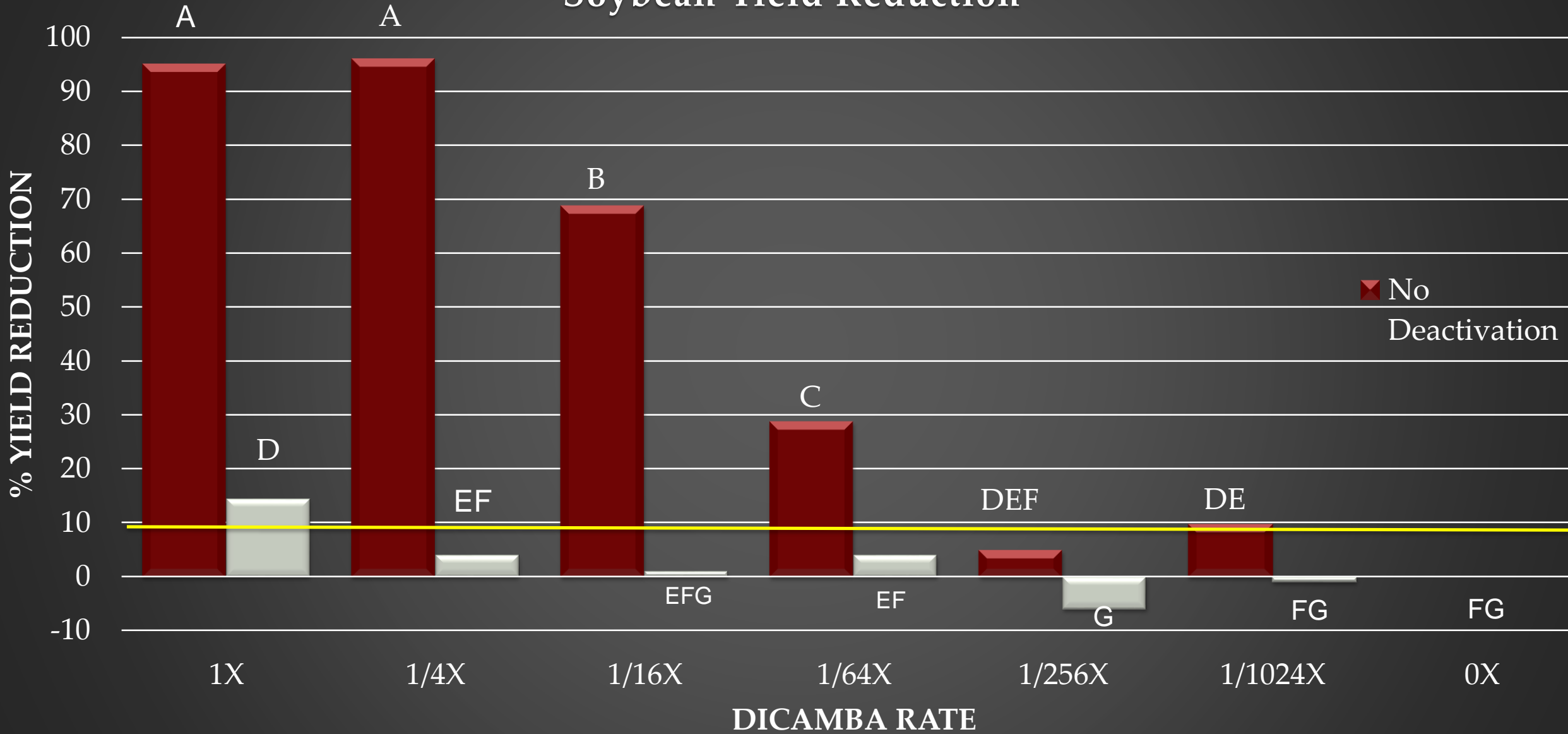
Soybean Injury 28 DAT



Soybean Height Reduction 28 DAT



Soybean Yield Reduction



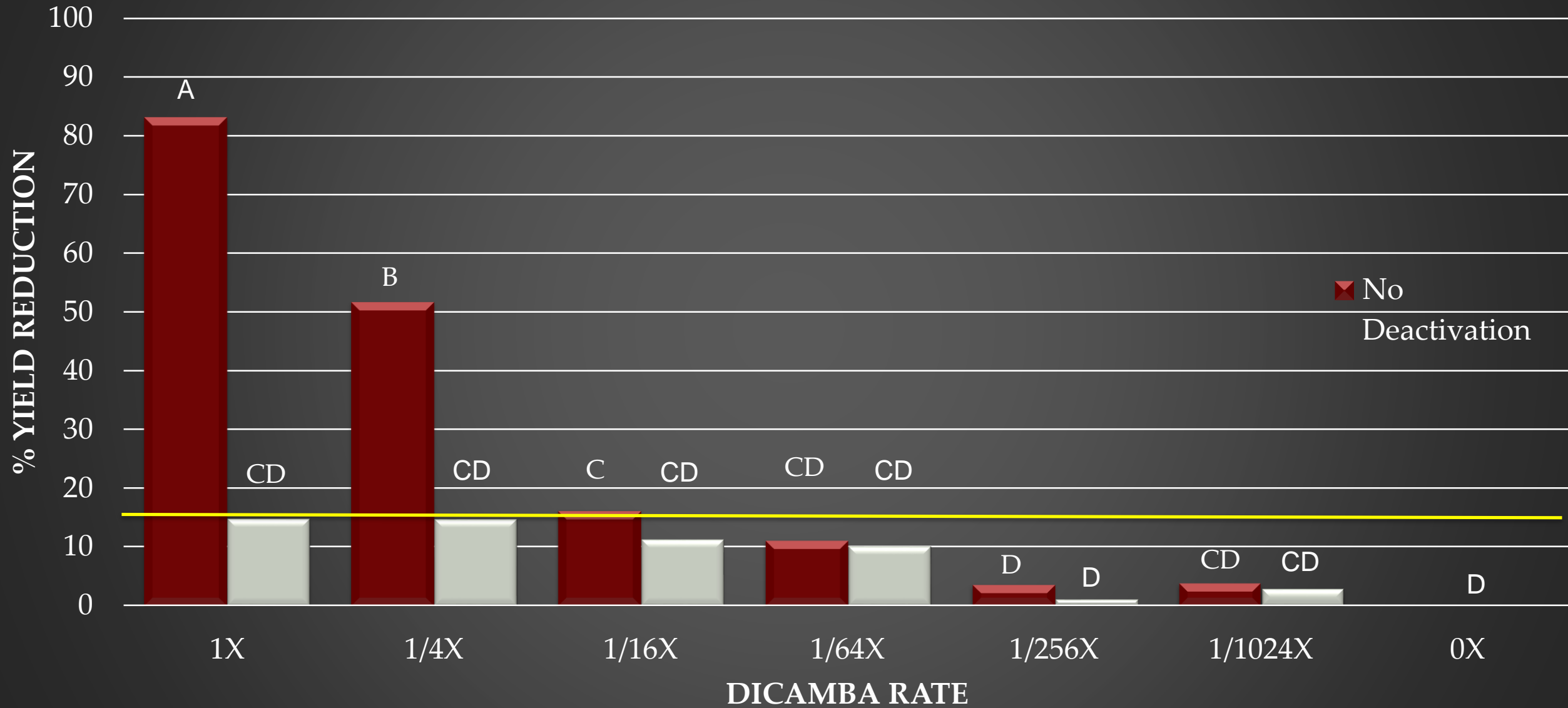
Deactivation of Dicamba Using Cotton as a Bio-indicator



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Cotton Yield Reduction



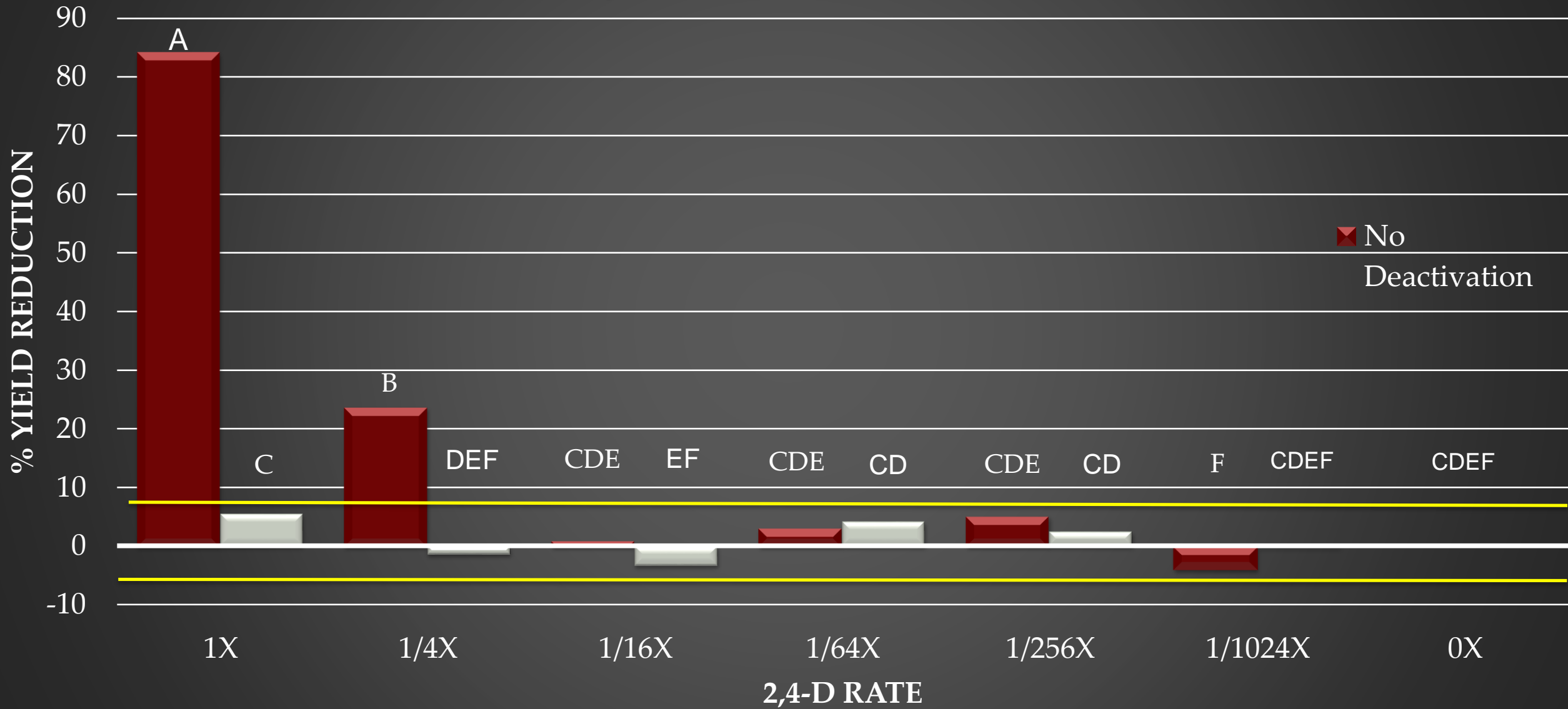
Deactivation of 2,4-D Using Soybean as a Bio-indicator



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Soybean Yield Reduction



Deactivation of 2,4-D Using Cotton as a Bio-indicator



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2,4-D 0X
28 DAT

No Deactivation

Deactivated



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2,4-D 1/1024X
28 DAT

No Deactivation

Deactivated



2,4-D 1/256X 28 DAT

No Deactivation

Deactivated



2,4-D 1/64X
28 DAT

No Deactivation

Deactivated



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2,4-D 1/16X
28 DAT

No Deactivation

Deactivated



2,4-D 1/4X 28 DAT

No Deactivation



Deactivated



2,4-D 1X
28 DAT

No Deactivation

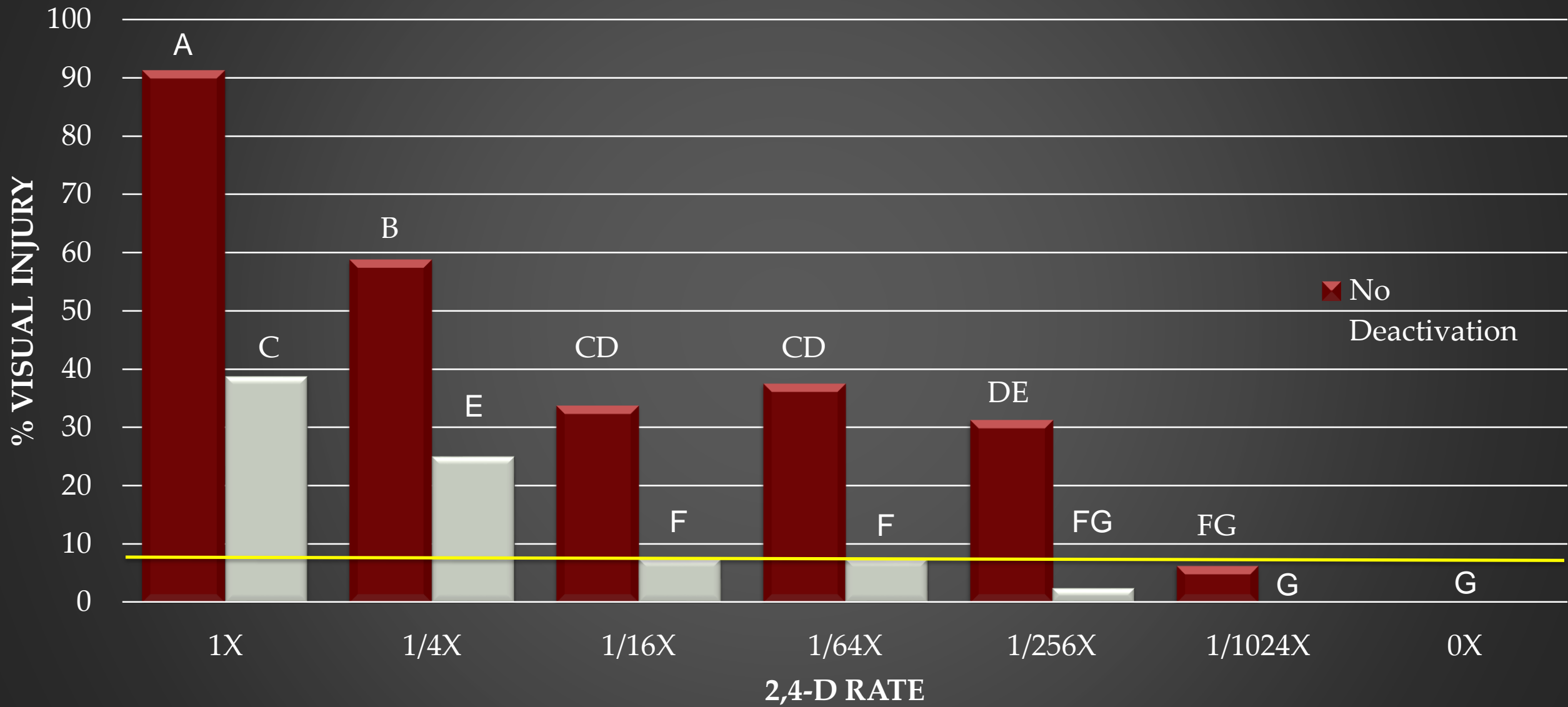
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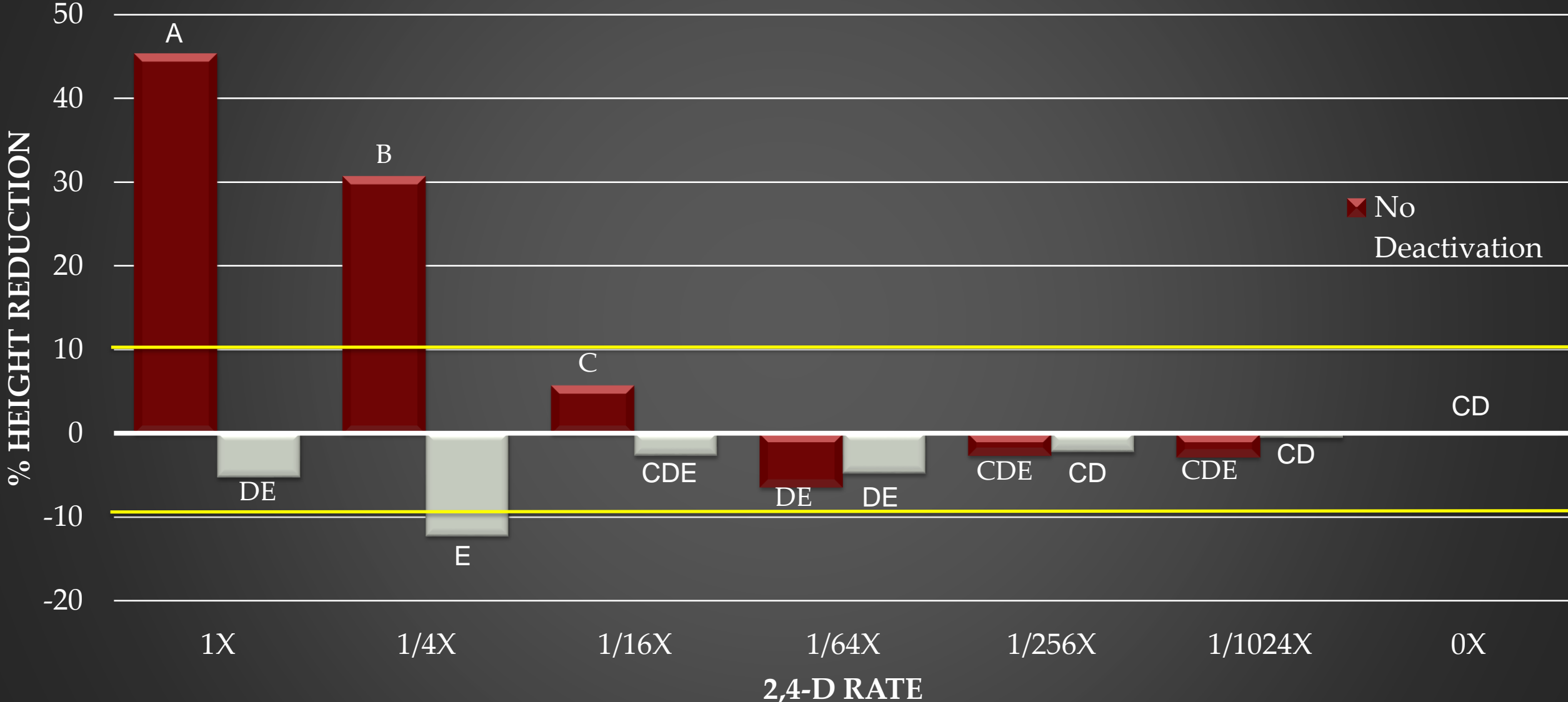
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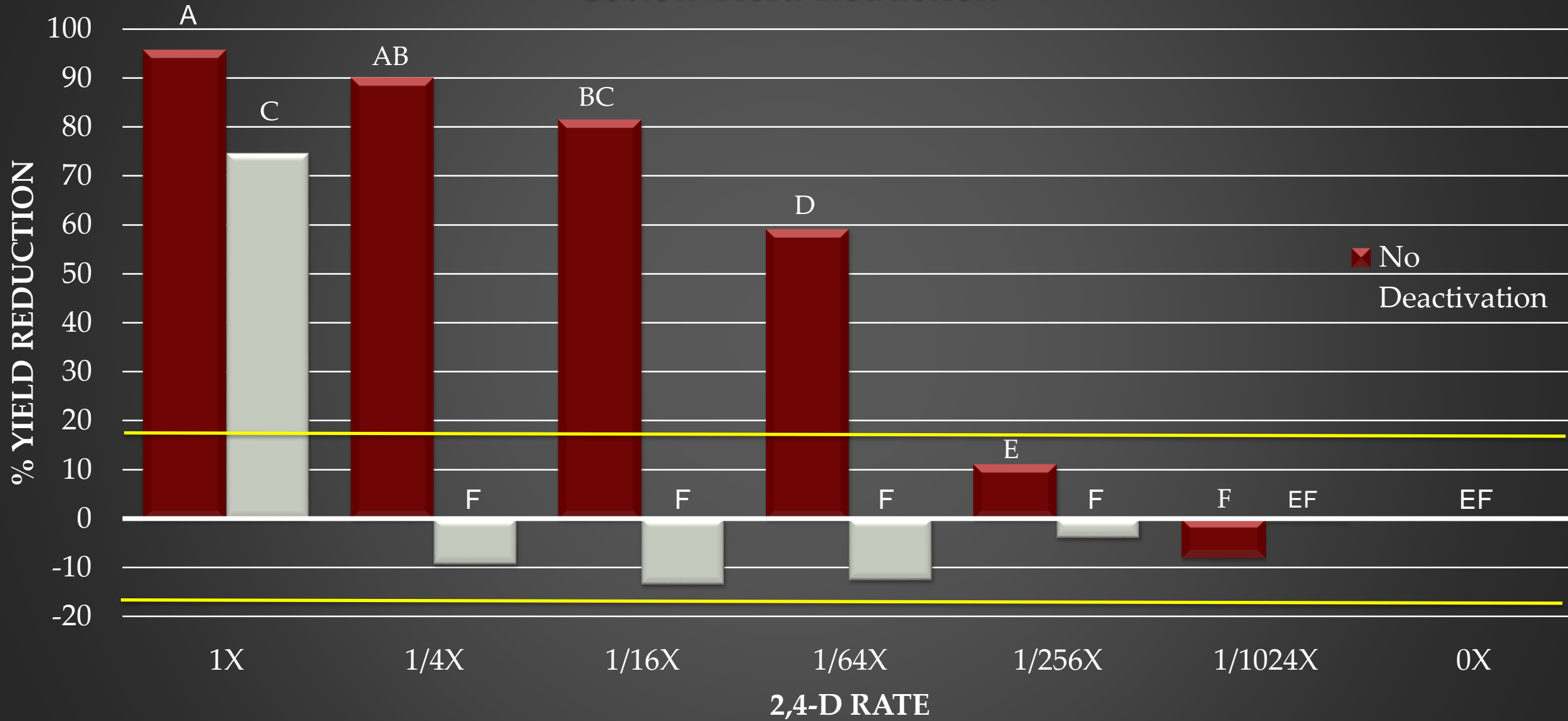
Cotton Injury 28 DAT



Cotton Height Reduction 28 DAT



Cotton Yield Reduction



Visual Sensitivity Scale for Dicamba in GA-2018

Lower	Moderate	Severe	Extreme
Broccoli Cabbage Kale Mustard Pecan Turnip	Cantaloupe Canola* Cucumber Peach Peanut Squash	Cotton Pepper Tomato Watermelon	Grapes* Lima Bean Southern Pea Snap Bean Soybean 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.

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

Source: Stanley Culpepper – Univ. Georgia



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Things to Consider About Sprayer Hygiene

Small quantities of residue may be highly injurious.

Sprayer should be free of residues before mixing!

Triple rinse system is needed to clean the system.

Should use a good quality tank cleaner in the second rinse.

Deactivators only work when they come in contact with chemical.





Analytical Method Development to Support Ag/Conservation Research Programs

Ashli Brown, MS State Chemist

Mississippi State Chemical Laboratory

ISO/IEC 17025:2005 Accredited

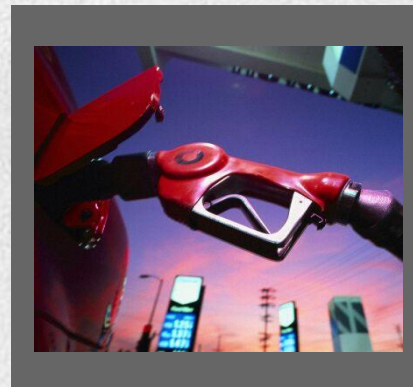


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The Laboratory

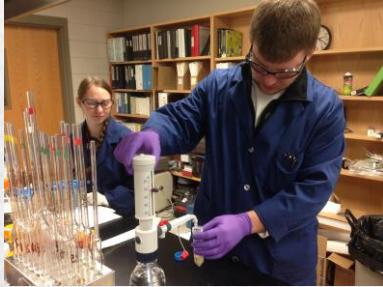
- **Mission:** To provide the analytical data to assure quality, labeling, and safety of fertilizers, animal feeds, human foods, pesticides, and petroleum products in Mississippi.



- Industrial & Agricultural Services
- Chemical & Environmental Regulatory
- Petroleum Products
- Research



Common Analytical Analyses



- Feed, Forage and Food
- Metal, Mineral, and Inorganic
- Fertilizer and Litter
- Water and Wastewater
- Drugs of Abuse and Controlled Substances
- Hormones, Antibiotics and Toxins
- Petroleum Products
- Environmental and Industrial Chemical Residues
- Pesticide Residue and Formulations
- Hazardous Waste, Wastewater Discharges, Priority Pollutants



Assist Citizens of MS in Pesticide Field Application

- Regulation of pesticide quality is important to agricultural productivity.
- MSCL tests for composition of pesticides in order to aid in regulation of those used in state agriculture.





Assist MS Residents in Litigation of Pesticide Misuse

MSCL tests approximately 400 samples each year to assist Mississippians in pesticide drift cases, pesticide misuse and improper applications.



Agilent 6400 Triple Quadrupole LC/MS

- Analytical Techniques to measure pesticides
- Types of Samples
 - Liquid
 - Air
 - Plant Tissue
 - Soil



How Concentrations are Reported

- Just as **per cent** means out of a hundred, so **parts per million** or **ppm** means out of a **million**. Usually describes the concentration of something in water or soil. **One ppm** is equivalent to **1** milligram of something **per** liter of water (mg/l) or **1** milligram of something **per** kilogram soil (mg/kg).
- PPM
 - one penny in \$10,000
 - one minute in two years
 - one dime in a one-mile-high stack of pennies
- PPB
 - one penny in \$10,000,000
 - one pinch of salt in 10 tons of potato chips
 - one second in 32 years
- PPT
 - about three seconds out of every hundred thousand years.



Five Different Types of Hoses Evaluated



1
Yellow

2
Blue

3
Grey

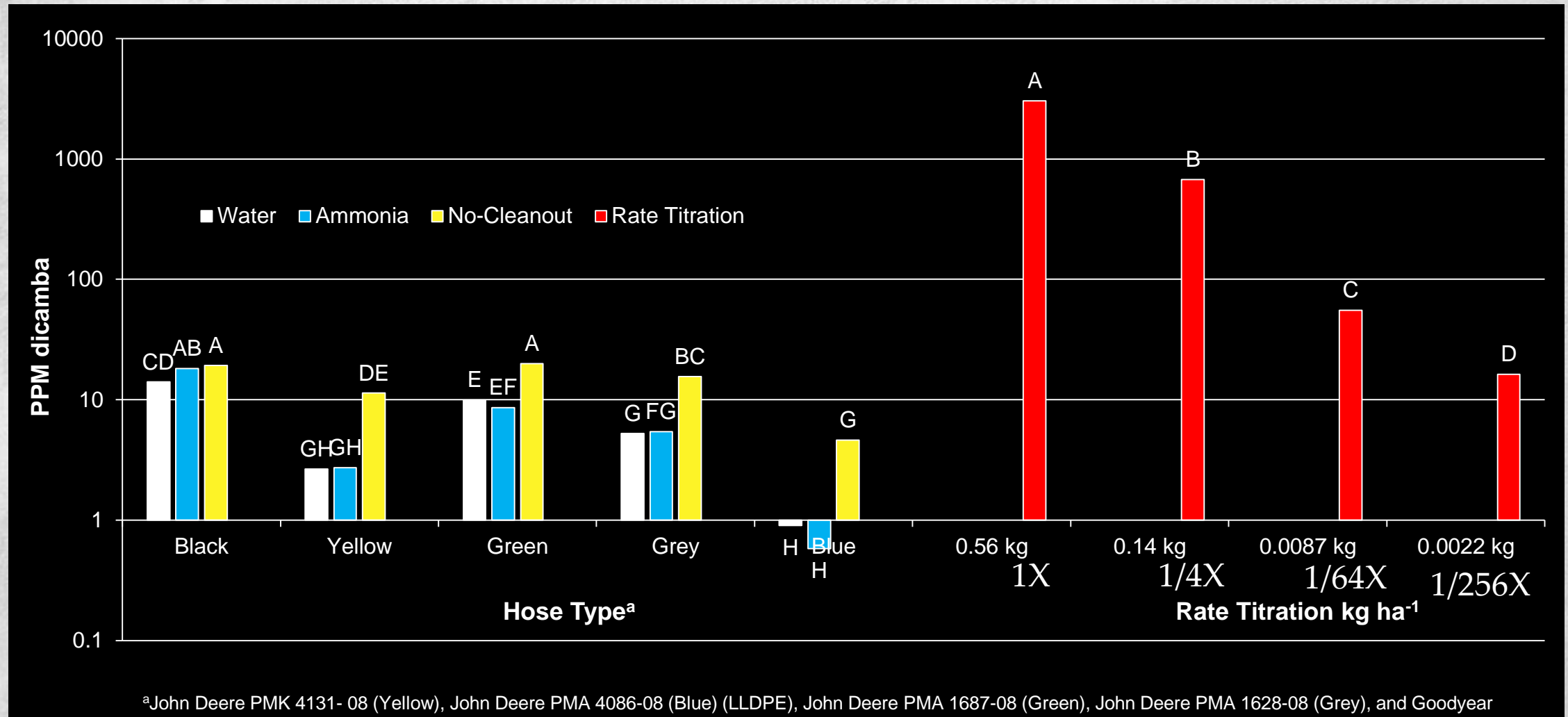
4
Green

5
Black

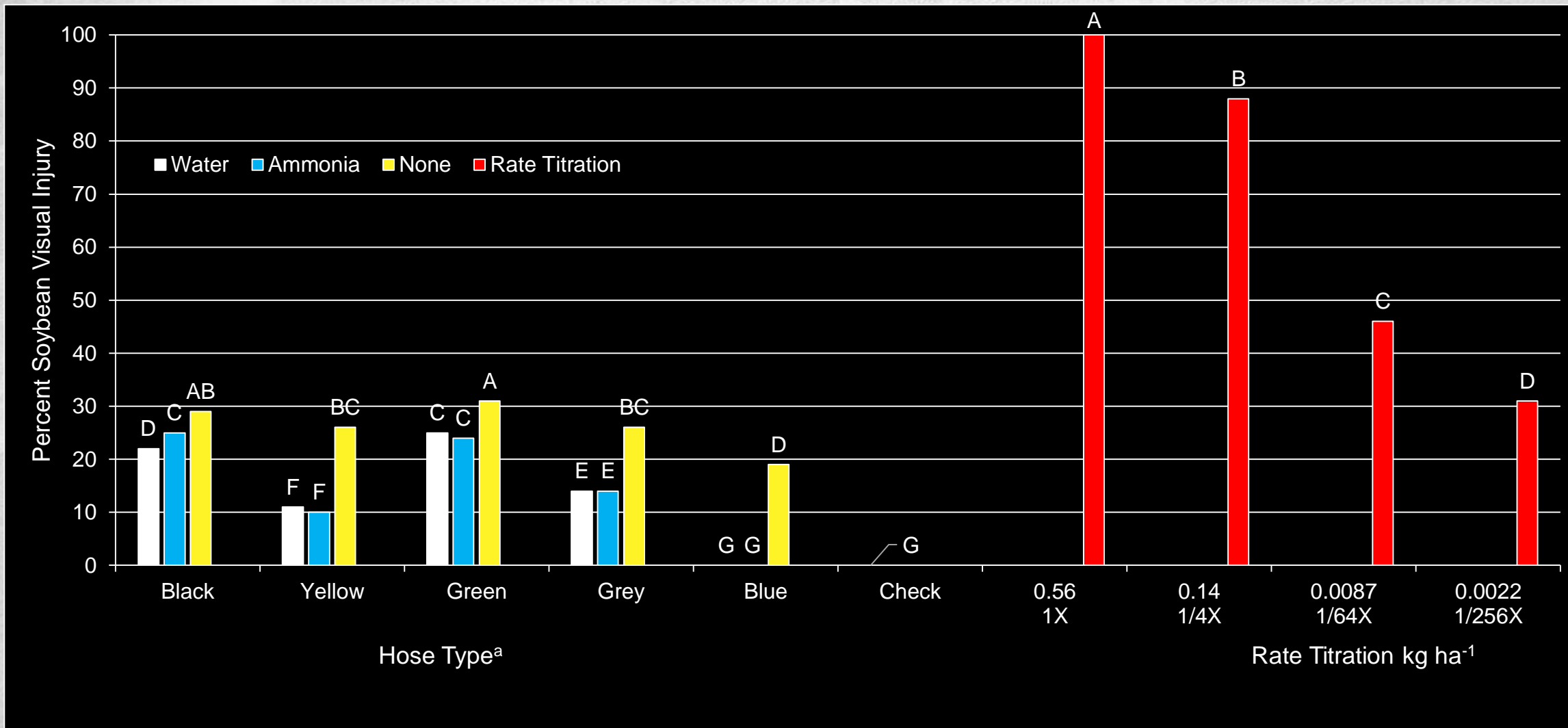
1. John Deere PMK 4131- 08 (PVC-high tensile strength yarn-1 ply) - Yellow
2. John Deere PMA 4086-08 (Linear/ low-density polyethylene blend) (LLDPE) - Blue
3. John Deere PMA1628-08 (Black PVC/polyurethane blend) - Grey
4. John Deere PMA 1687-08 (PVC/ polyurethane-high tensile-strength yarn-2 ply) - Green
5. Co-Op Hose (Versigard Synthetic Rubber) - Black



PPM dicamba Analyte



Percent Soybean Visual Injury 28 DAT



What Products Are Approved for Use in Extend Crops

- Engenia – (BASF)
- FeXapan with VaporGrip – (Dow/DuPont)
- XtendiMax with VaporGrip – (Monsanto)



Technique Selection

HPLC	FTIR
<ul style="list-style-type: none">• Great accuracy (quantitative & qualitative)	<ul style="list-style-type: none">• Good accuracy (qualitative)
<ul style="list-style-type: none">• Slower	<ul style="list-style-type: none">• Quicker
<ul style="list-style-type: none">• More expensive	<ul style="list-style-type: none">• Cheaper
<ul style="list-style-type: none">• Intensive	<ul style="list-style-type: none">• Low-hassle
<ul style="list-style-type: none">• Cleaving during extraction	<ul style="list-style-type: none">• No cleaving during extraction



DICAMBA @ 1/64X- SOYBEAN

- PCA-LDA analysis resulted in a classification model that accounted for:
 - 89, 92, 84, 91, 93% of explained variance at 0, 3, 7, 14, and 28 DAT
 - IR peaks at 1687 cm^{-1} and 1560 cm^{-1} identified as key identifiers



2,4-D @ 1/64X- COTTON

- PCA-LDA analysis resulted in a classification model that accounted for:
 - 90, 87, 90, 84, and 89% of explained variance at 0, 3, 7, 14, and 28 DAT
 - IR peaks at 1633-1556 cm⁻¹ and 1395-1350 cm⁻¹ identified as key identifiers



Air Samplers



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Contributing Partners



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EXTENSION**



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FORESTRY EXPERIMENT STATION**



**MS State
Support
Committee**

MISSISSIPPI DEPARTMENT OF
**AGRICULTURE
& COMMERCE**

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