# Understanding Induced Resistance – What it is and how to best use it for disease control

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# Induced Resistance

* What is Induced Resistance
* Plant Defense Activators
* How do I use IR and Plant Defense Activators to control disease

# What is Induced Resistance?

Plants are endowed with genes involved in the synthesis of antimicrobial compounds conferring resistance against plant pathogens.

| | | | |
|---|---|---|---|
| Chitinases | Peroxidase | Proteinases | Terpenoids |
| Proteinase inhibitors | Defensins | Glucanases | Thaumatin |
| Phytoalexins | Lignin | Callose | Thionin |

Many of these are "sleeping" genes, quiescent in healthy plants, which require specific signals to activate them.

Plant pathogens provide signals which activate these defense genes, a process known as "induced resistance."

Adapted from Reddy P.P. (2012) Plant Defence Activators. *In:* Recent advances in crop protection. Springer, New Delhi

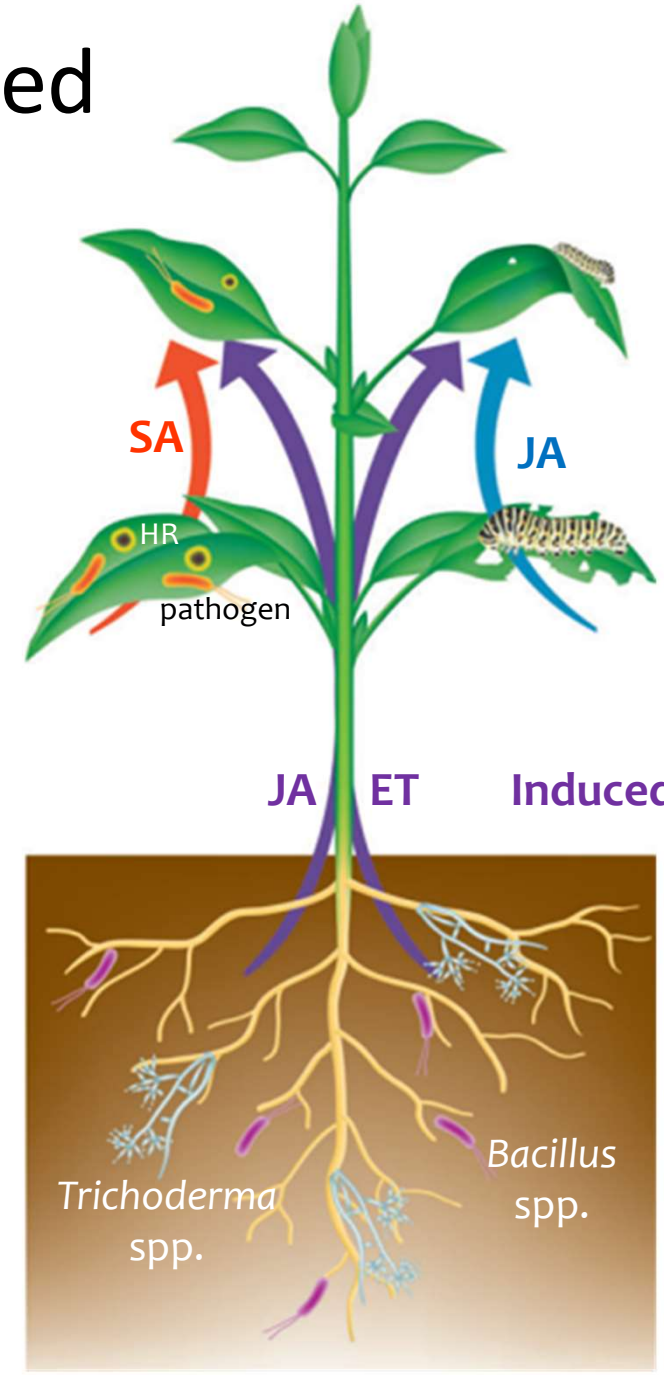
# Types of Induced Resistance (IR)

## Systemic Acquired Resistance (SAR)

Molecular patterns (elicitors) from pathogenic microbes trigger a hypersensitive response (HR) at the site of infection, and an increase in the signaling molecule salicylic acid (SA).

**RESULT**

Systemic resistance: Decreased susceptibility to further infection or damage beyond the point of initial contact.




Adapted from Pieterse *et al.* 2014. Ann. Rev. Phytopathol. 52: 347–75.

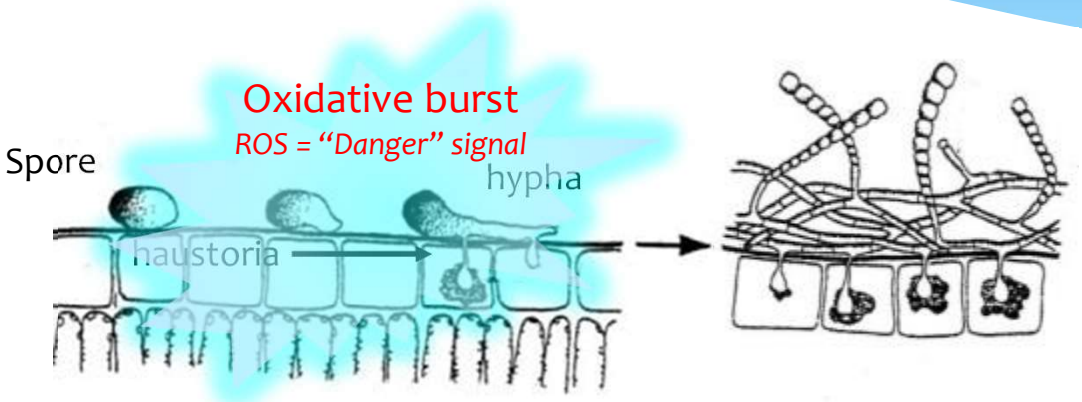
## Herbivore- or Stress-Induced Resistance (HIR)

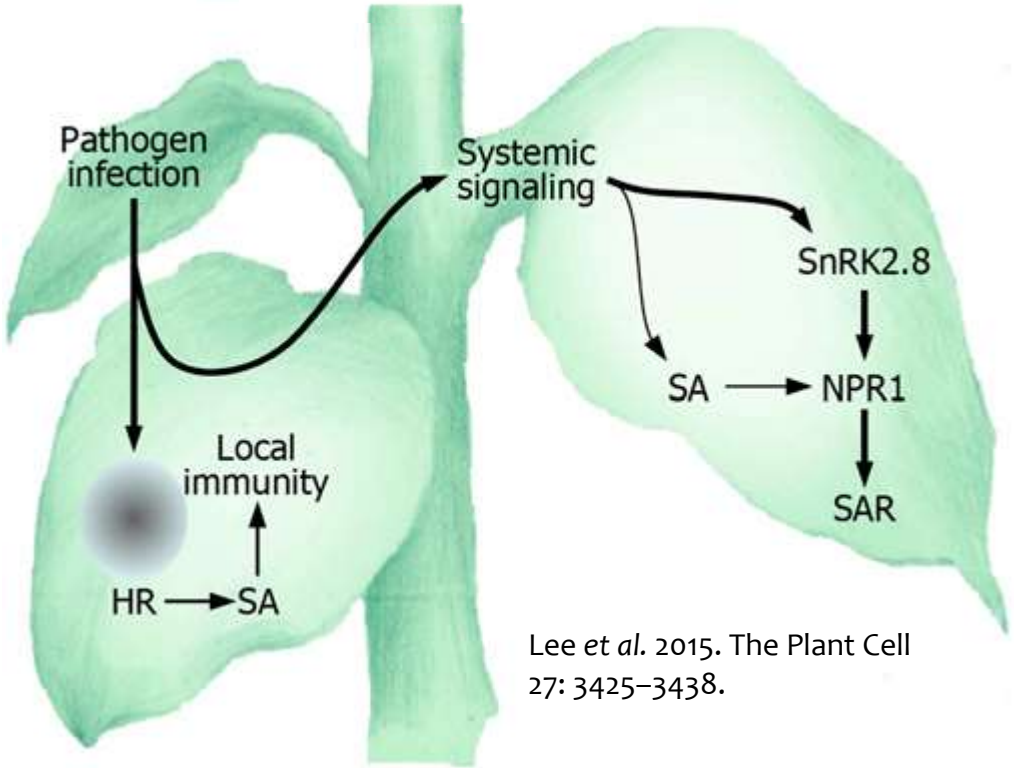
Chemical signals from damaged cells, insect saliva, or abiotic stress can trigger increase in the signaling molecule jasmonic acid (JA).

## Induced Systemic Resistance (ISR)

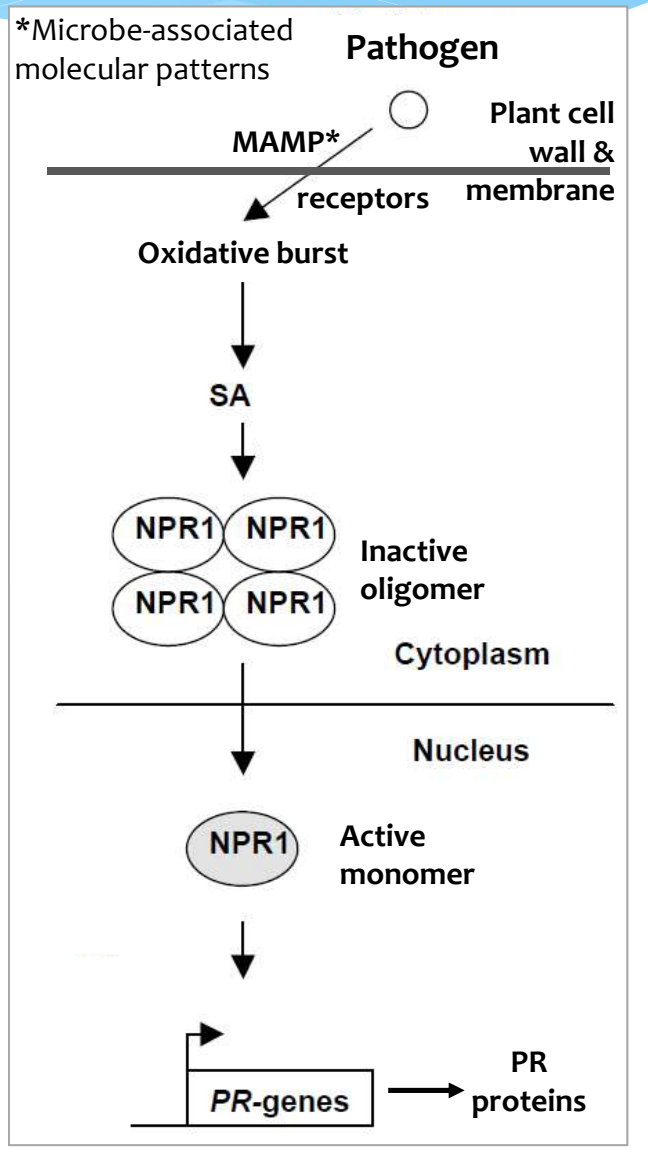
Molecular patterns from non-pathogenic microbes on roots or in the surrounding soil (rhizosphere) trigger increase in the signaling molecules jasmonic acid (JA) and ethylene (ET).

# SA signal Pathway



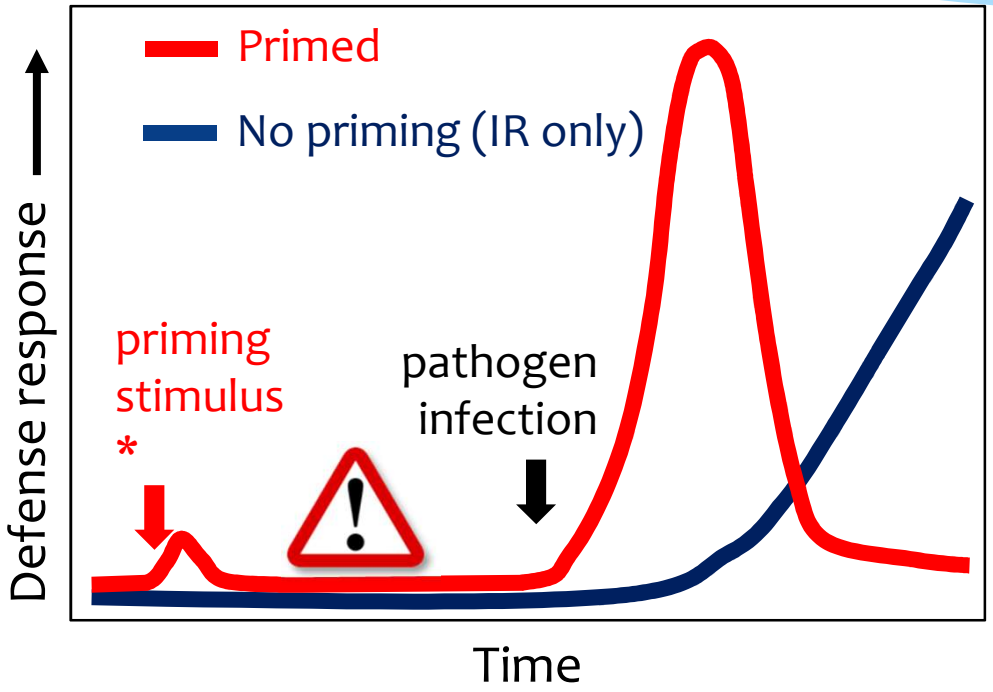

Lee *et al.* 2015. The Plant Cell 27: 3425–3438.



# Induced Resistance

## Priming for Enhanced Defense

*Source:* www.slideshare.net/DhanyaAgri/primeome-a-molecular-approach-towards-defense-priming




Plant defense activators mimic these signals, triggering defenses independent of pathogen infection.

# Examples of Plant Defense Activators

**Biological (EPA-registered Biopesticides):**

- Bacteria: *Bacillus mycoides, B. amyloliquefaciens, B. subtilis* (LifeGard®, Double Nickel®, Triathlon BA®, Cease®, Serenade®, etc.)
- Fungi: *Trichoderma* species (RootShield®, SoilGard®)
- Yeast extracts (KeyPlex®)
- Plant & algae extracts (Regalia®, Timorex Gold®, Vacciplant®)

**Chemical:**

- Salicylic acid (SA) and analogs (Leap)
- Benzothiadiazole (BTH) (Actigard®)
- Phosphites/Phosphorous acid (K-Phite®, Phostrol®)

**EPA registered plant activators:**
Safety & Efficacy testing, Quality Control, Clear labeling


Many biostimulant products are promoted as “plant activators.”

- Fertilizers, micronutrients and/or “stress relief” compounds, some containing multiple microbe species at very low concentrations.

- Thinly-veiled claims of disease control with little or no underlying scientific support.

- Currently no EPA regulatory framework or legal definition plant activator or biostimulant.

# Use Guidelines

* If possible pick a cultivar or variety with some resistance
* Spray BEFORE infection is suspected
* Allow 3-5 days  for product to fully induce the response
* Repeat on a regular basis (7-14 days) to maintain response

# How to use Plant Defense Activators

* 1) Stand Alone (Just cause you can doesn't mean you should!)
* 2) In a program – with other effective products (Most Common)
* 3) In addition to a program (Special Cases)

# 1) Stand Alone (Just cause you can doesn't mean you should!)

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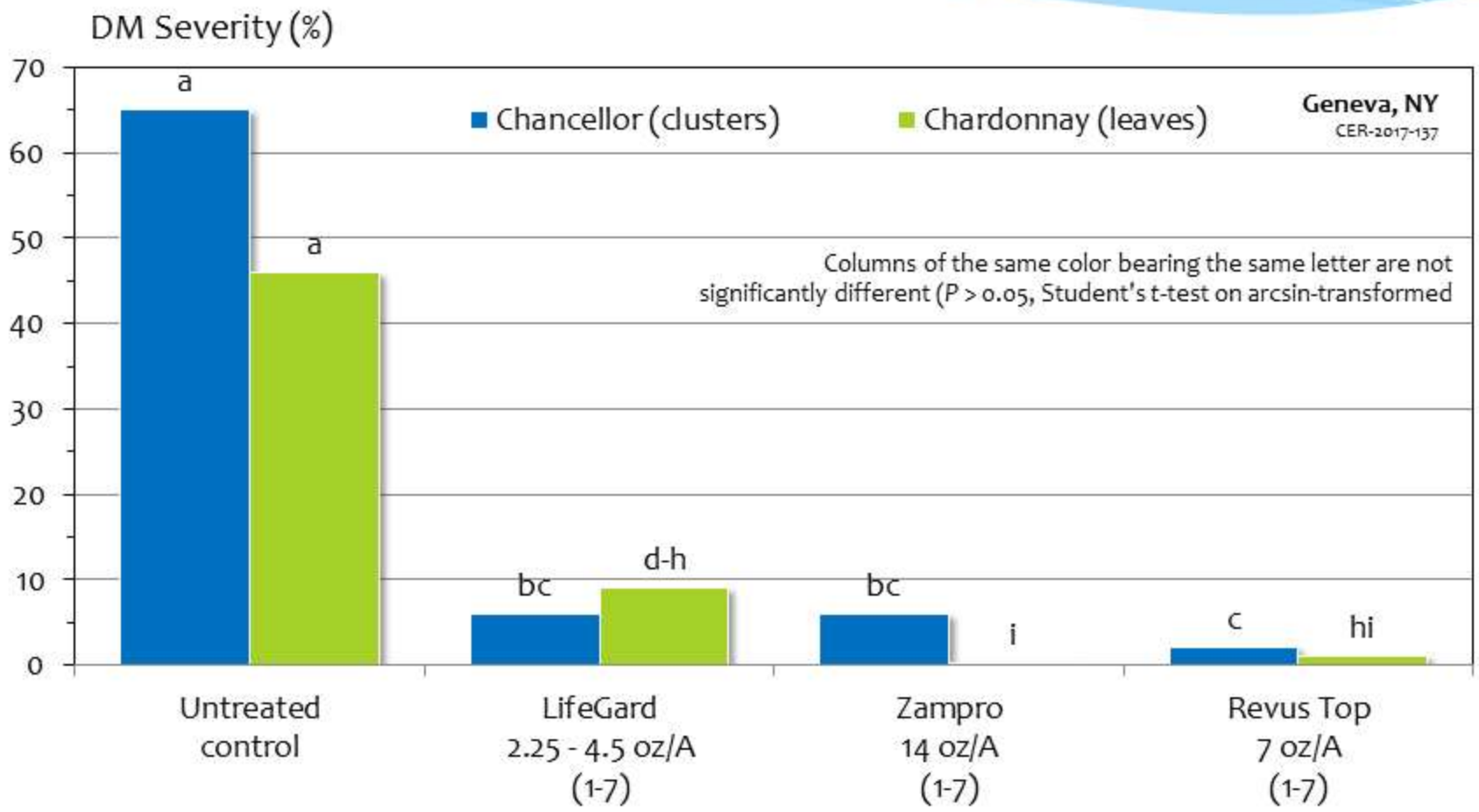
LifeGard™ WG

BIOLOGICAL PLANT ACTIVATOR




7 weekly applications with hooded boom sprayer (50 GPA pre- & 100 GPA post-bloom).

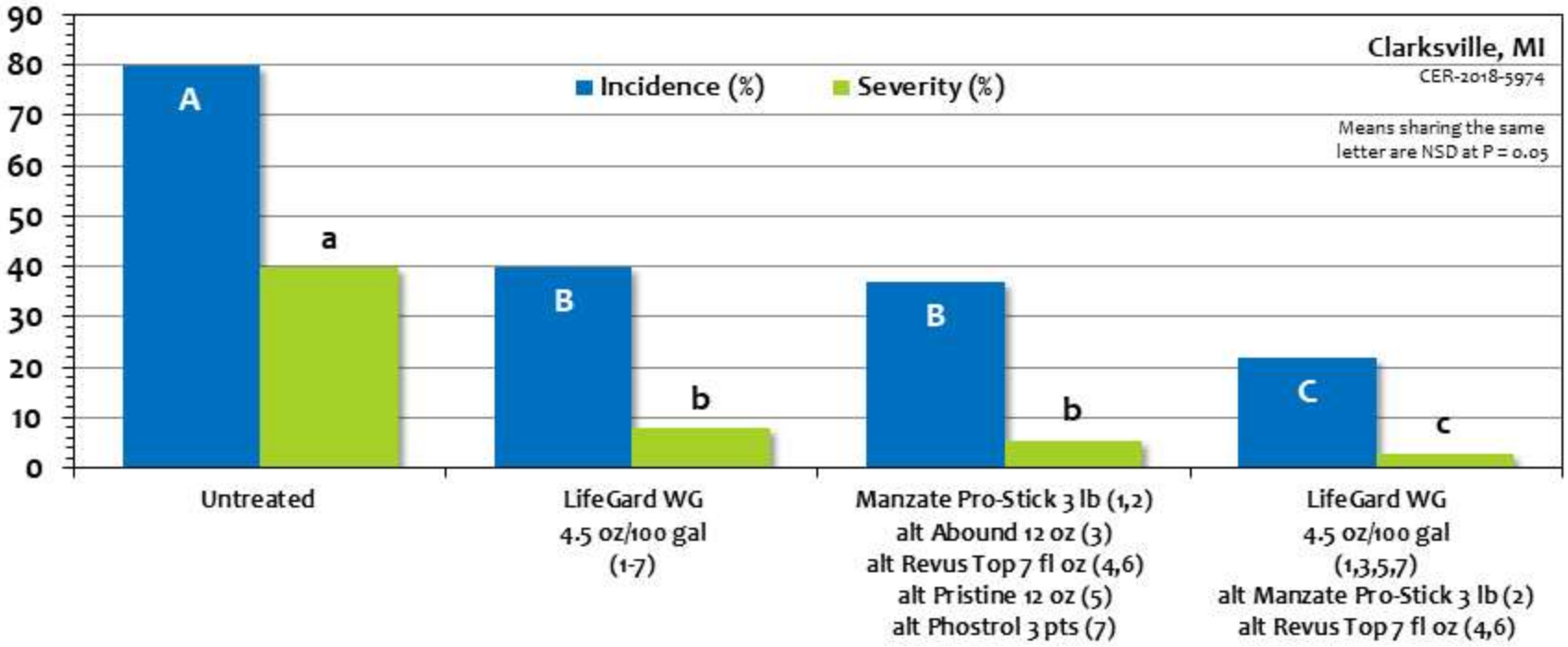
- LifeGard WG applied at concentration of $10^7$ cfu/ml.
- Cooperator: W. Wilcox, Cornell Univ.

# 2) In a program – with other effective products

LifeGard™ WG
BIOLOGICAL PLANT ACTIVATOR

# Grape

## Downy mildew on leaves (*Plasmopara viticola*)




- Variety: Niagara
- Treatments: 7 apps; 1 = Jun 4th, 2 = Jun 14th, 3 = Jun 27th, 4 = Jul 12th, 5 = Jul 25th, 6 = Aug 9th, 7 = Aug 23rd
- Apps made using a research sprayer calibrated to deliver 40-50 gal/ac @ 55 psi
- Downy mildew on leaves rated on Oct. 4th
- Cooperator: T. Miles & J. Gillett, Mich State Univ.

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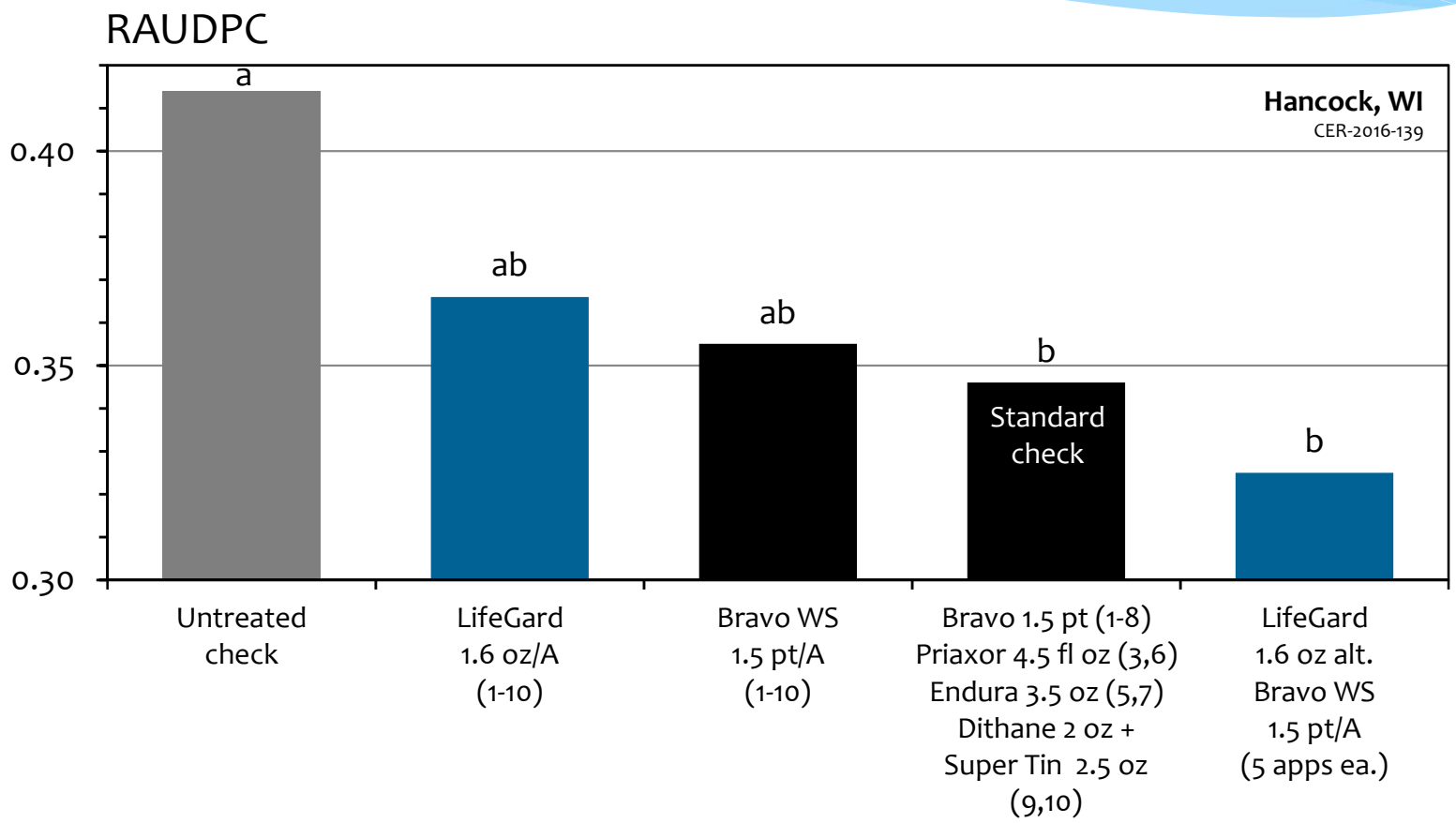
# Potato Early Blight



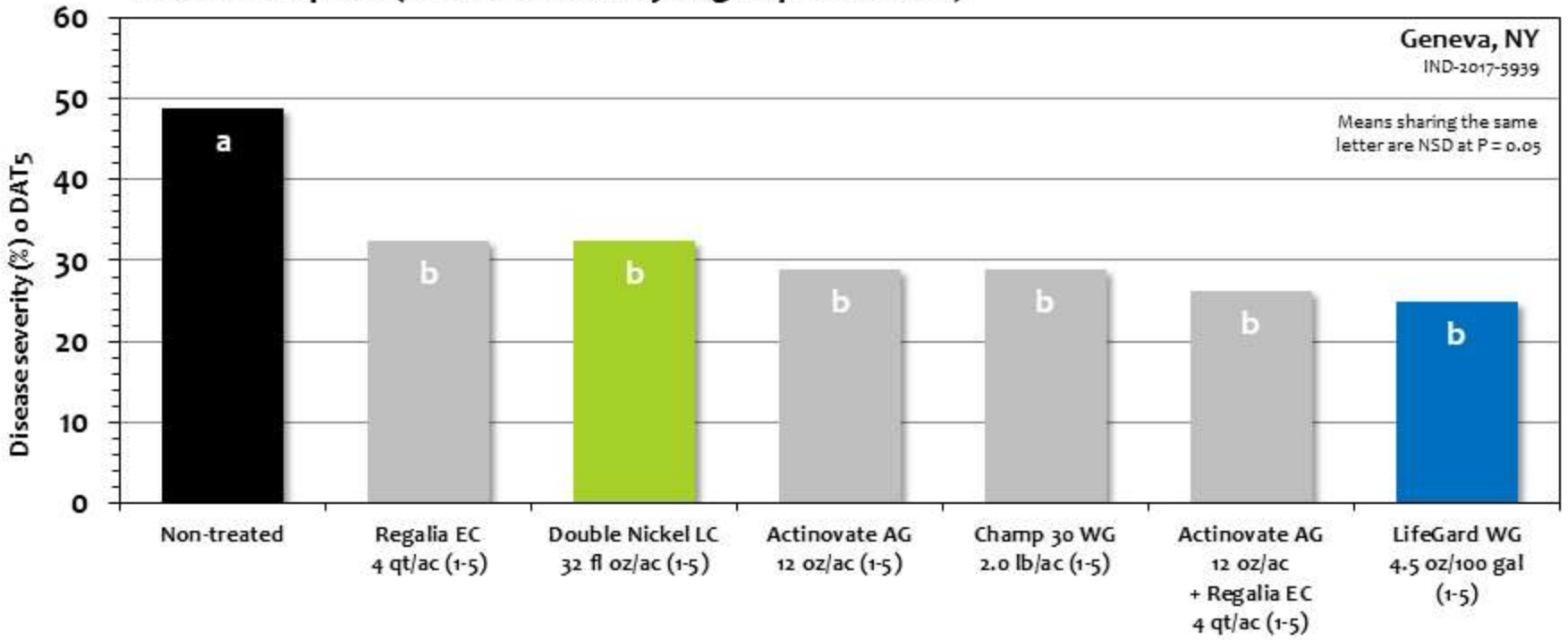

- 10 weekly applications 13 Jul - 7 Sep.
- Tractor-mounted spray boom delivering 35 GPA at 40 psi through 4 nozzles/row.
- LifeGard applied at concentration of $10^7$ cfu/ml (4.5 oz/100 gal).
- Cooperator: A. Gevens & S. Jordan, Univ. Wisconsin

# 3) In addition to a program

# Tomato

LifeGard™ WG
BIOLOGICAL PLANT ACTIVATOR

## Bacterial speck (*Pseudomonas syringae pv. tomato*)




- Variety: Mt. Fresh Plus
- Treatments: 5 apps; 1 = Jul 11th, 2 = Jul 19th, 3 = Jul 26th, 4 = Aug 2nd, 5 = Aug 7th
- Apps made using a calibrated backpack sprayer delivering 40 gal/ac at 40 psi via two flat fan TeeJet nozzles.
- Trial inoculated once with *Pseudomonas syringae pv. tomato* on Jul 13th
- Cooperator: H. Lange, Cornell Univ.

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# Tomato

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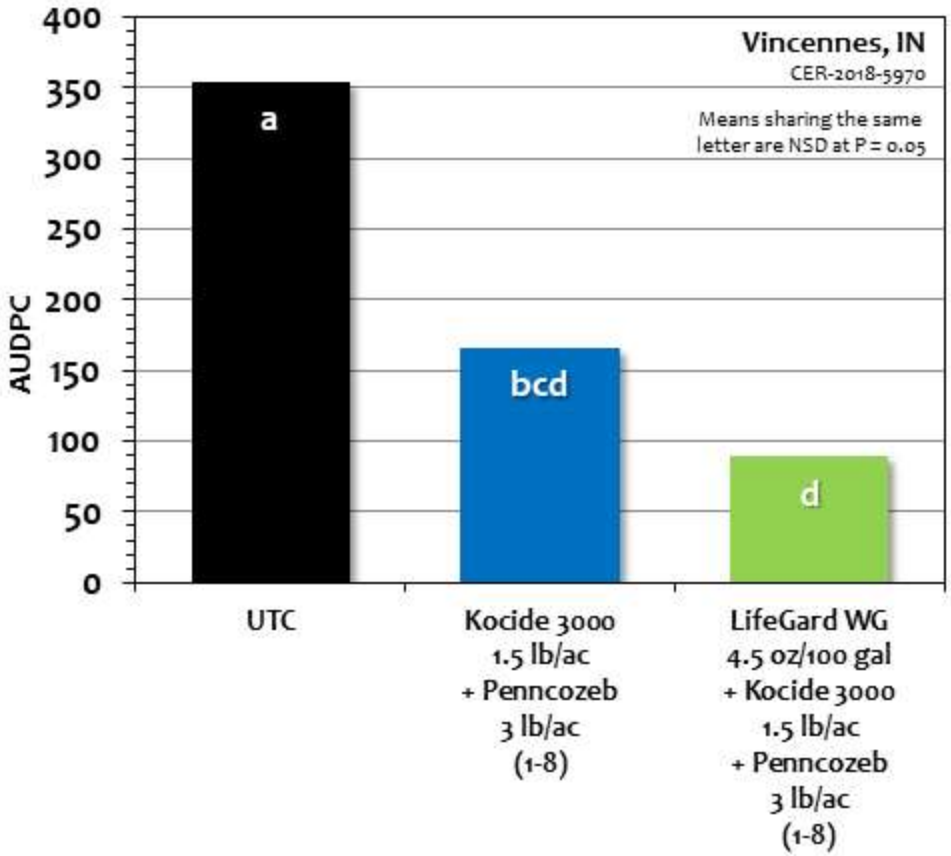
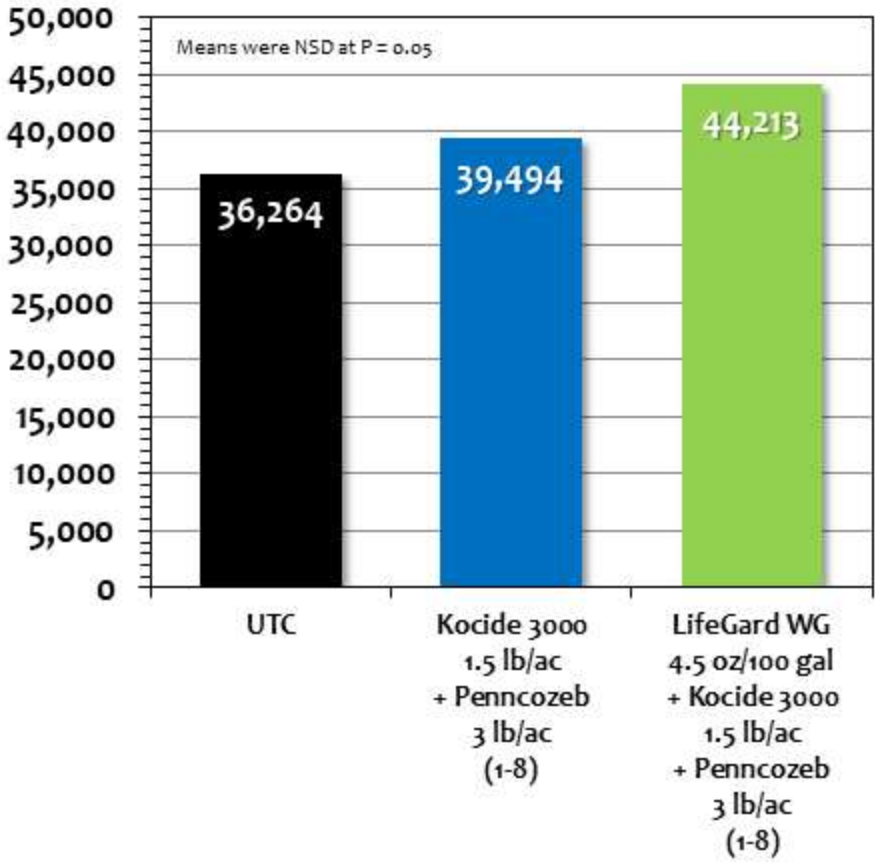
BIOLOGICAL PLANT ACTIVATOR

## Bacterial spot (*Xanthomonas perforans*)




## Marketable yield (lbs/ac)




Variety: BHN 410
8 applications made beginning 4 June – approx. weekly intervals @ 20 GPA
Cooperator – D. Egel Purdue University

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# Bacterial leaf spot in tomato

*K. Ivors, NC State University, Mills River, North Carolina*

| Appl | Standard program | LifeGard program | Actigard program |
|---|---|---|---|
| 1 | Endura, Kocide, Actigard | LifeGard | Actigard |
| 2 | Kocide | LifeGard | Actigard |
| 3 | Endura, Kocide, Actigard | LifeGard | Actigard |
| 4 | Kocide | LifeGard, Manzate, Kocide | Actigard, Manzate, Kocide |
| 5 | Endura, Kocide, Actigard, Bravo | LifeGard, Manzate, Kocide, Bravo | Actigard, Manzate, Kocide, Bravo |
| 6 | Kocide, Bravo | LifeGard, Manzate, Kocide, Bravo | Actigard, Manzate, Kocide, Bravo |
| 7 | Endura, Kocide, Actigard, Bravo | LifeGard,, Manzate, Kocide, Bravo | Actigard, Manzate, Kocide, Bravo |
| 8 | Kocide, Bravo | LifeGard, Manzate, Kocide, Bravo | Actigard, Manzate, Kocide, Bravo |
| 9 | Endura, Bravo | LifeGard, Manzate, Kocide, Bravo | Actigard, Manzate, Kocide, Bravo |
| 10 | Ranman | LifeGard, Manzate, Kocide, Bravo | Actigard, Manzate, Kocide, Bravo |
| 11 | Endura, Bravo | LifeGard, Manzate, Kocide, Bravo | Actigard, Manzate, Kocide, Bravo |


Untreated check

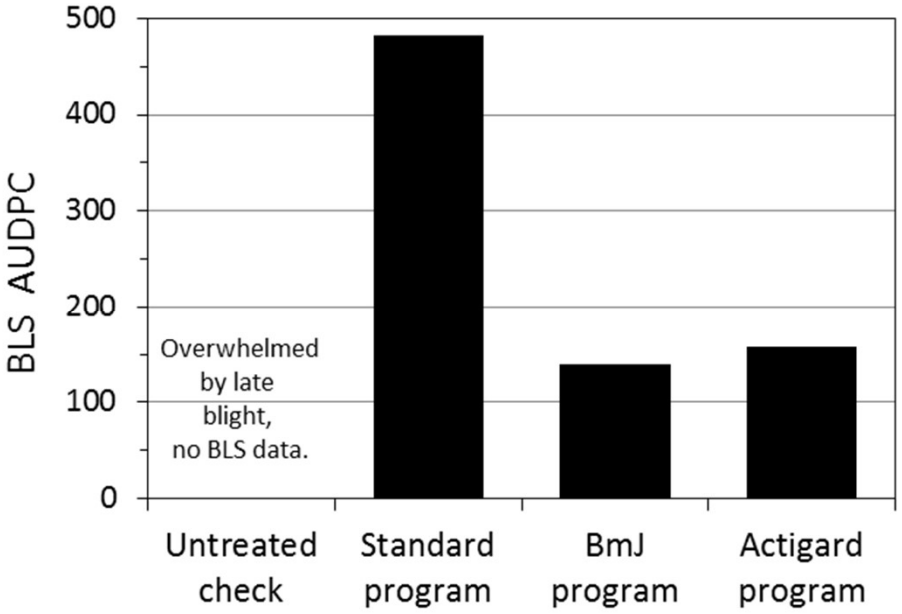

Grower standard

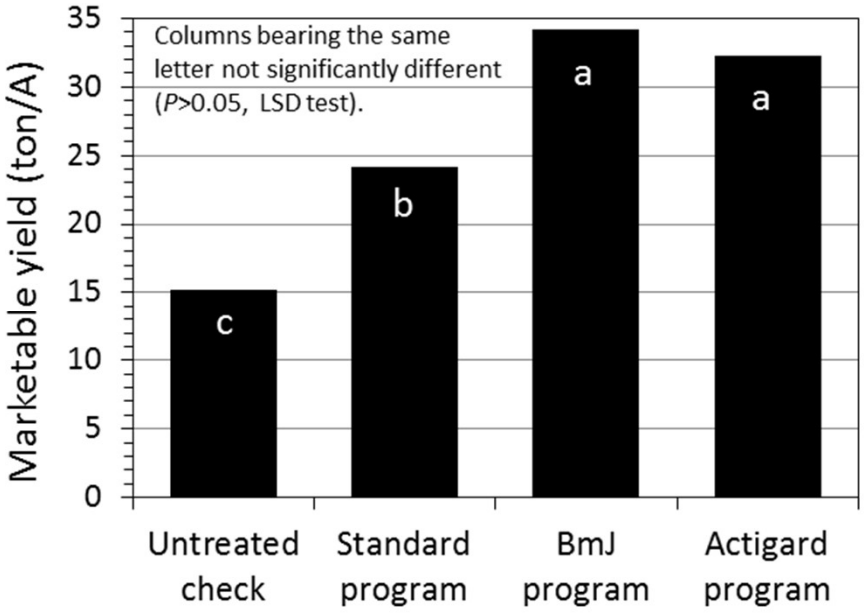

LifeGard program


Actigard program

Applied at 10-75 GPA, dependent on plant size, CER-2012-034

# Bacterial leaf spot in tomato



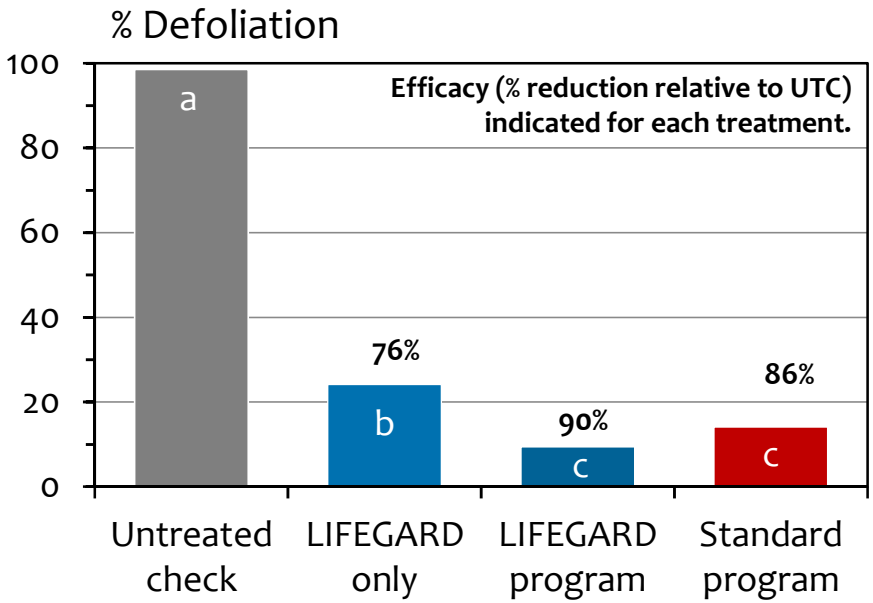

Application rates:

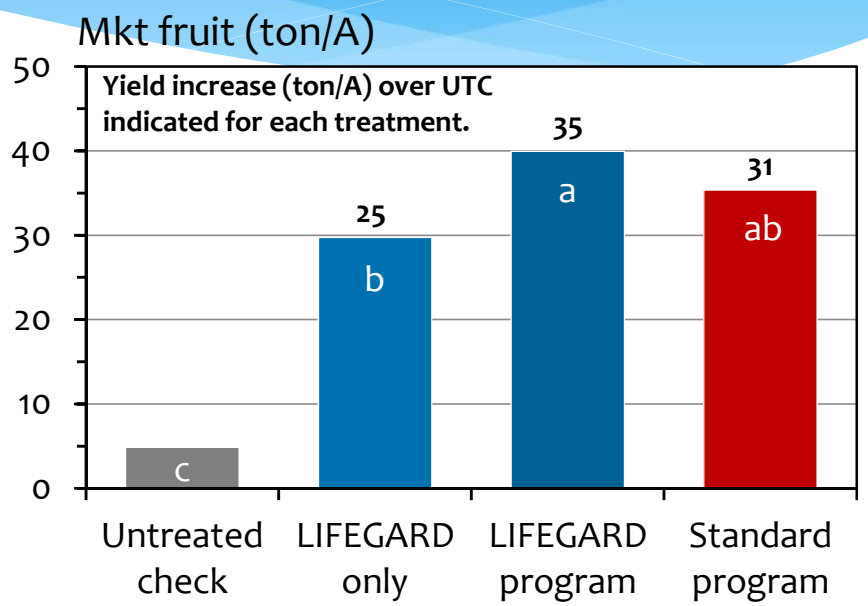
BmJ = LifeGard WG: 4.5 oz/100 gal ($8\times10^6$ cfu/ml)
Kocide® 3000 ($Cu(OH)_2$, Kocide L.L.C.): 1.75 lb/Ac
Manzate® DF (Zn/Mn/EBDC, UPI): 1.5 lb/Ac
Bravo Weather Stik® (chlorothalonil, Syngenta): 1.5 pt/Ac
Endura® (boscxalid, BASF): 3.5 oz/Ac
Ranman® (cyazofamid, FMC Corp.): 2.75 oz/Ac
Actigard® (ASM, Syngenta): 0.5 oz/Ac

Applied at 10-75 GPA, dependent on plant size, LifeGard WG: 4.5 oz/100 gal. CER-2012-034

*K. Ivors, NC State University, Mills River, North Carolina*

# Tomato Early & Late Blight



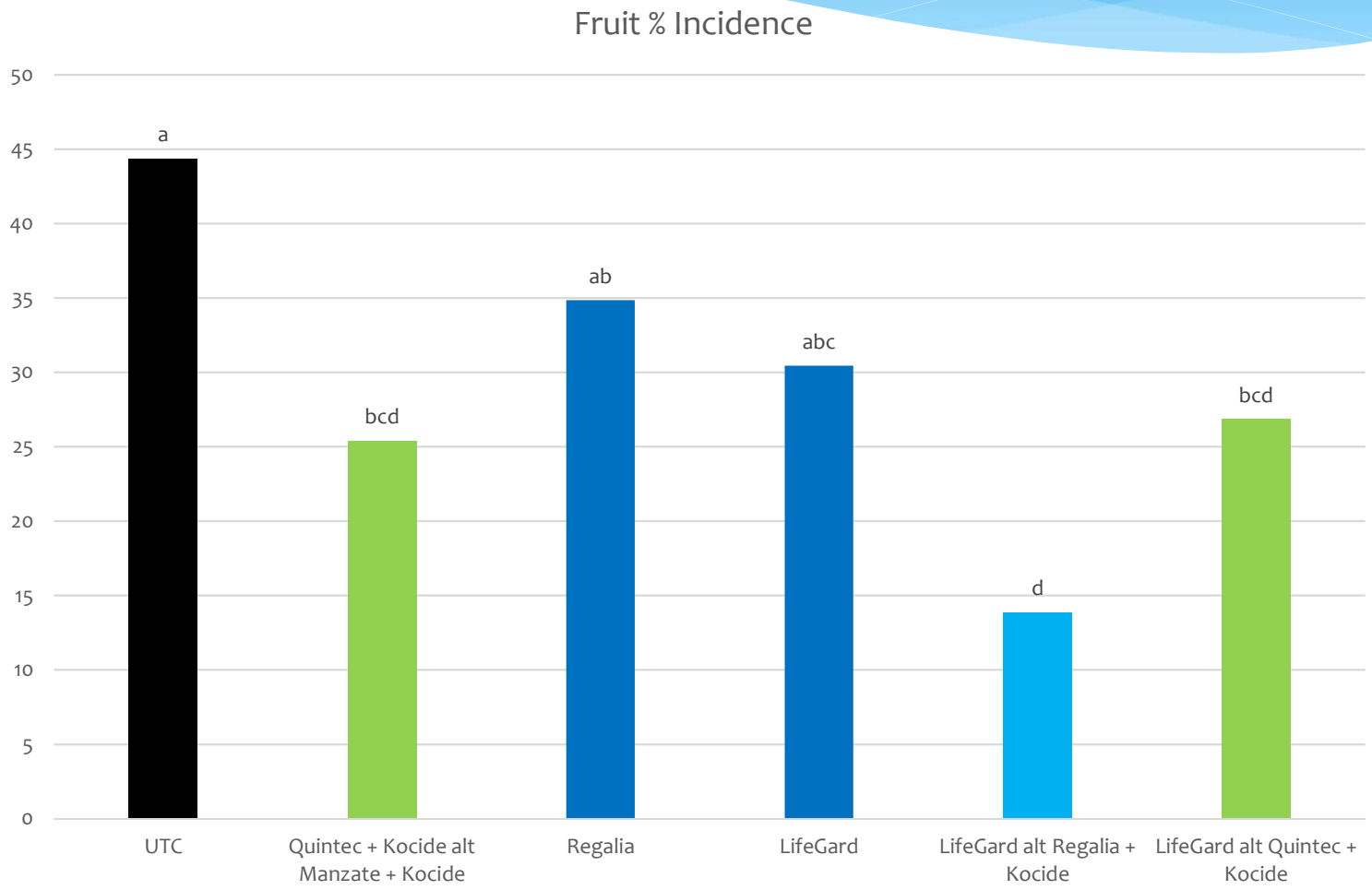

Untreated check

LIFEGARD

Standard program

*K. Ivors, NC State University, Mills River, North Carolina*

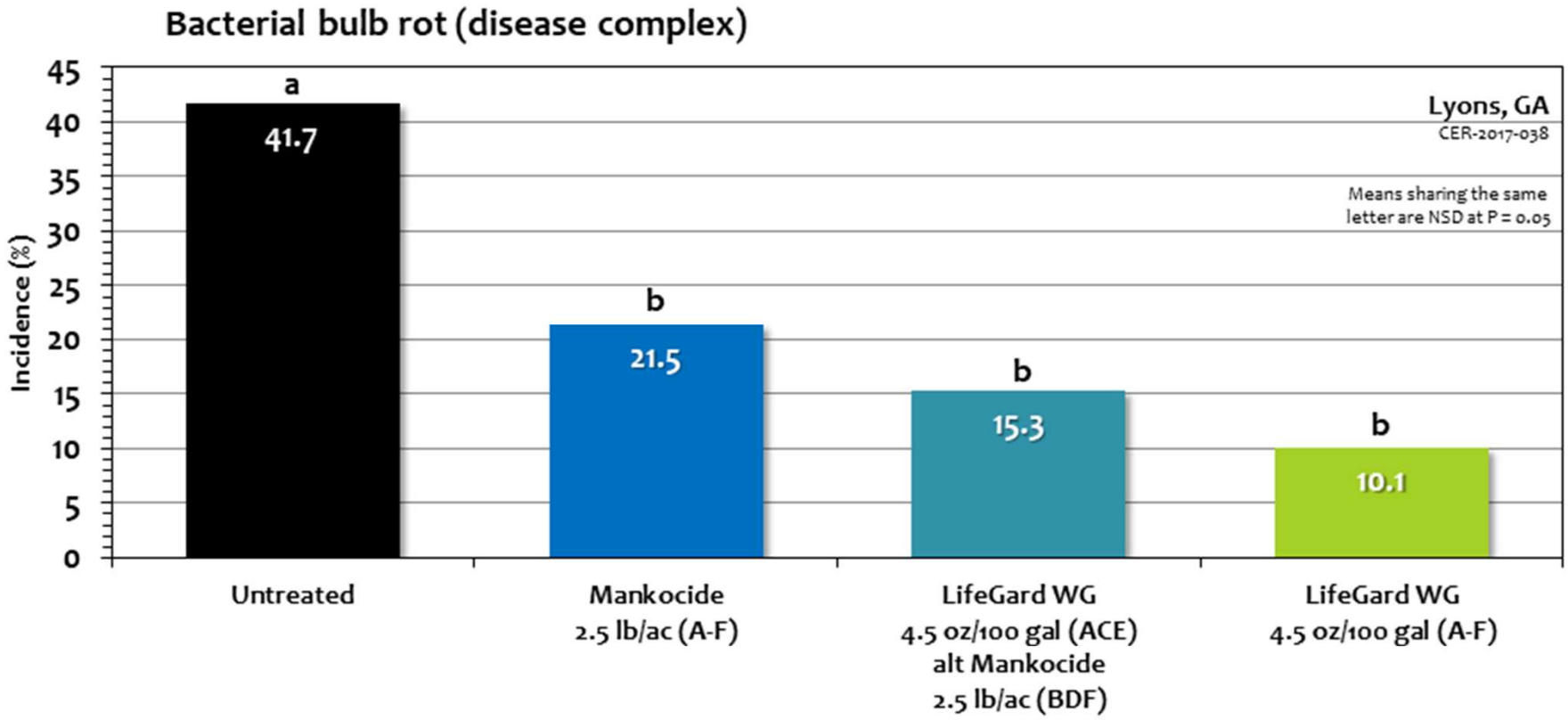
# Pumpkin Bacterial Spot




CER-2018-5976 – M. Babadoost U of Illinois, Champaign, IL
Pumpkin Var: Howden

# Onion

LifeGard™ WG
BIOLOGICAL PLANT ACTIVATOR




- Variety: Vidalia Cv. Alison
- Treatments: 6 apps; A = Feb 22nd , B = Feb 27th , C = Mar 7th , D = Mar 14th, E = Mar 24th, F = Mar 29th
- Apps made with three nozzle $CO_2$ backpack sprayer at 40 gal/A. Trial inoculated at 41 DAP.
- Trial was harvested and bulbs incubated for 7 days at ambient temps prior to disease rating.
- Cooperator: B. Dutta, Univ GA.

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# Remember

* If possible pick a cultivar or variety with some resistance
* Use in a program or in addition to a program containing other effective products
* Spray Plant Defense Activator BEFORE infection is suspected
* Allow 3-5 days  for product to fully induce the response
* Repeat on a regular basis (7-14 days) to maintain response

# Thank You

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