



THE OHIO STATE UNIVERSITY

COLLEGE OF FOOD, AGRICULTURAL,
AND ENVIRONMENTAL SCIENCES

Soilborne Diseases of Vine Crops and Their Management

Sally Miller

Department of Plant Pathology

Ohio Valley Giant Pumpkin Growers

Salem, OH

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When managing soilborne diseases, we want to

- Prevent existing pathogen populations from increasing
 - Keep disease pressure low
 - Use management practices that promote general plant and soil health
 - Use management practices that prevent pathogens from multiplying (such as using resistant varieties, rotation or fungicides)
- Reduce existing pathogen populations
 - Reduce disease pressure in soil
 - Involves some form of soil disinfestation



Keys to reducing soilborne diseases

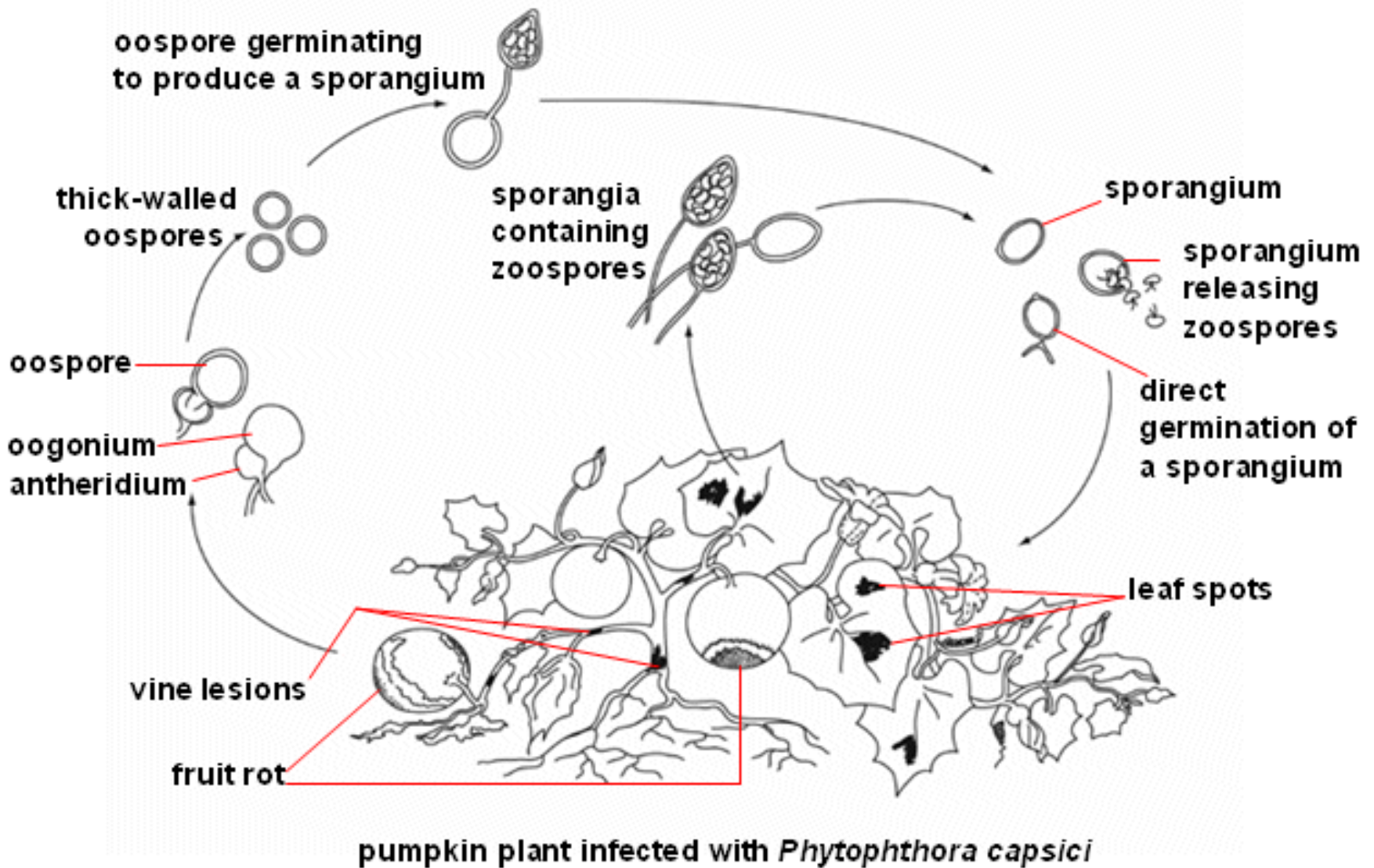
- Prevention
 - Use clean planting materials
 - Heat-treat seeds – for seedborne bacterial and fungal diseases
 - Clean transplants
 - When in doubt, throw it out!
- Sanitation
 - Remove plant materials
 - Rogue diseased plants
 - Clean equipment between areas
 - Sanitize walls, concrete floors between crops
- Rotate out of plant families (when possible)
- Grow resistant varieties
- Maintain proper fertility
- Reduce plant stress



Phytophthora Blight



- *Phytophthora capsici*
- Favored by warm, rainy conditions
- Most often observed in low spots or other areas with poor drainage
- Affects roots, stems, leaves and fruit
- Pathogen survives at least 5 years in soil





Management

- Rotate away from susceptible crops at least 3 years
- Choose appropriate site
 - Well-drained soil
 - Avoid low areas
 - Improve soil - increase organic matter content



- Use raised beds
 - High beds (≥ 9 in.); formed with a bed shaper
 - No depressions on top
 - Beds graded on ends for drainage
- Fill in trenches/depressions around base of transplants with soil



- Provide for drainage at the ends of the field
- Scout for and remove crown rot-diseased plants, and plants 5 ft into healthy area
- Apply fungicides



Phytophthora Blight Management - Fungicides

- Tested combinations of fungicides against Phytophthora blight (2nd year)
 - Drench + foliar vs. foliar alone
 - Effect of adding Kocide 3000 to each foliar application
- Conducted in field with natural infestation of Phytophthora, but also inoculated plants
 - Exposed test plots to one infected zucchini fruit
 - Disease incidence lower than in 2016
- Funded by OVSFRDP



Acorn squash 'Autumn Delight'



Treatment (Orondis Gold drench at transplant fb foliar fungicides)

Orondis Gold 200 4 fl oz/A (drench) fb

Ranman 400SC 2.75 fl oz/A + Activator 90SL 0.25% v/v (1,3,5)

alt **Presidio** 4SC 4 fl oz/A (2,4,6)

Orondis Gold 200 14 fl oz/A (drench)

Ranman 400SC 2.75 fl oz/A + Activator 90SL 0.25% v/v (1,3,5)

alt **Zampro** 14 fl oz/A + Activator 90SL 0.25% v/v (2,4,6)

Orondis Gold 200 14 fl oz/A (drench)

Presidio 4SC 4 fl oz/A (1,3,5)

alt **Zampro** 14 fl oz/A + Activator 90SL 0.25% v/v (2,4,6)

Orondis Gold 200 14 fl oz/A (drench)

Revus 2.09SC 8 fl oz/A + **Kocide 3000** 46.1DF 1 lb/A + Activator 90SL 0.25% v/v (1,3,5)

alt **Presidio** 4SC 4 fl oz/A (2,4,6)

Orondis Gold 200 14 fl oz/A (drench)

Revus 2.09SC 8 fl oz/A + **Kocide 3000** 46.1DF 1 lb/A + Activator 90SL 0.25% v/v (1,3,5)

alt **Tanos** 50 DF 10 oz/A + **Kocide 3000** 46.1DF 1 lb/A + Activator 90SL 0.25% v/v (2,4,6)

Orondis Gold 200 14 fl oz/A (drench)

Revus 2.09SC 8 fl oz/A + **Kocide 3000** 46.1DF 1 lb/A + Activator 90SL 0.25% v/v (1,3,5)

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alt **Presidio** 4SC 4 fl oz/A + **Kocide 3000** 46.1DF 1 lb/A (2,4,6)

Non-treated control



Treatment (Foliar fungicides only)

Orondis Ultra 8 fl oz/A (1,4)

alt **Ranman** 400SC 2.75 fl oz/A + Activator 90SL 0.25% v/v (2,3,5,6)

Orondis Ultra 8 fl oz/A + **Kocide** 3000 46.1DF 1 lb/A (1,4)

alt **Ranman** 400SC 2.75 fl oz/A + **Kocide** 3000 46.1DF 1 lb/A
+ Activator 90SL 0.25% v/v (2,3,5,6)

Orondis Ultra 8 fl oz/A (1,4)

alt **Presidio** 4SC 4 fl oz/A (2,3,5,6)

Orondis Ultra 8 fl oz/A + **Kocide** 3000 46.1DF 1 lb/A (1,4)

alt **Presidio** 4SC 4 fl oz/A + **Kocide** 3000 46.1DF 1 lb/A (2,3,5,6)

Orondis Ultra 8 fl oz/A (1,4)

alt **Tanos** 50DF 10 oz/A + **Kocide** 3000 46.1DF 1 lb/A + Activator 90SL 0.25% v/v (2,3,5)

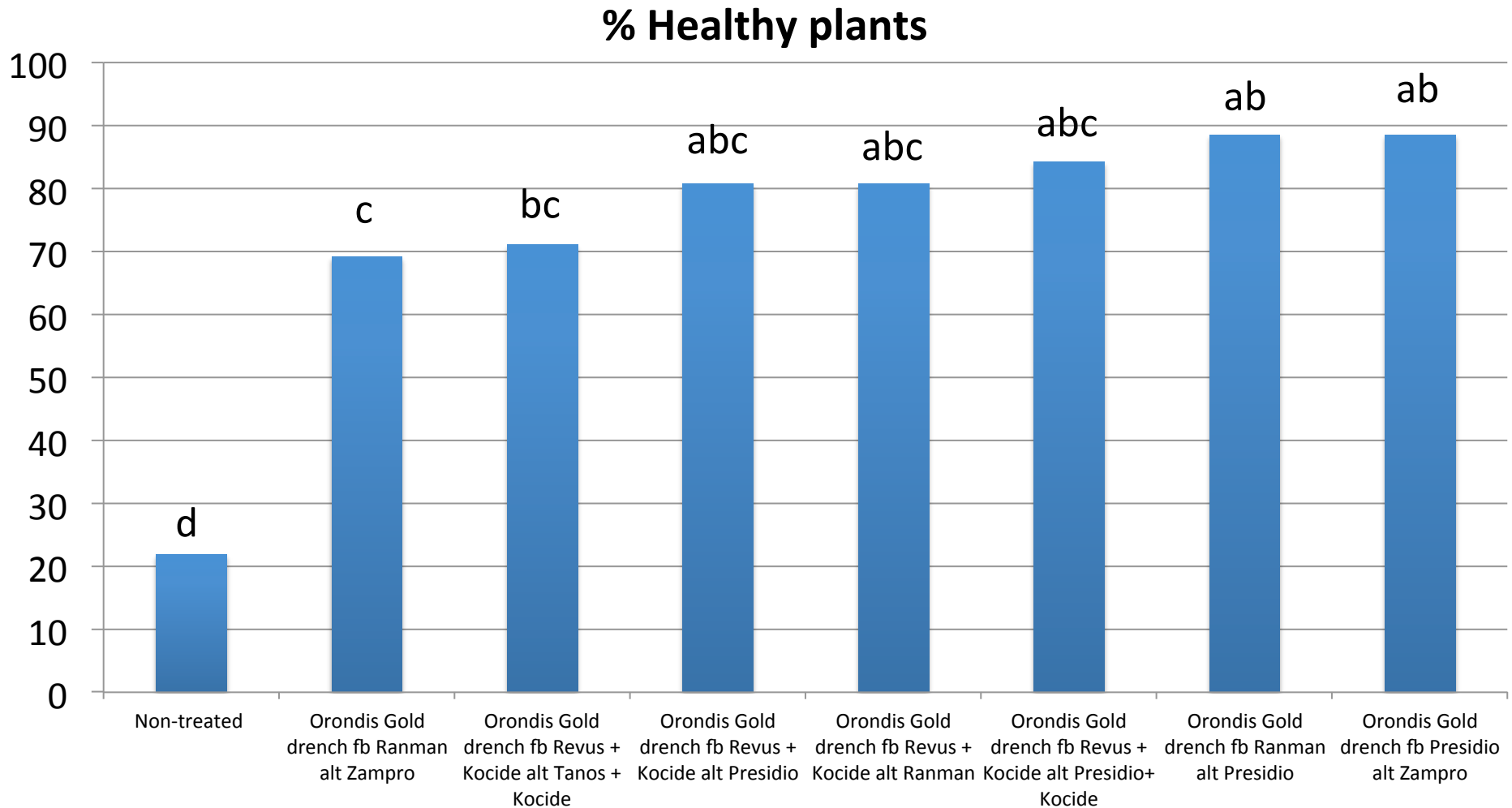
Orondis Ultra 8 fl oz/A + **Kocide** 3000 1 lb/A (1,4)

alt **Tanos** 50DF 10 oz/A + **Kocide** 3000 1 lb/A + Activator 90SL 0.25% v/v (2,3,5)

Non-treated control

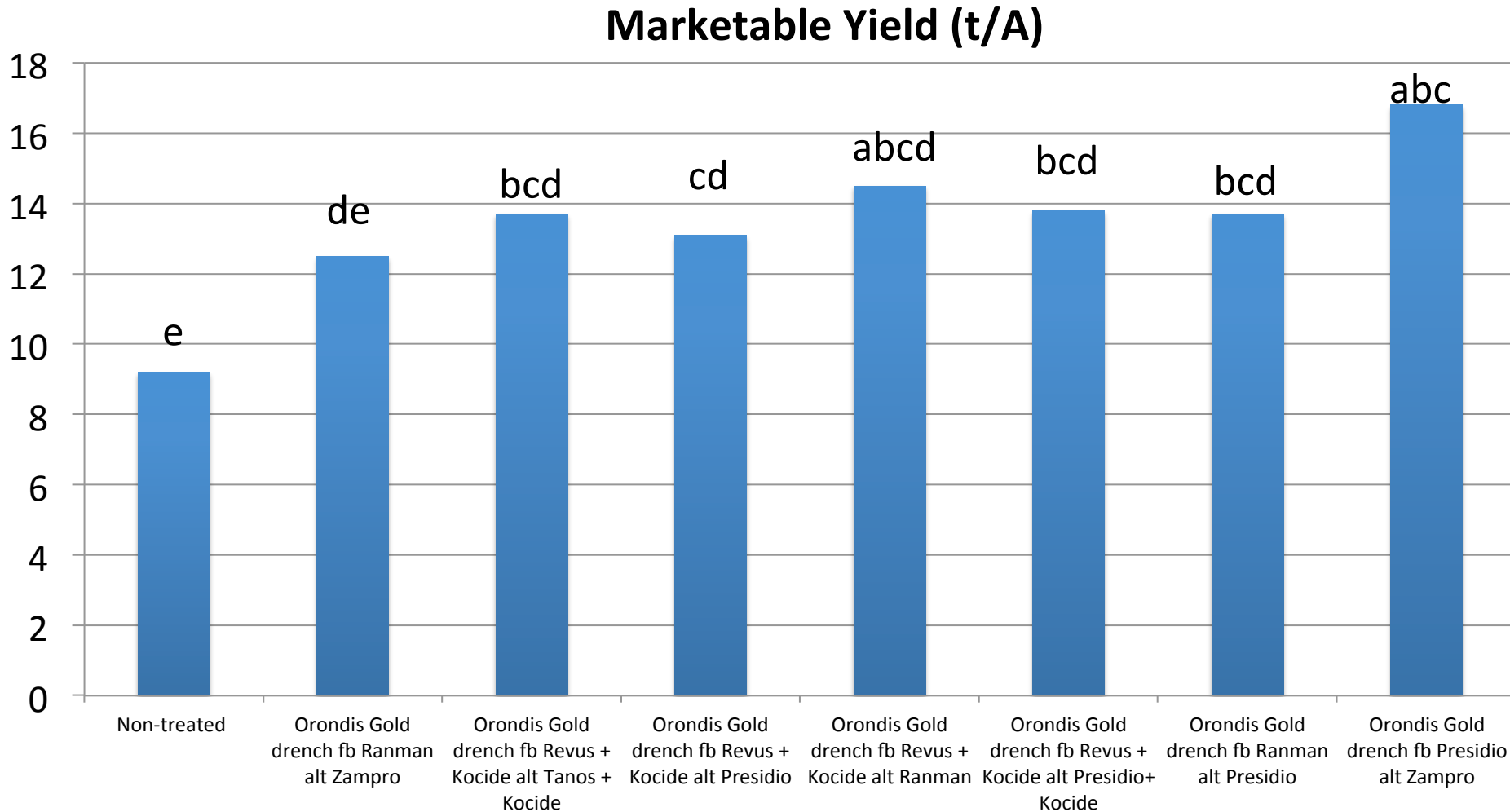


Orondis Gold Drench at Transplanting fb Foliar Fungicides





Orondis Gold Drench at Transplanting fb Foliar Fungicides





Orondis Gold drench fb Presidio alt Zampro foliar

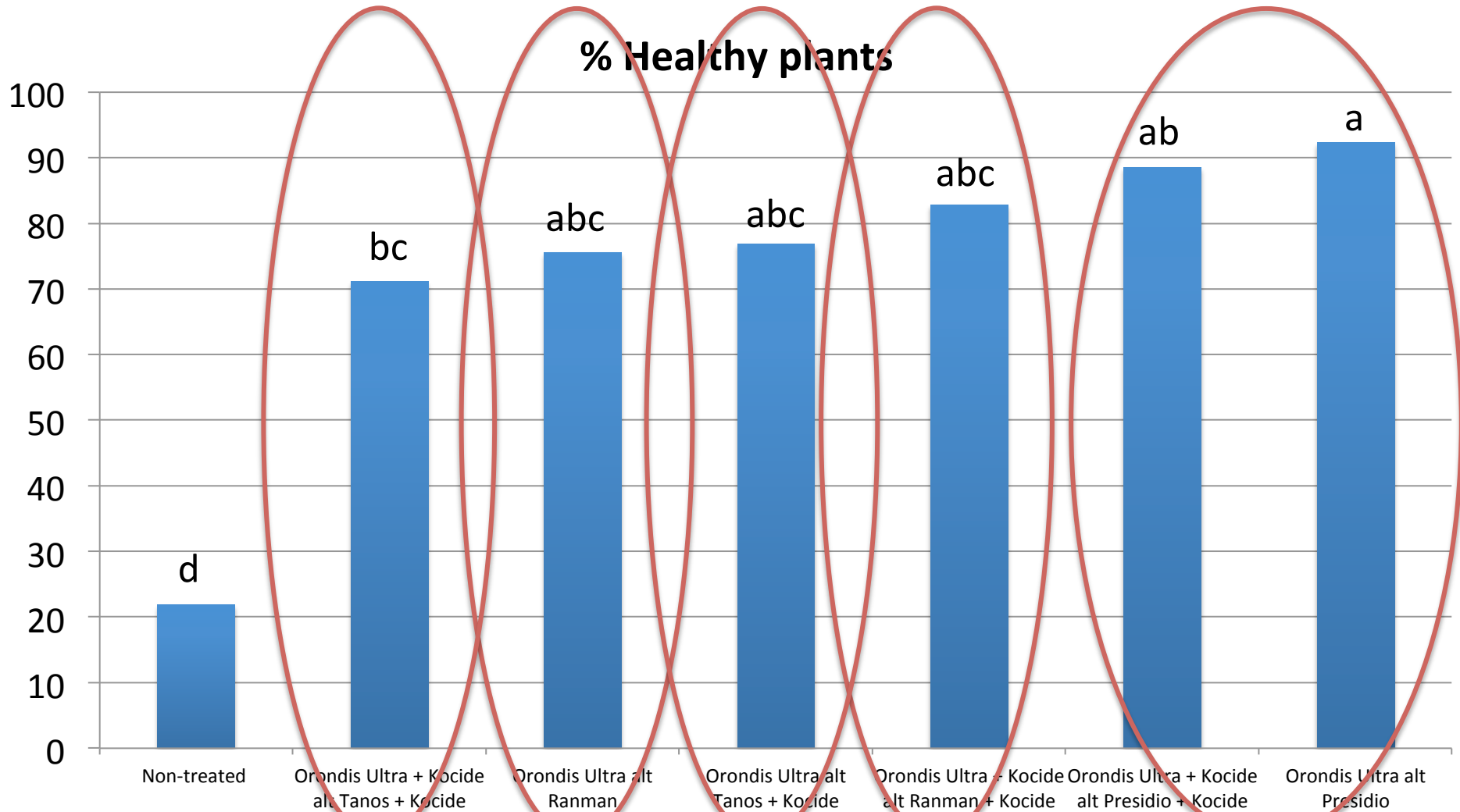


Non-treated control





Foliar Fungicides Only





Orondis Ultra alt Presidio foliar



Non-treated control





- For second year, no apparent advantage to Orondis Gold application as a drench at transplanting vs. Orondis Ultra foliar
 - Phytophthora blight usually first observed in July; squash planted May 31, exposed to inoculum July 18 – likely very low residual fungicide by mid-July
- All treatments suppressed Phytophthora blight
- No apparent advantage to adding Kocide 3000 to the foliar fungicides
- Orondis is not effective against Pythium species



- Vines and fruit very susceptible
- Apply effective foliar fungicides prior to symptoms
 - Orondis Ultra (0 days PHI)
 - Orondis Opti (0)
 - Presidio (2)
 - Ranman (0)
 - Zampro (1)



Symptoms usually start appearing in mid-July



Biological Disease Prevention and Rescue

- “Purposeful utilization of introduced or resident living organisms, other than disease resistant host plants, to suppress the activities and populations of one or more plant pathogens” Pal and McSpadden Gardener, Plant Health Instructor 2006
 - Microbial inoculants and/or their metabolites to suppress a given pathogen or class of pathogens – specific suppression
 - Managing soils to promote the combined activities of native soil- and plant-associated microorganisms that contribute to general suppression



Common Fungal Biopesticides

Product	Registrant	Target	Active Ingredient
SoilGard	Certis	<i>Pythium, Rhizoctonia, Fusarium</i>	<i>Gliocladium virens</i> GL-21
Actinovate	Novozymes	Soilborne pathogens, <i>Botrytis</i> , PM	<i>Streptomyces lydicus</i> WYEC 108
Mycostop	Agbio, Inc.	<i>Fusarium, Phytophthora, Pythium, Alternaria</i>	<i>Streptomyces griseoviridis</i> K61
Prestop	Agbio, Inc.	Broad claims – fungal pathogens	<i>Gliocladium catenulatum</i> J1446
Rootshield Home & Garden; Rootshield WP	Bioworks	<i>Pythium, Phytophthora, Rhizoctonia, Fusarium</i>	<i>Trichoderma harzianum</i> KRL-AG2
Rootshield PLUS WP	Bioworks	<i>Pythium, Phytophthora, Rhizoctonia, Fusarium</i>	<i>T. harzianum</i> KRL-AG2/ <i>T. virens</i> G-41



Bacillus Biopesticides - Crops

Product (formulation type)*	Registrant	Target	Crops	Active Ingredient
Double Nickel WG	Certis	Fungal and Bacterial diseases	Many crops	<i>Bacillus amyloliquefaciens</i> strain D 747
Lifeguard WG	Certis	Fungal and bacterial diseases	Many crops	<i>Bacillus mycoides</i> isolate J
Prevont (SC)	Seipasa	Fungal diseases	Many crops	<i>Bacillus subtilis</i> strain IAB/BS03
Serifel (SC)	BASF	Fungal and Bacterial diseases	Many crops	<i>Bacillus subtilis</i> , strain MBI 600
Serenade ASO (SC)	Bayer	Fungal and Bacterial diseases	Many crops	<i>Bacillus subtilis</i> , strain QST 713
Serenade Opti (WP)	Bayer	Fungal and Bacterial diseases	Many crops	<i>Bacillus subtilis</i> , strain QST 713
Taegro (SC)	Novozymes	Fungal and Bacterial diseases	Many crops	<i>Bacillus subtilis</i> var. <i>amyloliquefaciens</i> strain FZB24



Common Biorationals/Sanitizers

Product	Registrant	Target	Active Ingredient
Regalia	Marrone Bio	Broad claims	Giant knotweed extract
Trilogy	Certis	Powdery mildew	Neem oil
Fungastop	Soil Technologies	<i>Pythium, Rhizoctonia, Fusarium</i>	Citric acid/mint oil
Proud 3	Huma Grow	<i>Pythium, Phytophthora, clubroot, Sclerotium, nematodes</i>	Thyme oil
Sporatec	Brandt Consolidated	Anthraco-nose, powdery mildew, downy mildew, Botrytis, leaf spots, bacterial s	Rosemary, thyme, clove oils
Kaligreen	Otsuka Chem	Powdery mildew	Potassium bicarbonate
Milstop	Bioworks	Powdery mildew	Potassium bicarbonate
Oxidate	Biosafe Systems	<i>Pythium, Rhizoctonia, Fusarium</i>	Hydrogen dioxide



Specific Suppression of Damping-Off

- Pre-emergence
 - Reduced germination
- Post-emergence
 - Seedling death or injury
- Often associated with excessive moisture, suboptimal temps

- *Pythium* spp.
- *Rhizoctonia solani*
- *Fusarium* spp.



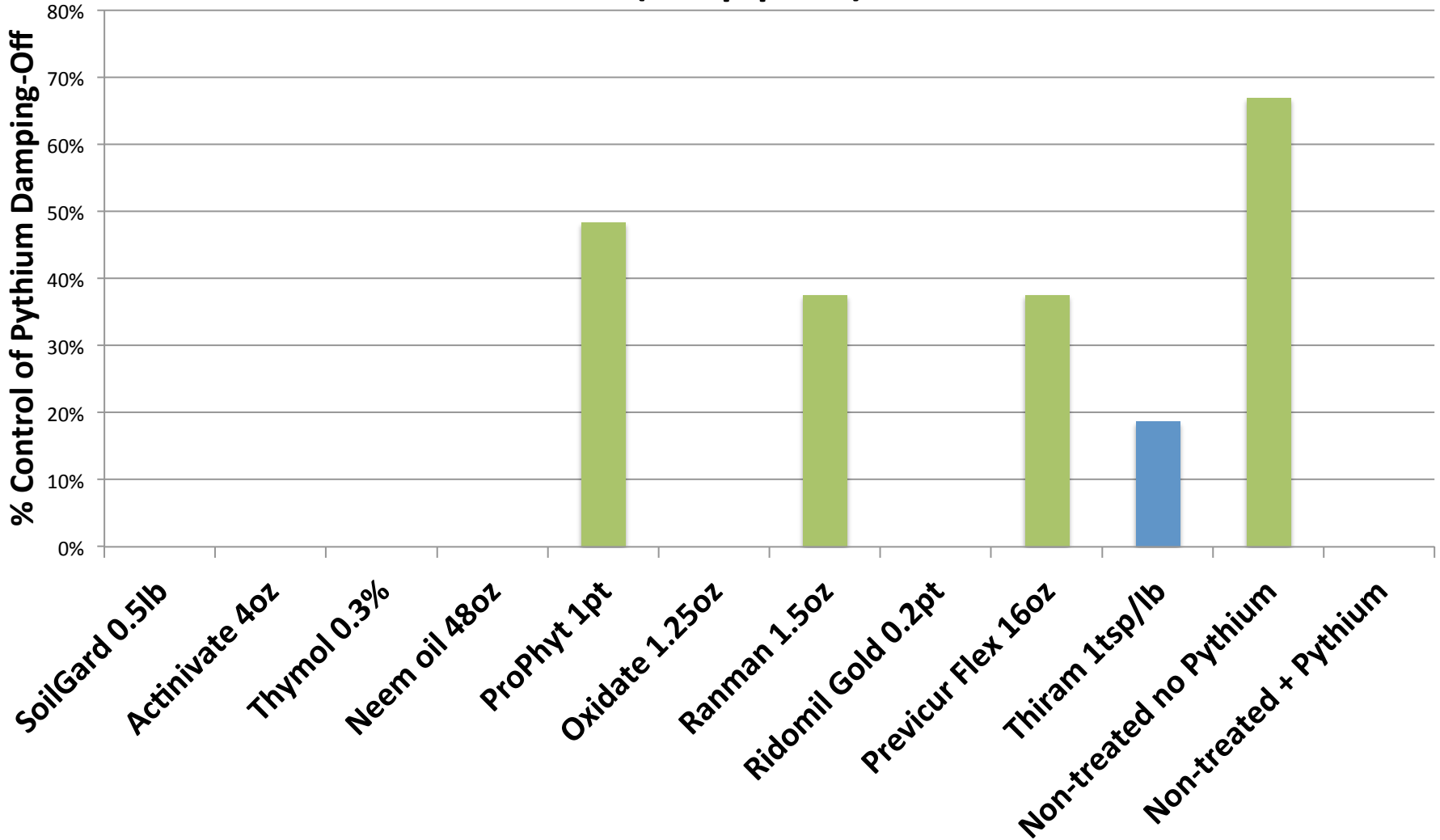


Biorational Products to Prevent Pythium Damping-Off

Product	Type	Active Ingredient
SoilGard	Biological	<i>Trichoderma virens</i>
Actinovate	Biological	<i>Streptomyces lydicus</i> WYEC 108
Thymol	Botanical	Thyme extract
Neem oil	Botanical	Neem extract
ProPhyt	Chemical/ISR	Potassium phosphite
Oxidate	Chemical	Hydrogen dioxide
Ranman	Fungicide	Cyazofamid
Ridomil Gold	Fungicide	Mefanoxam
Previcur Flex	Fungicide	Propamocarb hydrochloride
Thiram	Fungicide	Thiram

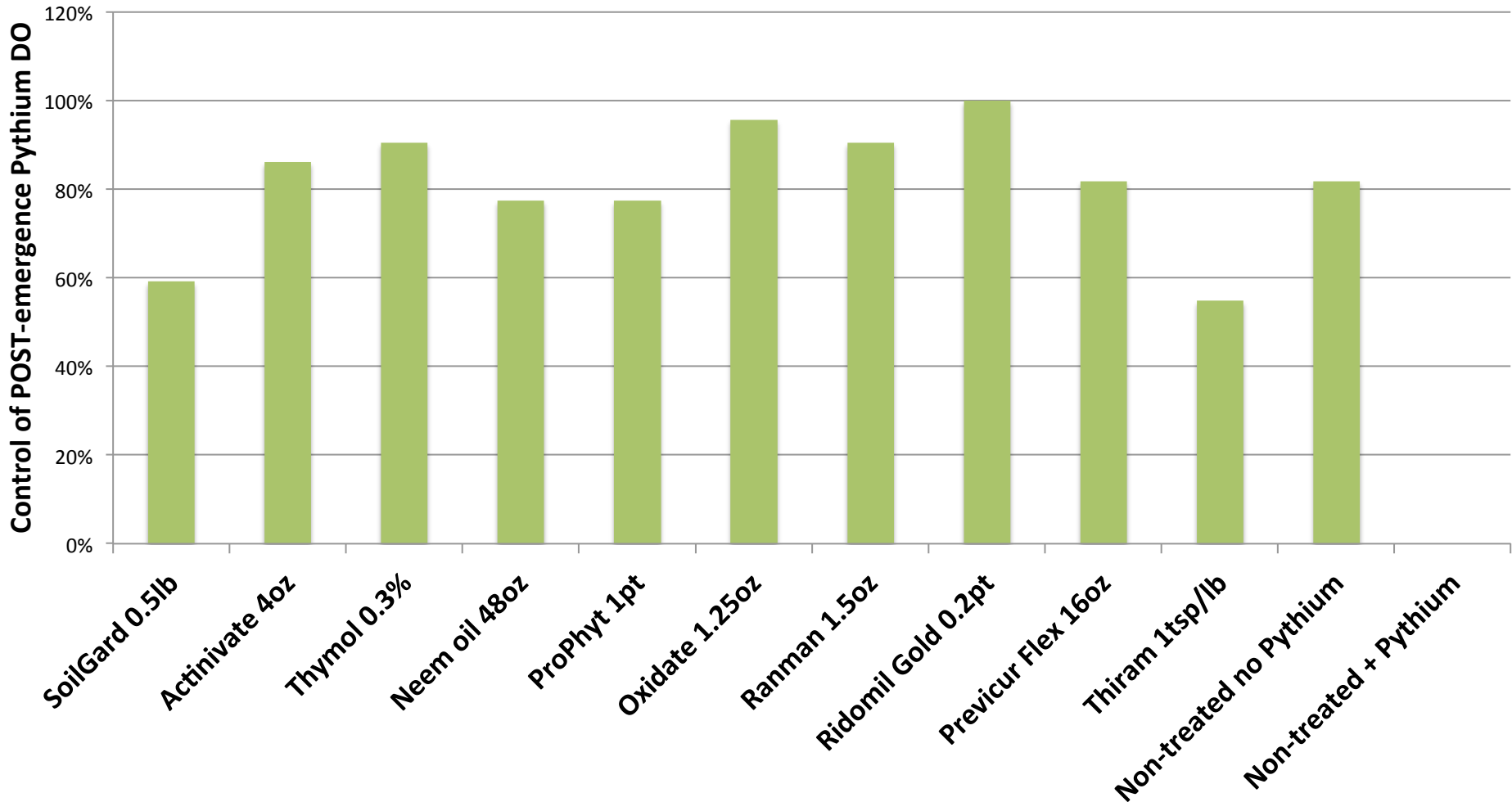


Biocontrol of Pythium PRE-emergence Damping-Off (Pepper)





Biocontrol of Pythium POST-emergence Damping-Off (Pepper)



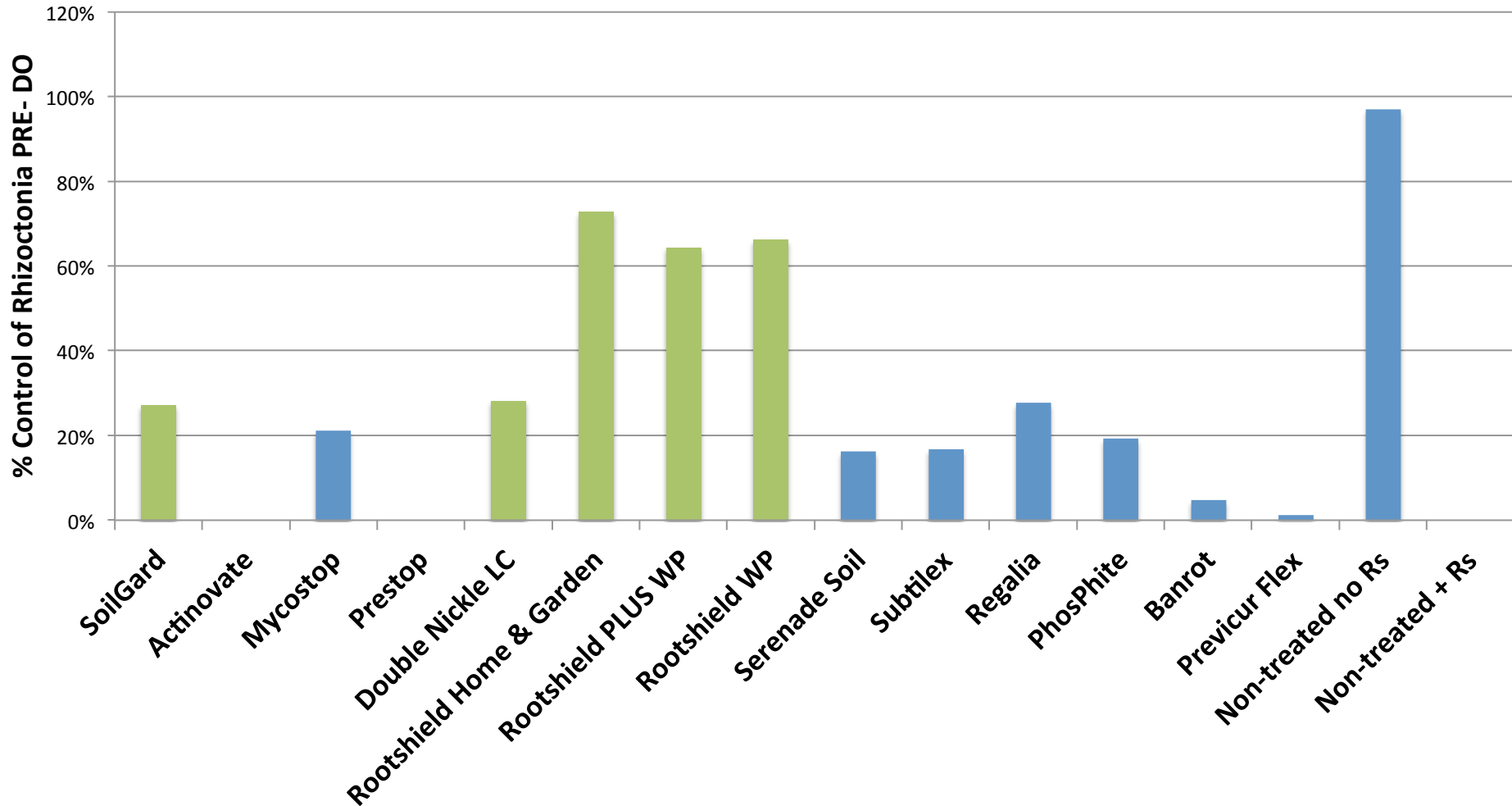


Biorational Products: Rhizoctonia Damping-Off

Product	Type	Active Ingredient
SoilGard	Biological	<i>Gliocladium virens</i> GL-21
Actinovate	Biological	<i>Streptomyces lydicus</i> WYEC 108
Mycostop	Biological	<i>Streptomyces griseoviridis</i> K61
Prestop	Biological	<i>Gliocladium catenulatum</i> J1446
Double Nickle LC	Biological	<i>Bacillus amyloliquefaciens</i> D747
Rootshield Home & Garden	Biological	<i>Trichoderma harzianum</i> KRL-AG2
Rootshield PLUS WP	Biological	<i>T. harzianum</i> KRL-AG2/ <i>T. virens</i> G-41
Rootshield WP	Biological	<i>Trichoderma harzianum</i> KRL-AG2
Serenade Soil	Biological	<i>Bacillus subtilis</i> QST713
Subtilex	Biological	<i>Bacillus subtilis</i> MBI600
Regalia	Botanical	Giant knotweed extract
PhosPhite	Chemical/ISR	Phosphoric Acid (28%)/sol. potash (26%)
Banrot	Fungicide	Etridiazole (15%)/thiophanate-methyl (25%)
Previcur Flex	Fungicide	Propamocarb hydrochloride



Biocontrol of Rhizoctonia PRE-emergence Damping-Off (Pepper)





General Suppression Approaches

- Manipulate (soil) environment to
 - Optimize plant nutrition
 - Build/introduce beneficial microbial communities
 - Increase competition against pathogens
- Provide exogenous food supplies
 - Green manure
 - Composted animal manure

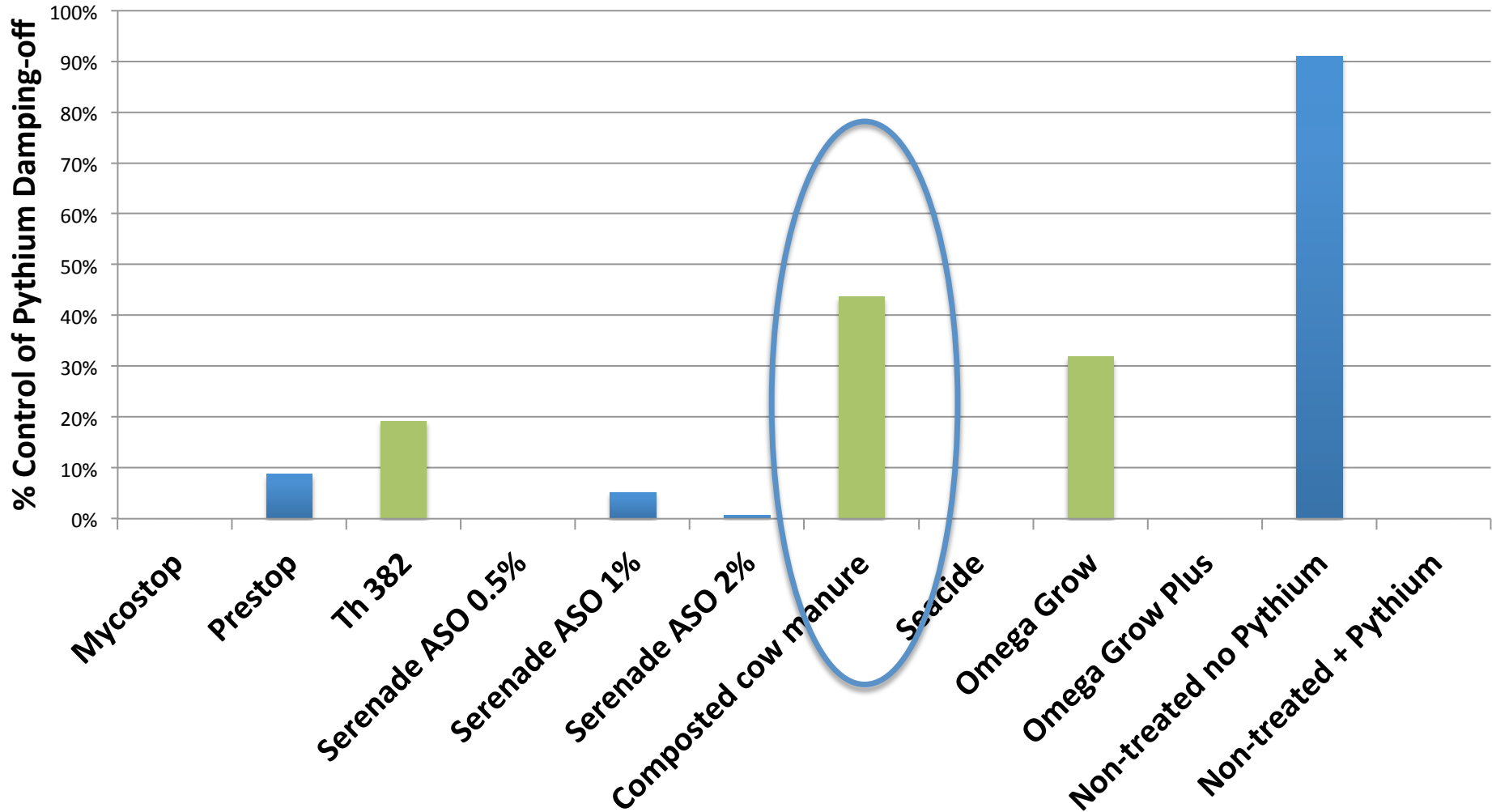


Biorational Products and Amendments

Product	Type	Active Ingredient
Mycostop	Biological	<i>Streptomyces griseoviridis</i> K61
Prestop	Biological	<i>Gliocladium catenulatum</i> J1446
Th 382	Biological	<i>Trichoderma hamatum</i> 382
Serenade ASO 0.5%	Biological	Bacillus subtilus QST713
Serenade ASO 1%	Biological	Bacillus subtilus QST713
Serenade ASO 2%	Biological	Bacillus subtilus QST713
Composted cow manure	Animal-based	Compost
Seacide	Animal-based	Fish emulsion
Omega Grow	Animal-based	Fish emulsion
Omega Grow Plus	Animal-based	Fish emulsion

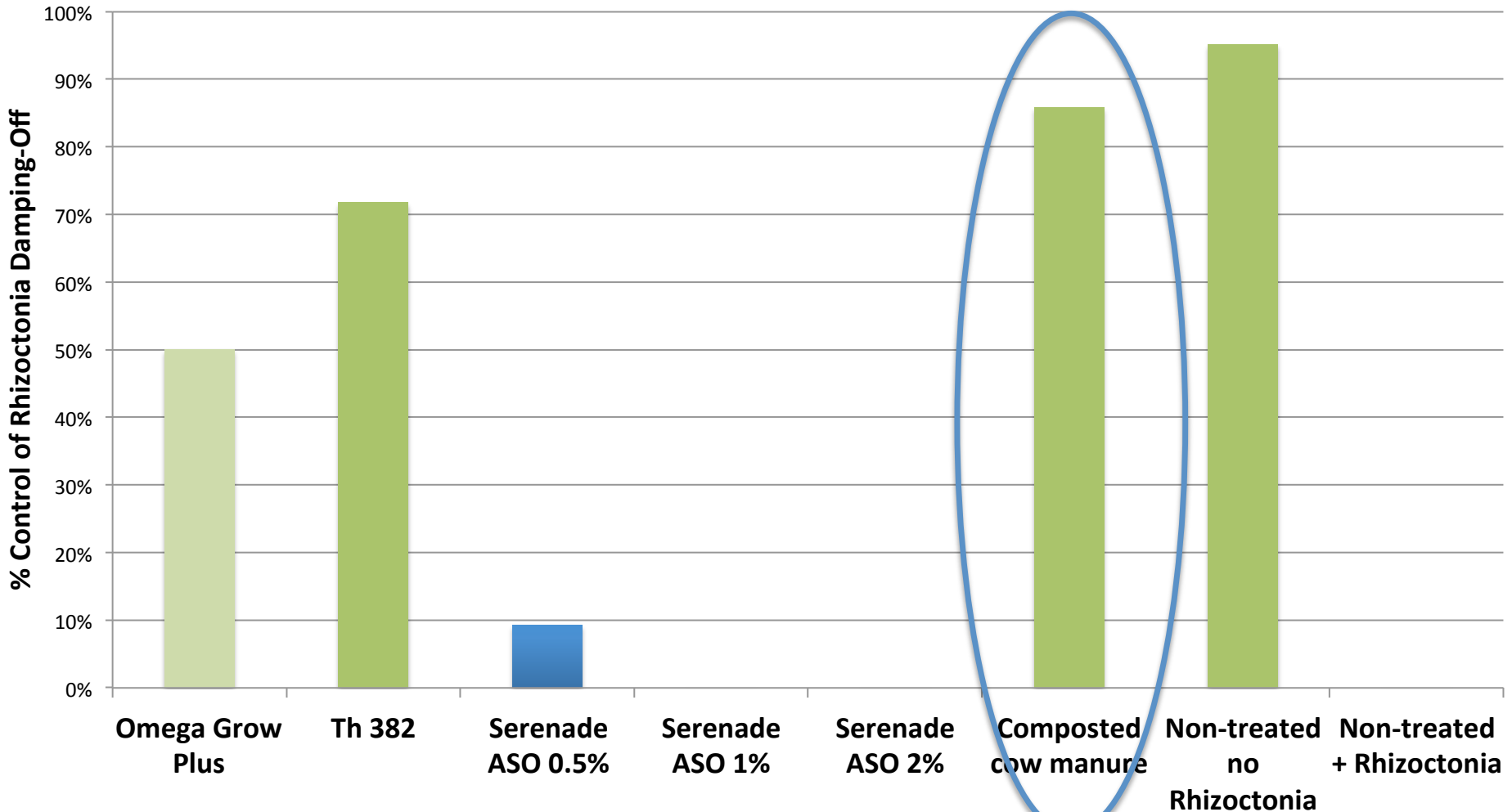


Suppression of Pythium Damping-Off





Suppression of Rhizoctonia Damping-Off





New Approach for Soilborne Disease Management

- Anaerobic soil disinfestation (ASD)
 - Microbial soil rehabilitation
 - Reduce soil populations of pathogens, pests and weeds
 - Still being optimized
 - Open field and protected culture



Anaerobic Soil Disinfestation (ASD)

- Biological soil disinfestation, reductive soil disinfestation, biosolarization
- Add carbon source, irrigate, and tarp
- Effective in a wide variety of cropping systems
 - Open field, raised beds, protected culture
 - Vegetables, fruits, nuts, trees, flowers
- Effective against a wide variety of pathogens



Pathogens Controlled by ASD

Fungi	Oomycetes	Bacteria	Nematodes
<i>Verticillium dahliae</i>	<i>Phytophthora</i> spp.	<i>Ralstonia solanacearum</i>	<i>Meloidogyne</i> spp.
<i>Fusarium</i> spp.	<i>Pythium</i> spp.	<i>Agrobacterium tumefaciens</i>	<i>Globodera pallida</i>
<i>Rhizoctonia solani</i>			<i>Pratylenchus penetrans</i>
<i>Sclerotium rolfsii</i>			
<i>Pyrenochaeta lycopersici</i>			
<i>Sclerotinia</i> spp.			



ASD Carbon Sources



wiseGEEK

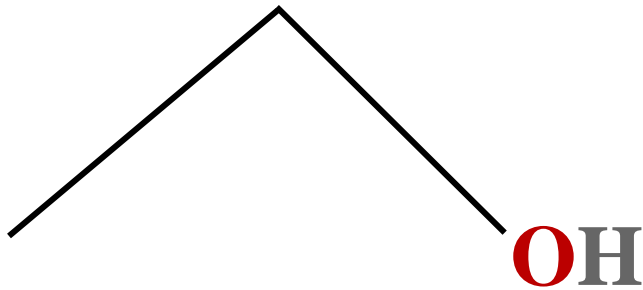
Wheat bran



Rice bran



Molasses



Ethanol



Cover crops and crop residues



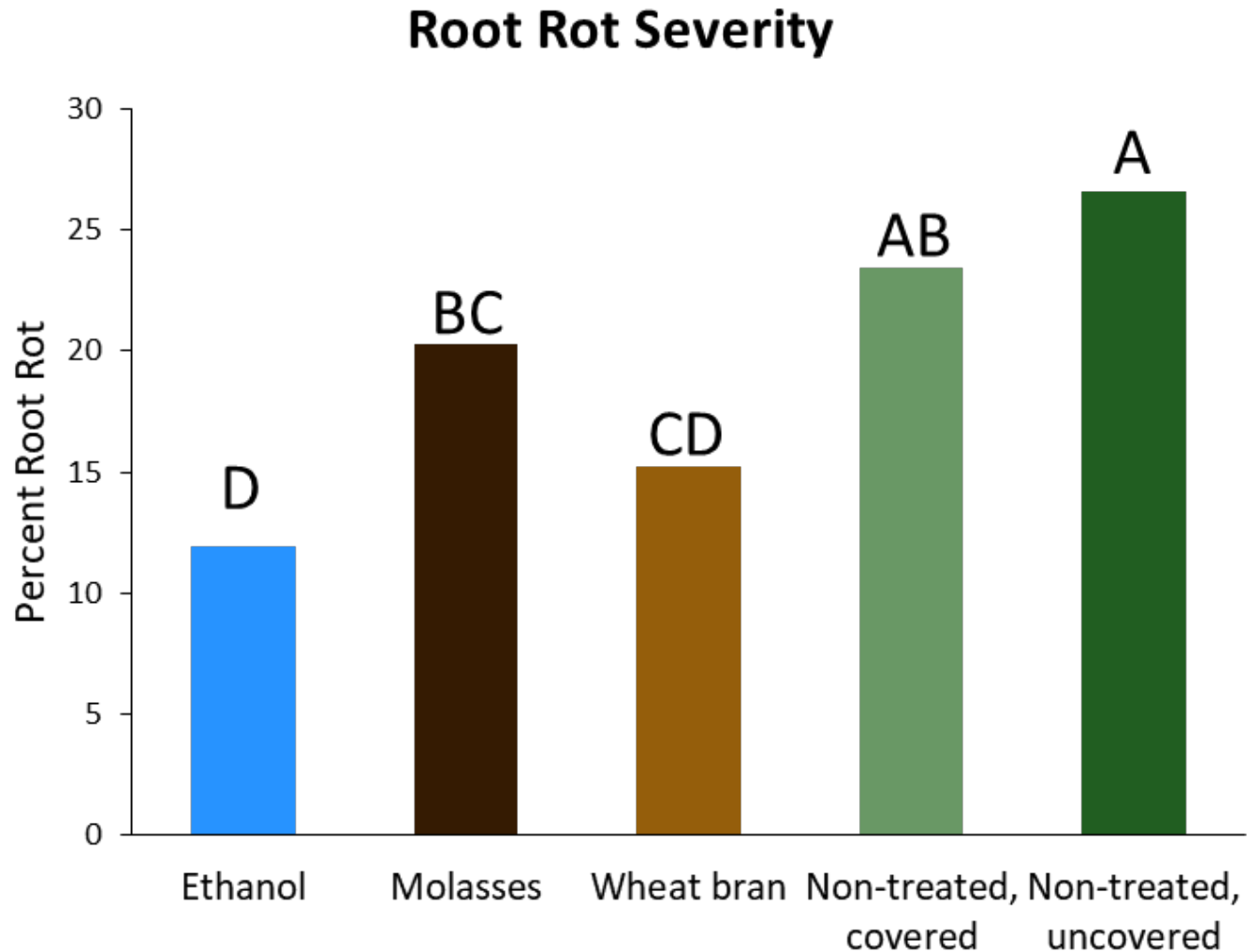
Application of ASD



Wheat bran
(9 tons/acre)

Untreated

Wheat bran
(9 tons/acre)
+ molasses
(4.5 tons/acre)





ASD kills nematodes

RKN following ASD



RKN with no treatment





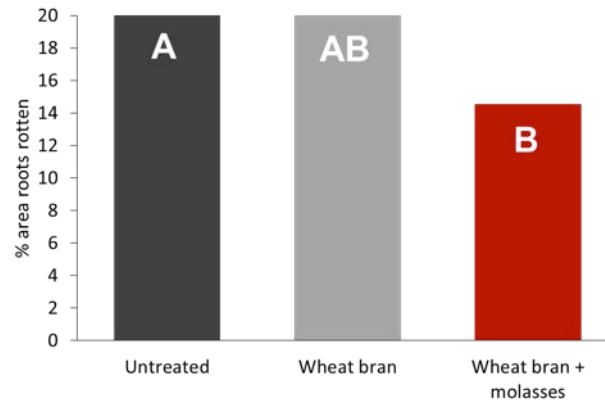
Effects on Plant Health

Aboveground Dry Biomass



p = 0.006

Root Rot Severity



p = 0.07

Nematode Damage



p = 0.001



Three Steps of ASD

1. Incorporate organic matter
2. Saturate the soil
3. Tarp with plastic





Choosing a Carbon Source

- Many options available
 - Wheat bran, rice bran, molasses, cover crops, ethanol
- Usually applied at a rate of 6-9 tons per acre
- Our best combination is wheat bran at 9 t/a and molasses at 4.5 t/a





Spreading the Wheat Bran

Small scale



Large scale





Incorporating the Wheat bran

Small scale



Large scale



Work to a depth of 6-8 inches



Adding Molasses

Small scale



Large scale



If spraying, nozzles often clog even if diluted



Soil needs to be saturated to the point where water just begins to pond and won't drain anymore
Supplemental water may be needed



Tarp with Plastic

Small scale



Large scale



Use a heavy plastic mulch and bury or cover edges of plastic to prevent air exchange

Soil temperature should be above 68° F for at least first week (warmer and longer is better)

Keep plastic on for 4-6 weeks (4 weeks is usually plenty!)



Planting Following an ASD Treatment

- Remove plastic or cut holes in plastic
- Allow soil to drain and breathe for about one week
- Check soil fertility
- Plant as usual
- Watch plants for signs of nutrient deficiencies
 - Especially nitrogen
- If disease levels are high, treatment may need to be applied for several years



ASD Costs

- Wheat bran, \$9-14 per 50 lb bag
 - Cost per 30' x 96' high tunnel: \$216-336
- Organic molasses, \$36 for 5 gallons (approximately 60 lbs)
 - Cost per 30' x 96' high tunnel: \$720
- Conventional feed-grade molasses, \$15 for 100 lbs
 - Cost per 30' x 96' high tunnel: \$179



- **We conduct farmer-focused research**
- Identifying the best carbon sources (NC-SARE)
 - Alternate carbon sources
 - Cover crops
 - Ag waste products
- Optimizing ASD for high tunnels (ODA and NC-SARE)
- ASD in different settings
 - Greenhouse
 - High tunnel
 - Open field
 - Muck soils
- ASD for management of multiple pests (OVSFRDP)
 - Soilborne disease complex in tomato
 - Root knot nematode in lettuce
 - Clubroot in mustard greens



Questions???

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