The Science Behind Herbicide Volatility

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2019 Row Crop Short Course
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Overview of presentation

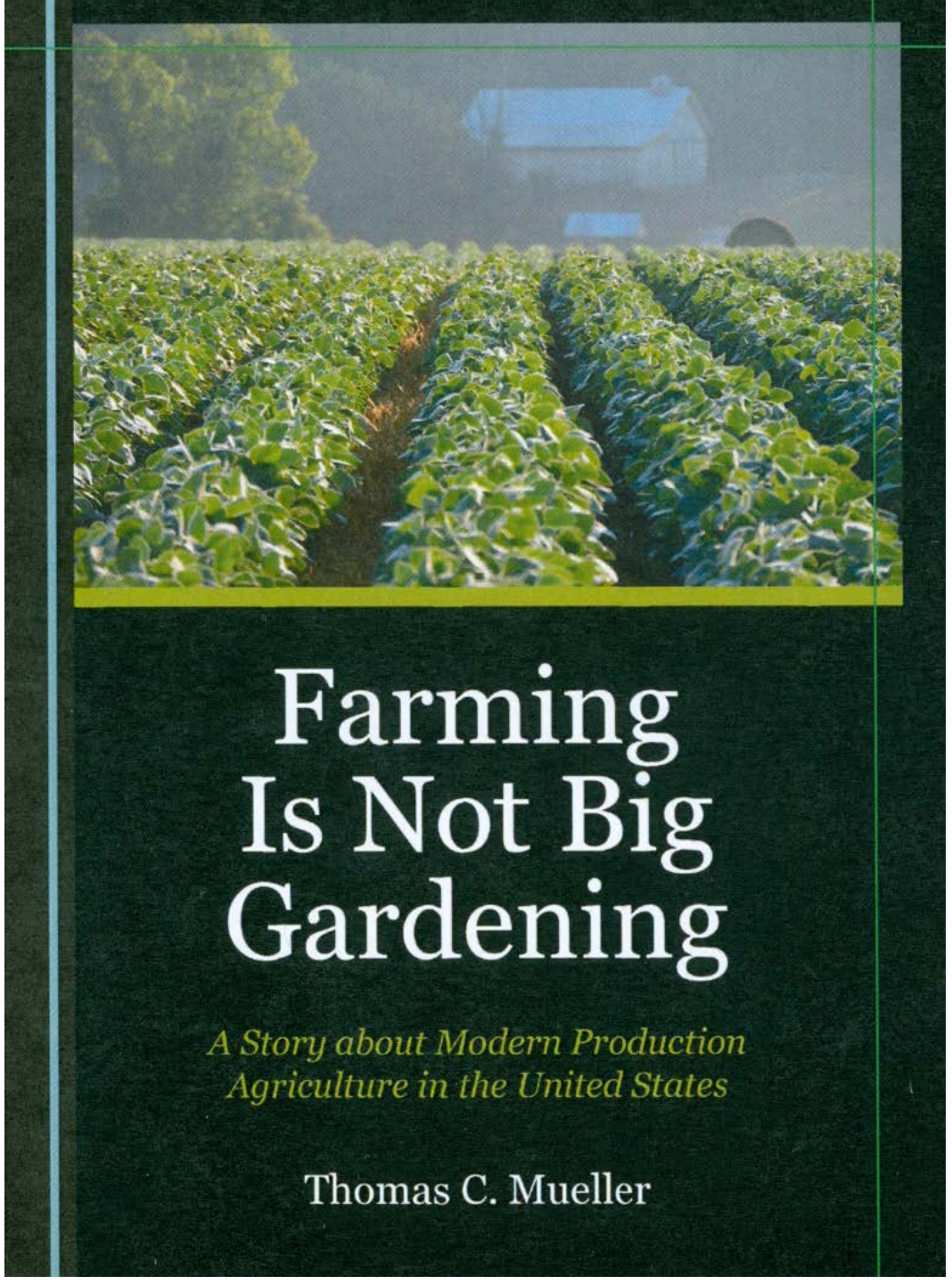
- Research overview
- Dicamba studies:
- Field
  - field surface condition
  - dicamba formulation
  - Effect of rainfall
- Laboratory
  - Effect of spray pH, temperature, formulation
  - Formulation effects of spray pH
- Closing thoughts

Overview of presentation

- What I am NOT going to cover today:
- Vapor pressure calculations
- Henry’s law constants
- Inversions
- Acid:Base Equilibria concepts
- Ukraine, or The Ukraine

Disclaimer

- Views and Ideas expressed in this presentation do not represent the views of the University of Tennessee
- Department of Plant Sciences
- Tennessee Department of Agriculture
- Tennessee Soybean Promotion Board
- Mention of a product does not constitute endorsement of that product to the exclusion of other similar products
- Some of this data is unpublished and subject to interpretation



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Drift comments

- Contrast Particle and Vapor drift
- Particle drift
  - Droplet never hits target
- Vapor Drift
  - Droplet hits targets, moves later

Dicamba

- Much recent effort to emissions under field and lab conditions
- All herbicides volatilize to some extent
- Roundup alone very low emissions
- Carbamothioates very high
  - (must be incorporated)
  - Eradicane
  - Sutan +

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Weed Science 2013 61:586–593

Effect of Formulation and Application Time of Day on Detecting Dicamba in the Air under Field Conditions

Thomas C. Mueller, Daniel R. Wright, and Kirk M. Remund*

The development of dicamba-tolerant and other auxin-tolerant crops will enable the use of these effective herbicides in soybean and cotton at application timings such as at planting or over-the-top that are not currently possible. This research examined the effect of various factors on detection of postapplication amounts of dicamba in the air under field conditions by coupling a sample collection system with advanced chemical analysis of those samples. The quantity of dimethylamine salt of dicamba that was detected within 48 hr after application was two times greater ($P < 0.05$) than the quantity of diglycoamine salt formulation based on field studies in 2009. Regardless of application timing, the amount of detected dicamba was greatest during the 0 to 12 hr time period after application. However, the total detected after 48 hr was less for evening applications (5 micrograms [µg]) compared with midday (17 µg) or morning (14 µg) applications based on 2010 field trials. Average ambient air temperature (and other weather variables) correlated with higher detection levels of dicamba in the air in the field.

Nomenclature: Dicamba; soybean, *Glycine max* (L.) Merr.
Key words: Dicamba, drift, off-site movement, stewardship, volatility.

Published by Mueller and 2 co-authors from Monsanto
These methods are the basis for later studies discussed.

Dicamba formulations

- DiGlycolAmine (DGA) salt, Clarity, others
- Xtendimax from Monsanto (Bayer)
  - DGA + Vapor Grip (acetate pH modifier)
- Engenia (BAPMA salt) from BASF
  - Different salt has lower emissions

Tractor spraying herbicide

Sampler in field, exhaust port vented

Hobo soil probes to record temperature

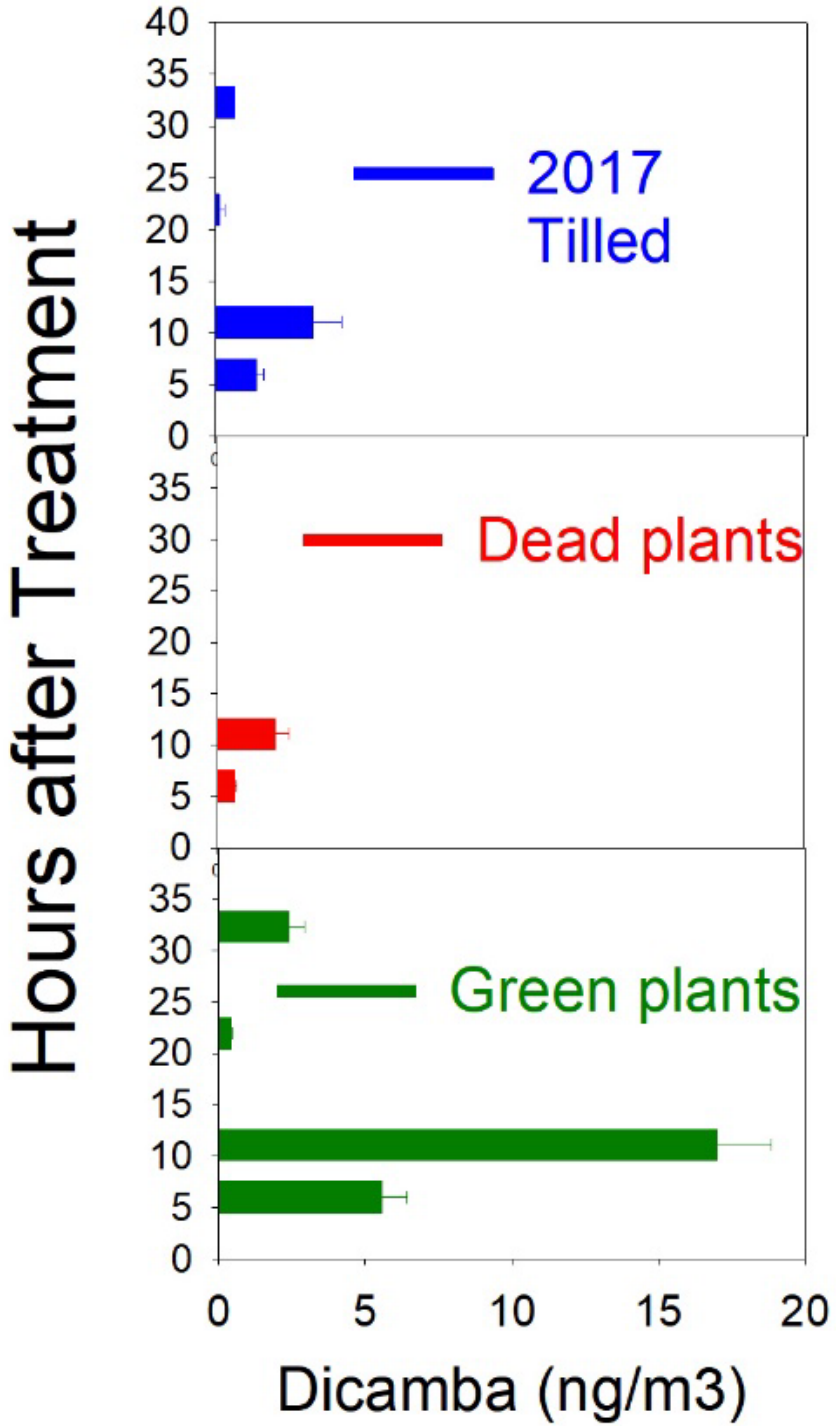
How does surface condition affect dicamba volatility?

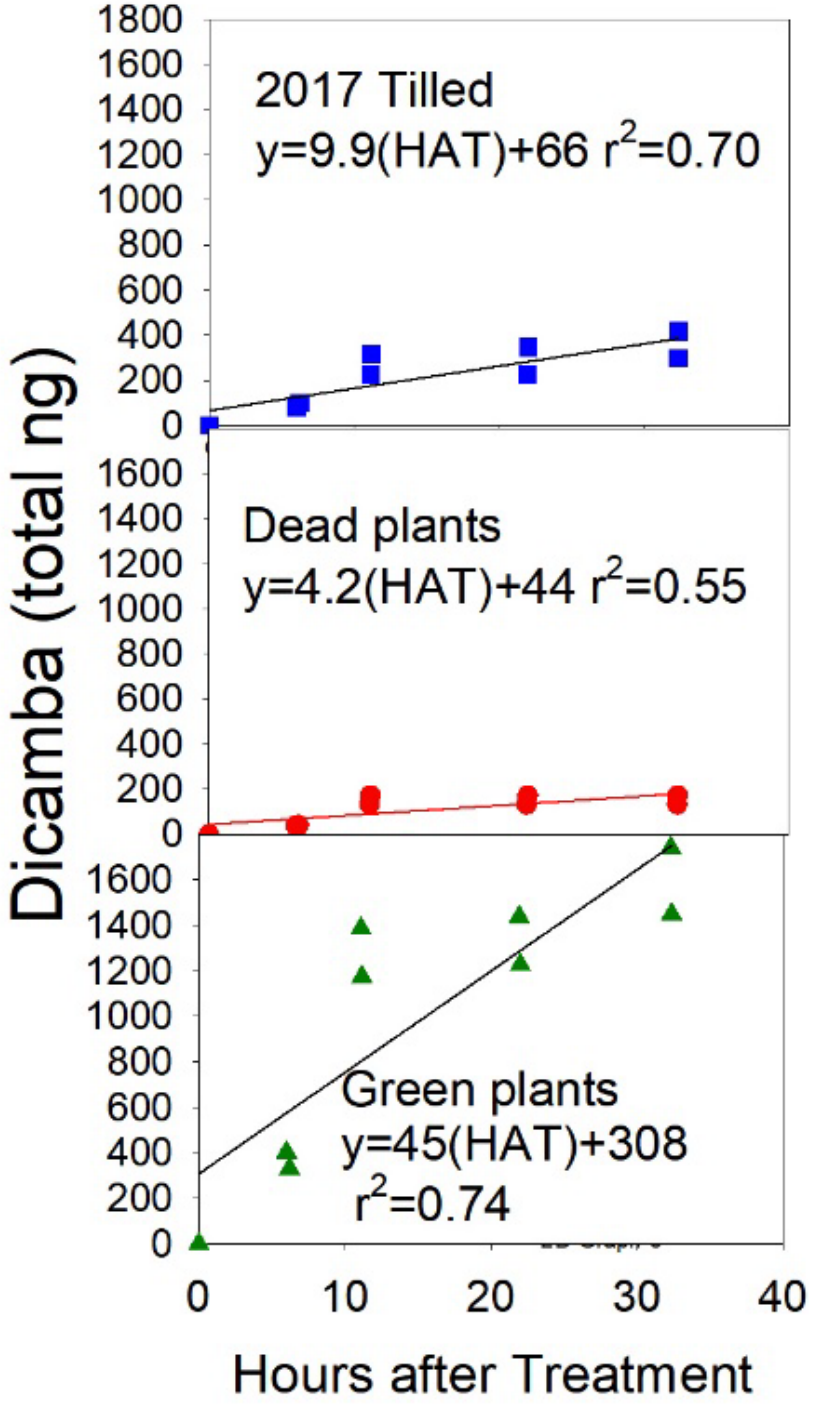
A. tilled ground

B. dead plant vegetation

C. Live (green) plant vegetation

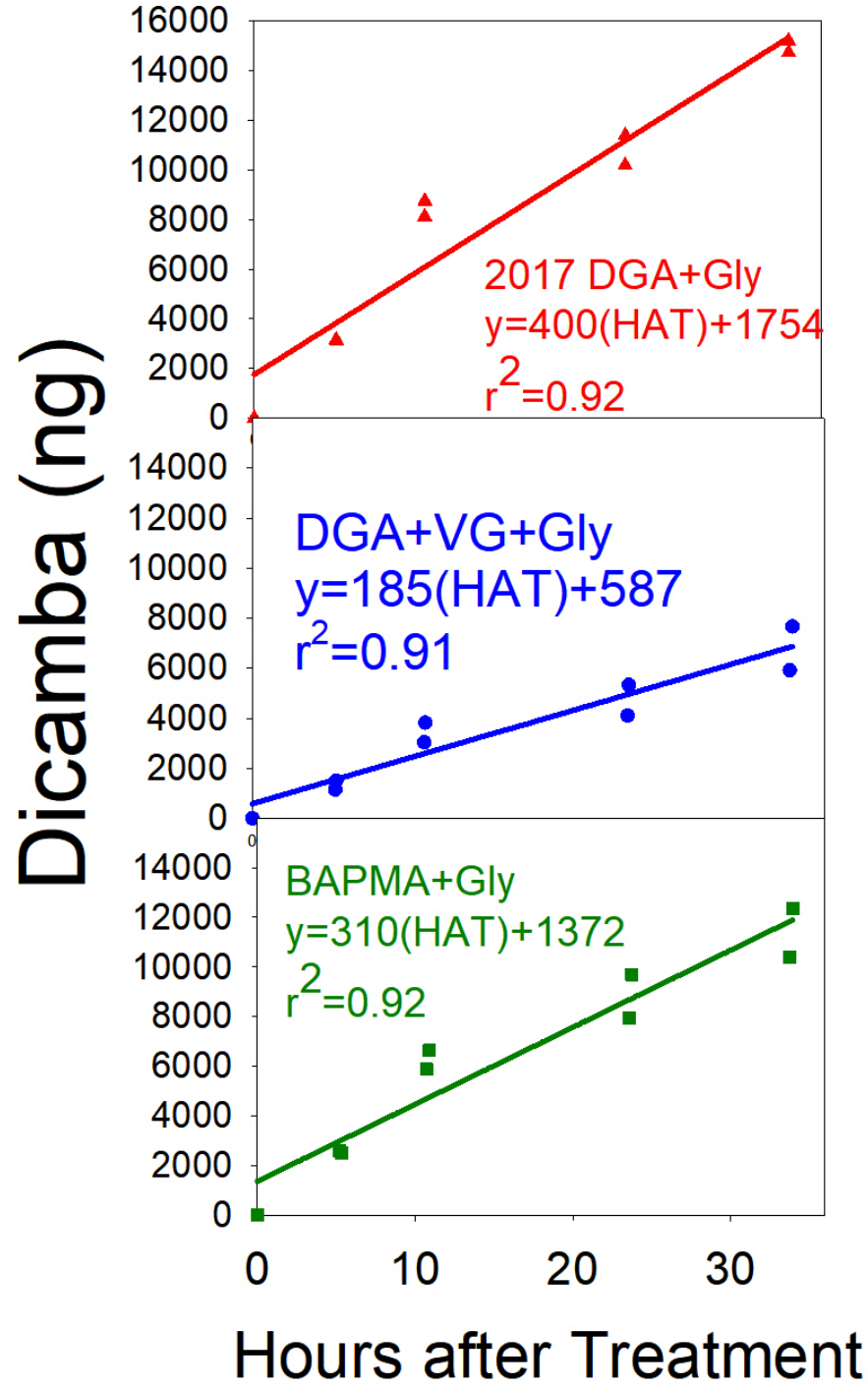
rainfall occurred 12 HAT





Do new formulations volatilize?

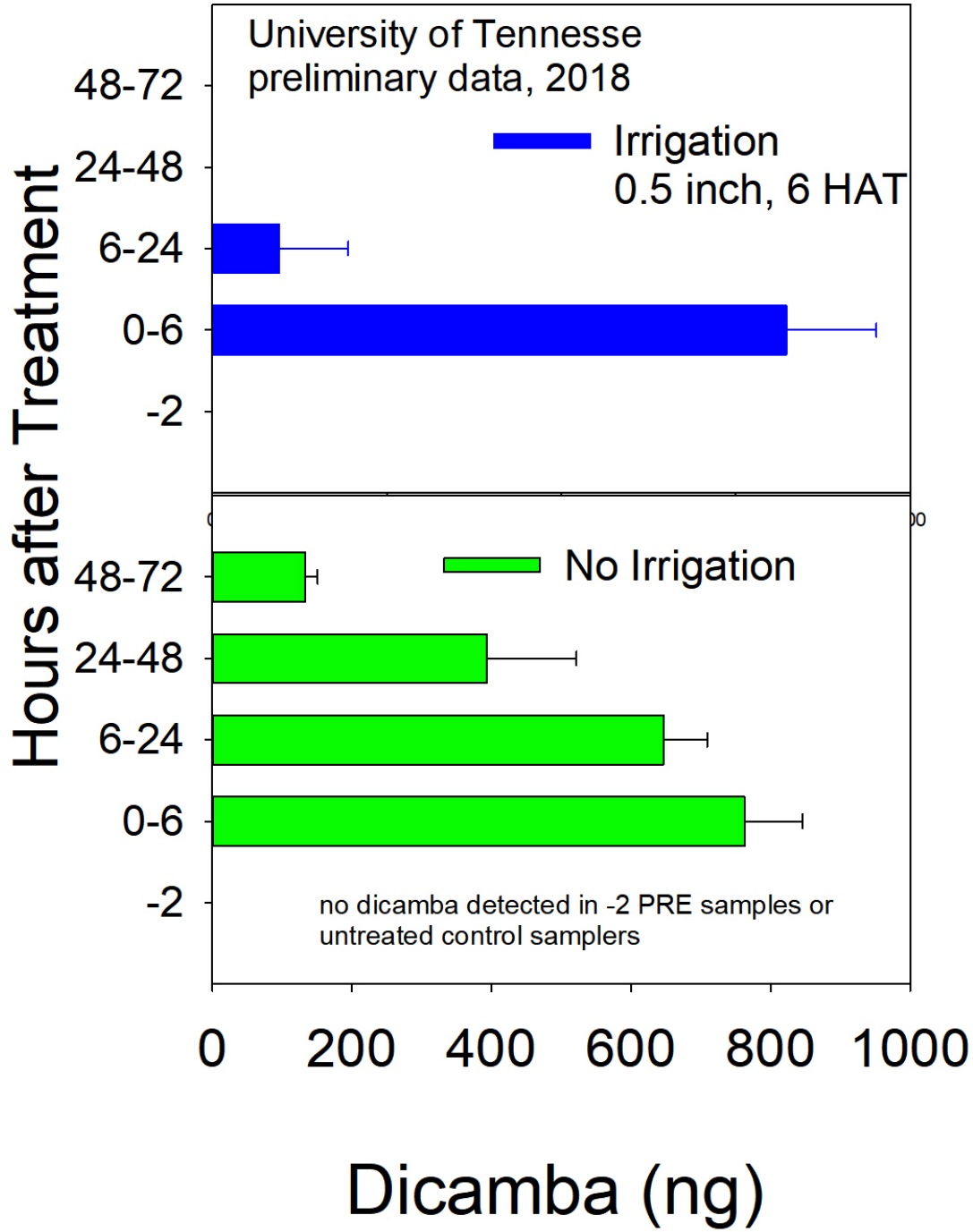
1. Set up trial with DGA, BAPMA and DGA+VG
2. All with Roundup Powermax in tank

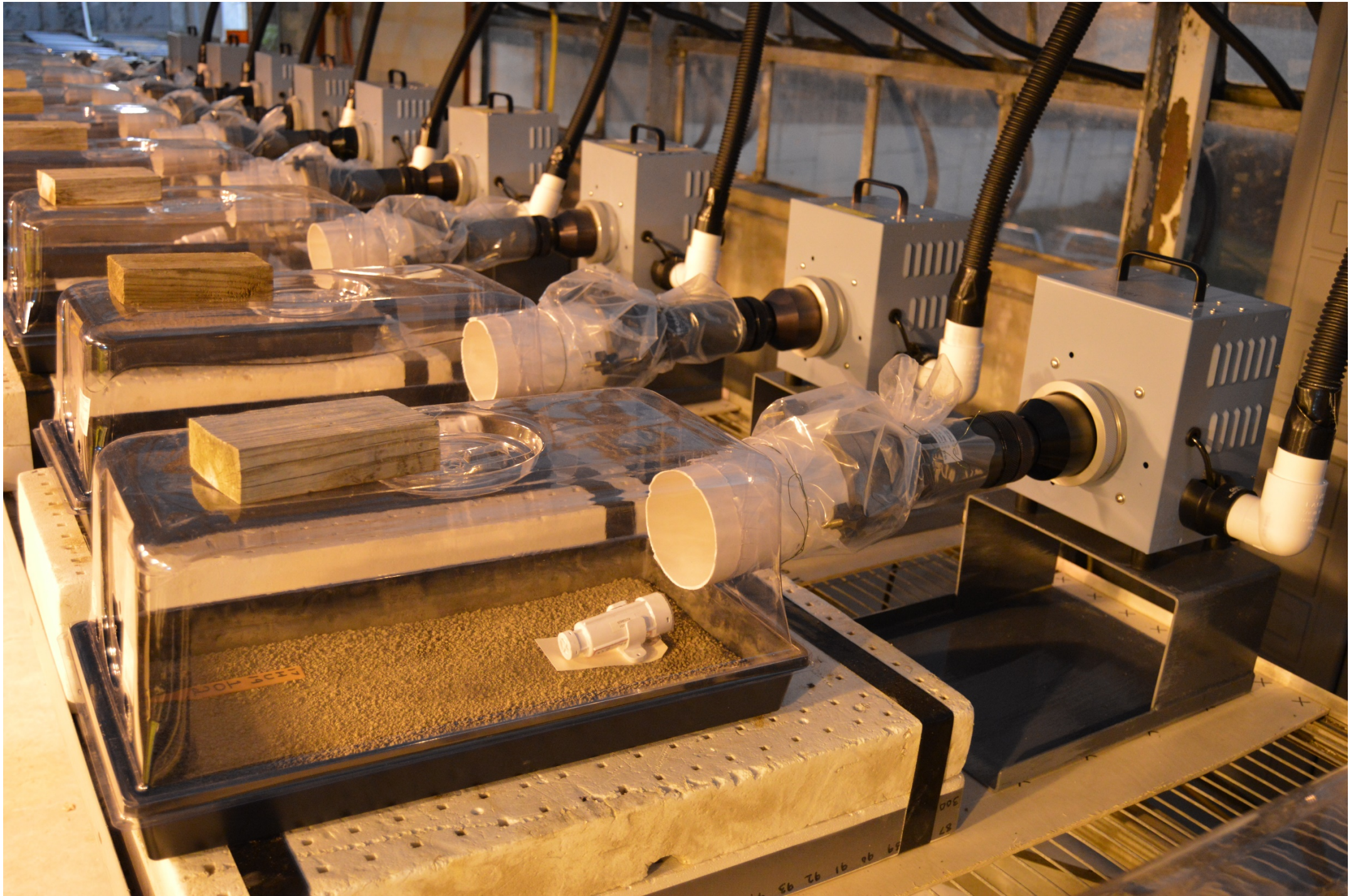

Dicamba (ng)
16000
14000
12000
10000
8000
6000
4000
2000
0
2017 DGA+Gly
y=400(HAT)+1754
r2=0.92
DGA+VG+Gly
y=185(HAT)+587
r2=0.91
BAPMA+Gly
y=310(HAT)+1372
r2=0.92
0
10
20
30
Hours after Treatment

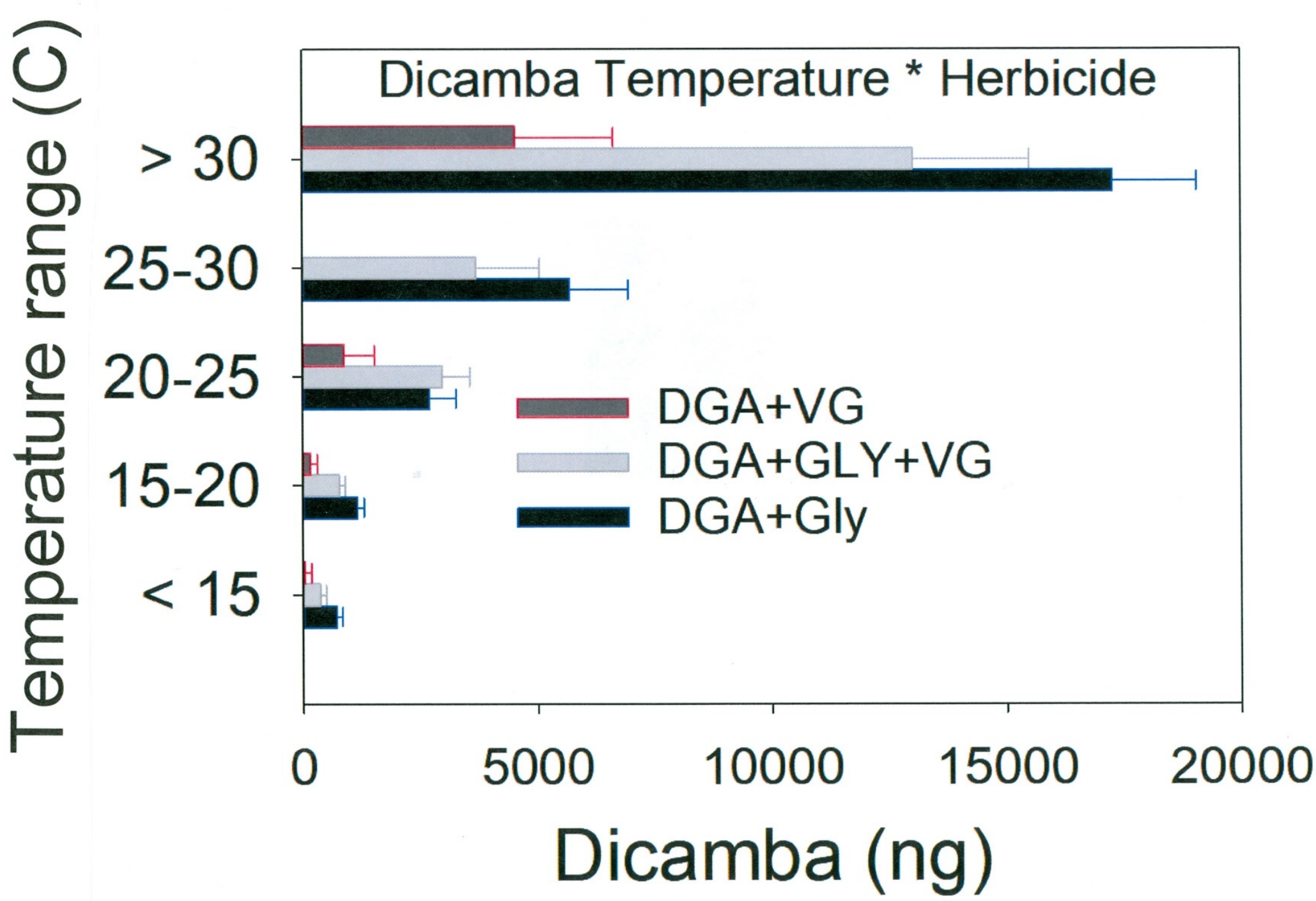
What is the effect of rainfall on dicamba vapors?

1. Paired plot design (yes and no irrigation)
2. Dicamba (DGA+VG)+glyphosate on both plots
3. Samplers inside plot area

New samplers
Water-resistant
Automatic flow adjustment

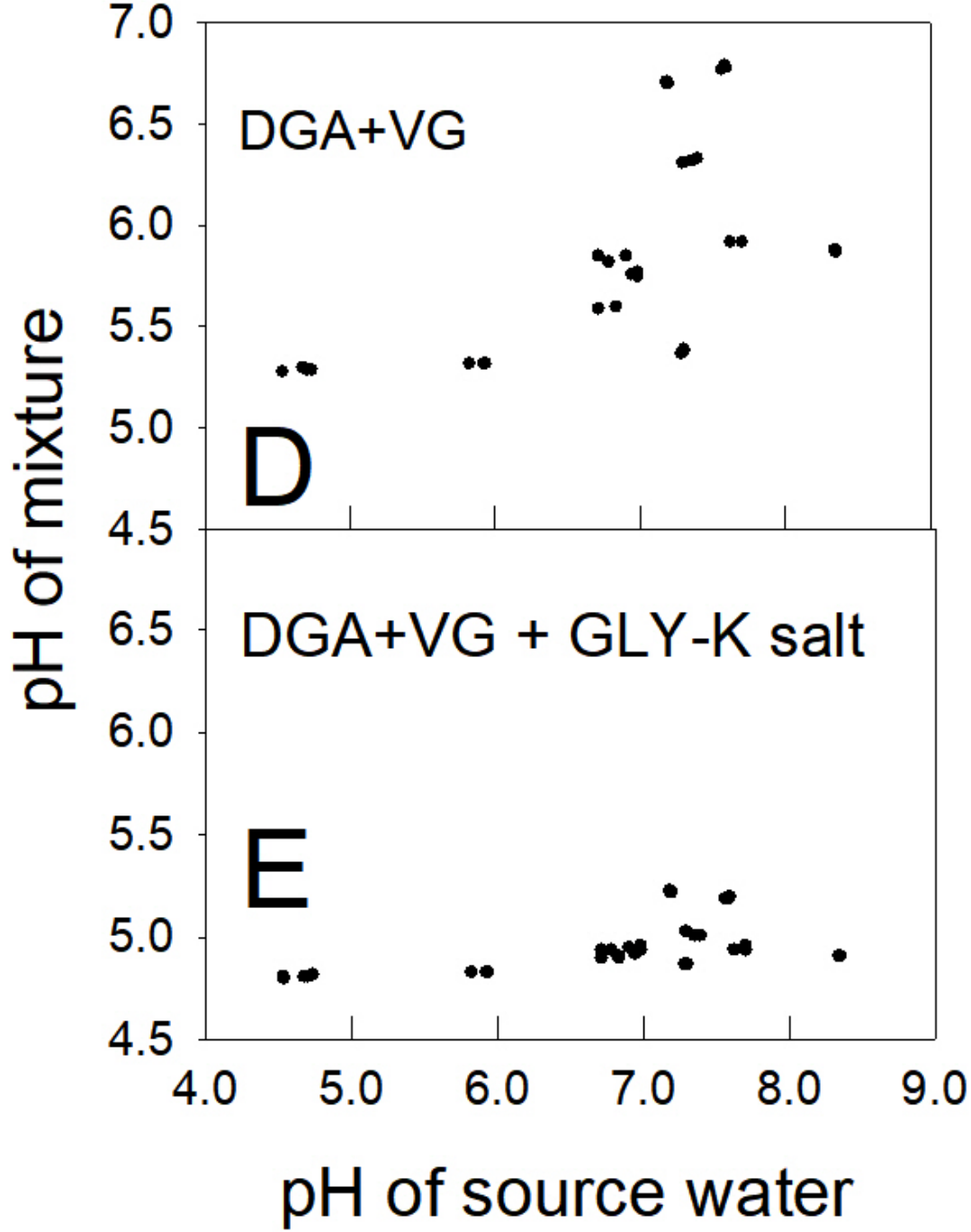

University of Tennesse
preliminary data, 2018
Irrigation
0.5 inch, 6 HAT
No Irrigation
Hours after Treatment
48-72
24-48
6-24
0-6
-2
no dicamba detected in -2 PRE samples or
untreated control samplers
0
200
400
600
800
1000
Dicamba (ng)




Dicamba Temperature * Herbicide
Temperature range (C)
> 30
25-30
20-25
15-20
< 15
DGA+VG
DGA+GLY+VG
DGA+Gly
0
5000
10000
15000
20000
Dicamba (ng)

pH effects of tank mixtures?

1. All lab studies
2. Water sources with pH from 4.6 to 8.3
3. Various mixtures, measure pH
4. pH < 5.0 indicates off-label application


DGA+VG
D
DGA+VG + GLY-K salt
E
pH of mixture
pH of source water
7.0
6.5
6.0
5.5
5.0
4.5
4.0
5.0
6.0
7.0
8.0
9.0

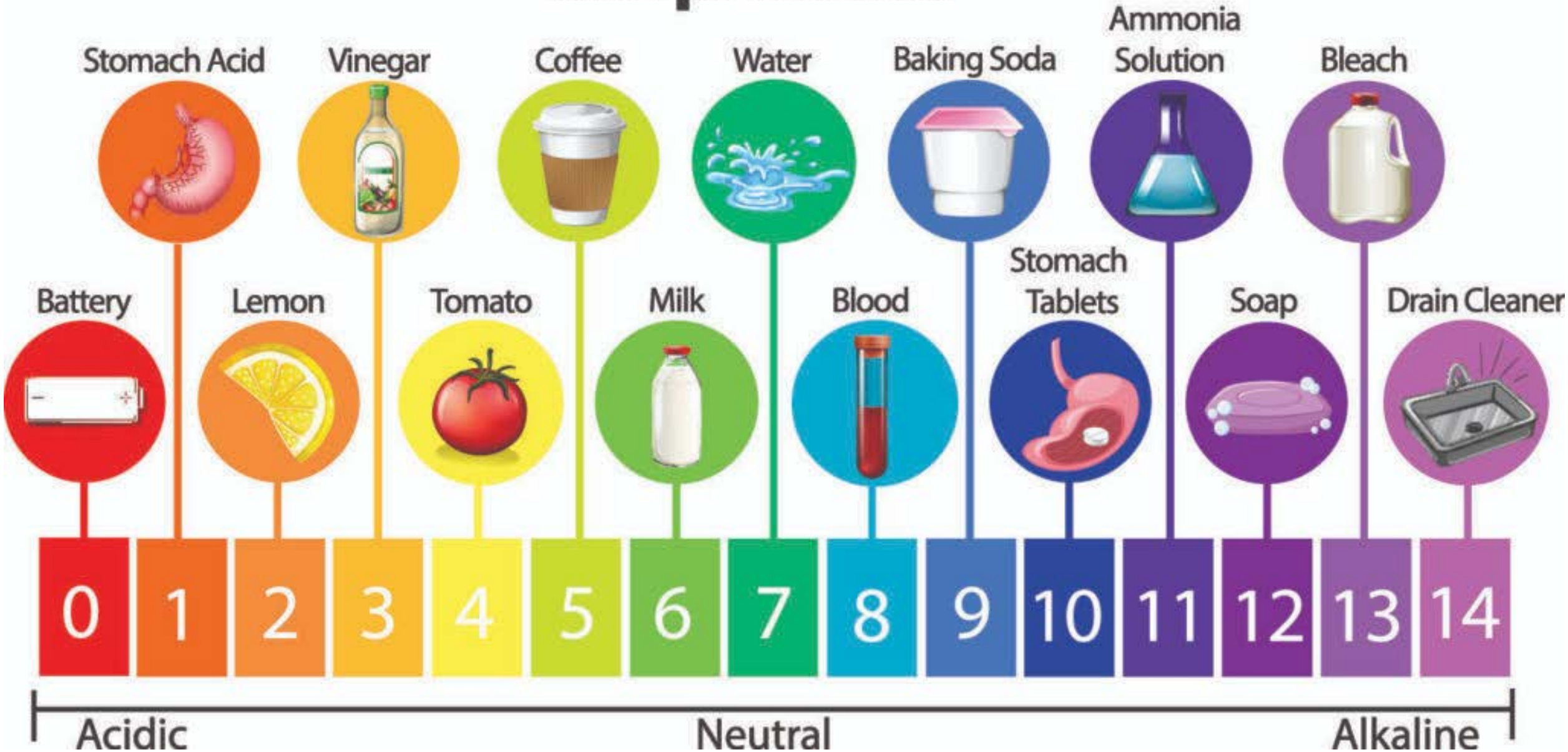
General Observations

- More dicamba from green plant material
- Similar volatility of new formulations to DGA
- Temperature & spray pH affect dicamba emissions
- Rainfall reduces dicamba emissions
- Glyphosate lowers spray pH

Comments on water pH

- pH is on a log scale
- Conduct demonstration

The pH Scale


Stomach Acid
Vinegar
Coffee
Water
Baking Soda
Ammonia Solution
Bleach
Battery
Lemon
Tomato
Milk
Blood
Stomach Tablets
Soap
Drain Cleaner
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
Acidic
Neutral
Alkaline

Comments on water pH

- What is the pH of your water in your sprayer?
- If < 5.0, then more dicamba will go to vapors
- Many choices to raise spray mixture pH

Closing comments

- How to stop dicamba volatilization
- 1. cannot stop completely
- 2. spray at lower temperatures
- 3. do not add Roundup to tank
- 4. spray earlier in the season
  - Lower temp
  - Less plant material

Acknowledgments

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- Technical assistance by David Kincer, Joe Beeler, Trey Clark and several student workers
- Always read and follow all label instructions for all crop protection products

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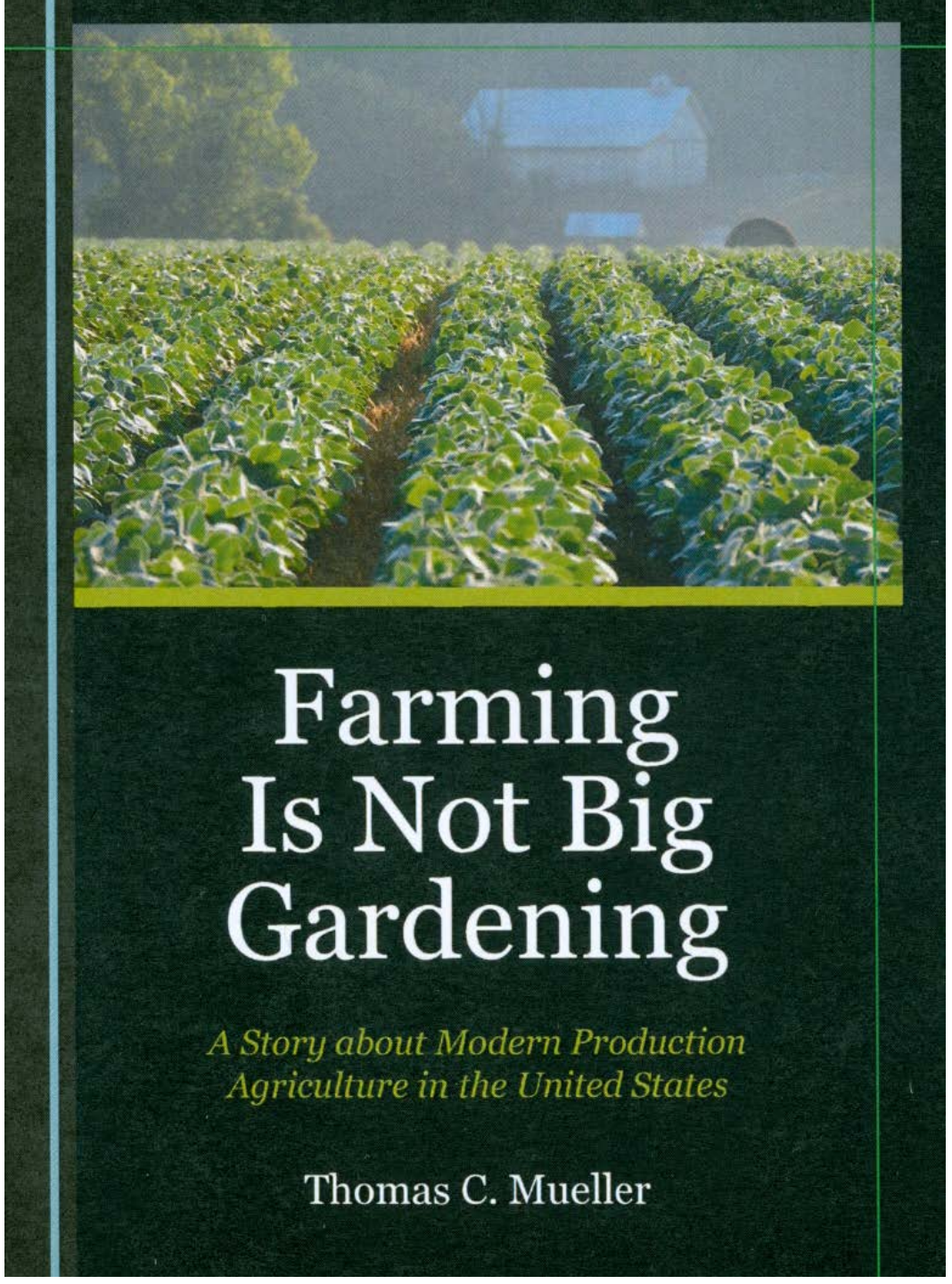

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Questions?