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Managing soilborne diseases: A case study using Fusarium wilt of watermelon.

New Technology for Commercial Crop Production (XI)
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Nicholas S. Dufault
Associate Professor
Dept. of Plant Pathology
University of Florida

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Dr. B. Sajeewa Amaradasa

Dr. Tatiana Sanchez

Kris Beckham

Preston Stern

Matthew Cullen

Melissa Irizarry

James Fulton

Zhuxuan Xu

NFREC Staff

PSREU Staff

Collaborators

Dr. Mathews Paret

Dr. Josh Freeman

Dr. Xin Zhao

National Watermelon Association

Plant Pathology UF/IFAS

USDA United States Department of Agriculture National Institute of Food and Agriculture

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Florida Watermelon Association

Georgia Watermelon Assoc.

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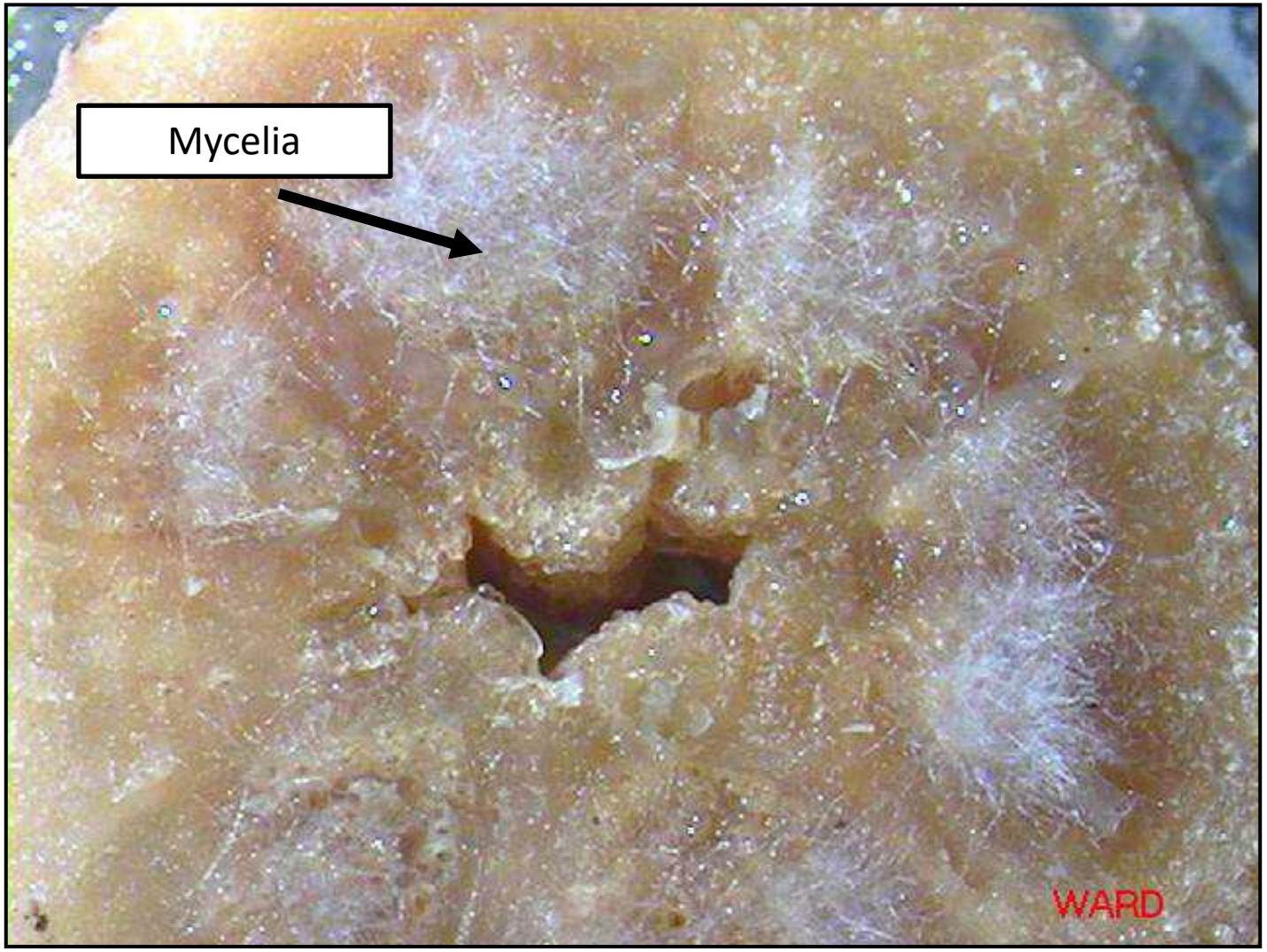
Improve your understanding of:

- Soilborne disease management techniques (they need to target plant roots & crown, & soil)
- Integrated approaches for managing soilborne diseases (efficacy improves with integration)
- Proper pathogen identification as it is critical for logical, efficient integrated disease management

2012 significant vine death present

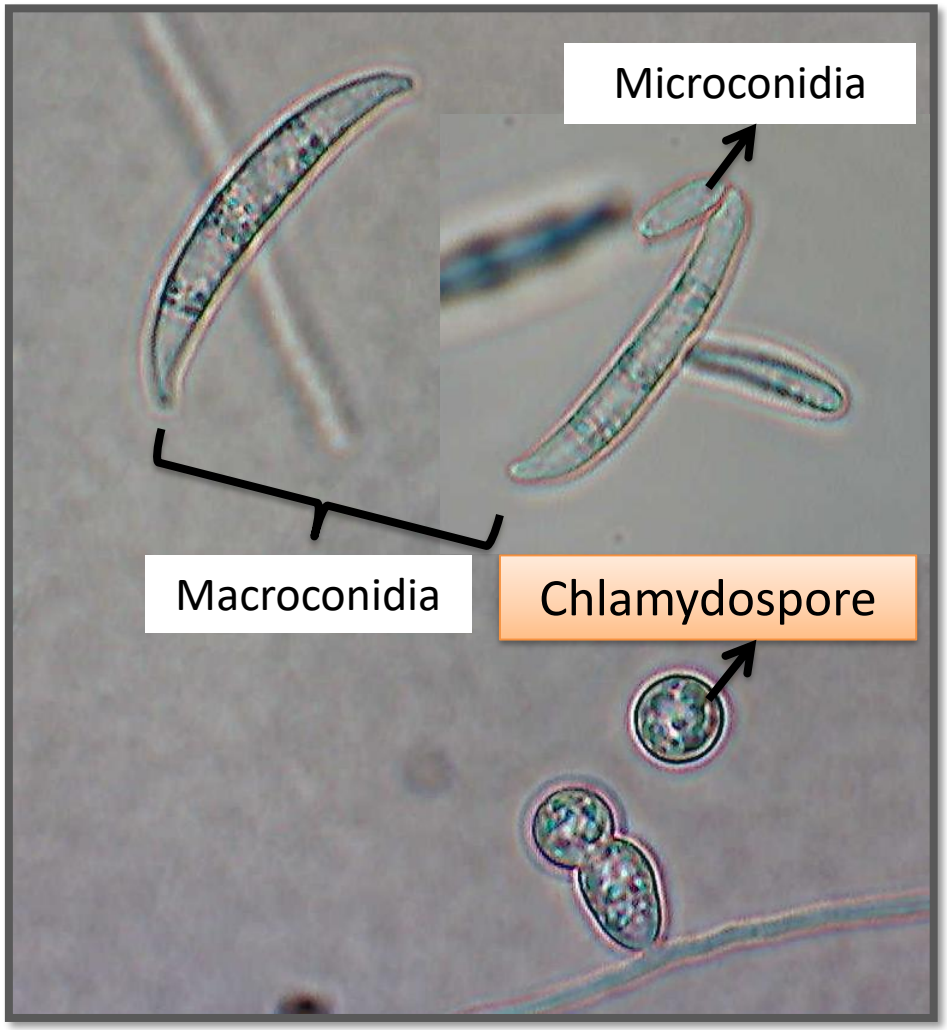
Fusarium wilt, identified by mycelia in xylem



Why was this pathogen/disease an issue again?

What is Fusarium wilt? A fungal disease

Fusarium oxysporum f.sp. *niveum* - (Fon)



Chlamydospore considered **most** important source of inoculum

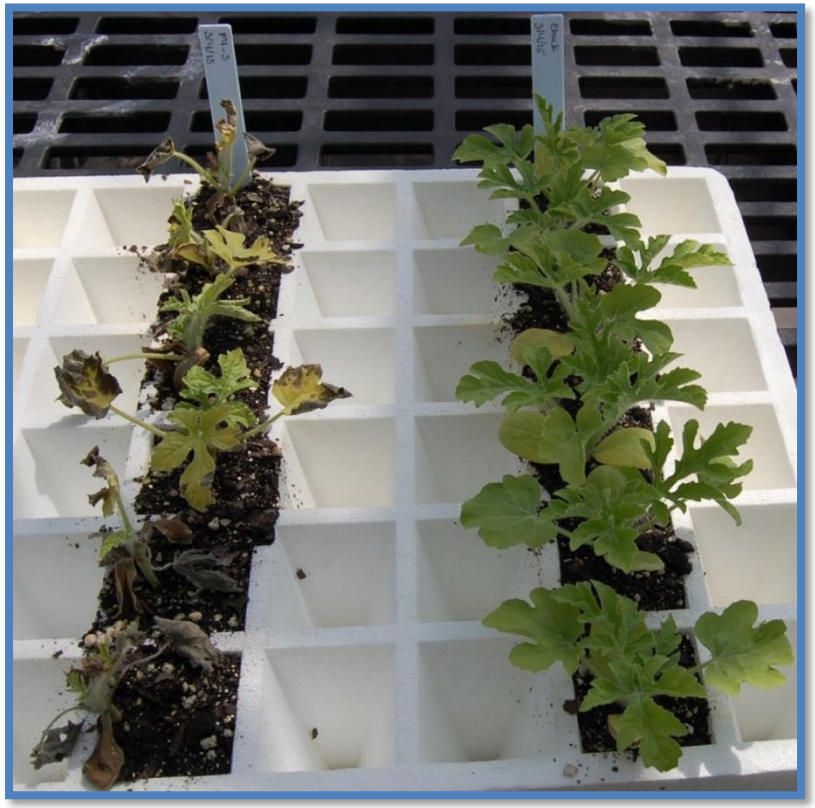
Survives 10+ years

“Chokes” the plants water supply- wilt

Watermelon Runner Sectoring

Eventually leading to gaps and weeds!

The pathogen can vary in how it causes disease



- Aggressiveness varies
  - Race 0 & 1: weak
  - Race 2: mod-strong
  - Race 3: strong
- Current Resistance
  - Race 0 & 1 available
  - Race 2 limited
  - Race 3 unavailable*

Accurate diagnosis is needed to choose management

Everts & Himmelstien, Crop Protection, 2015

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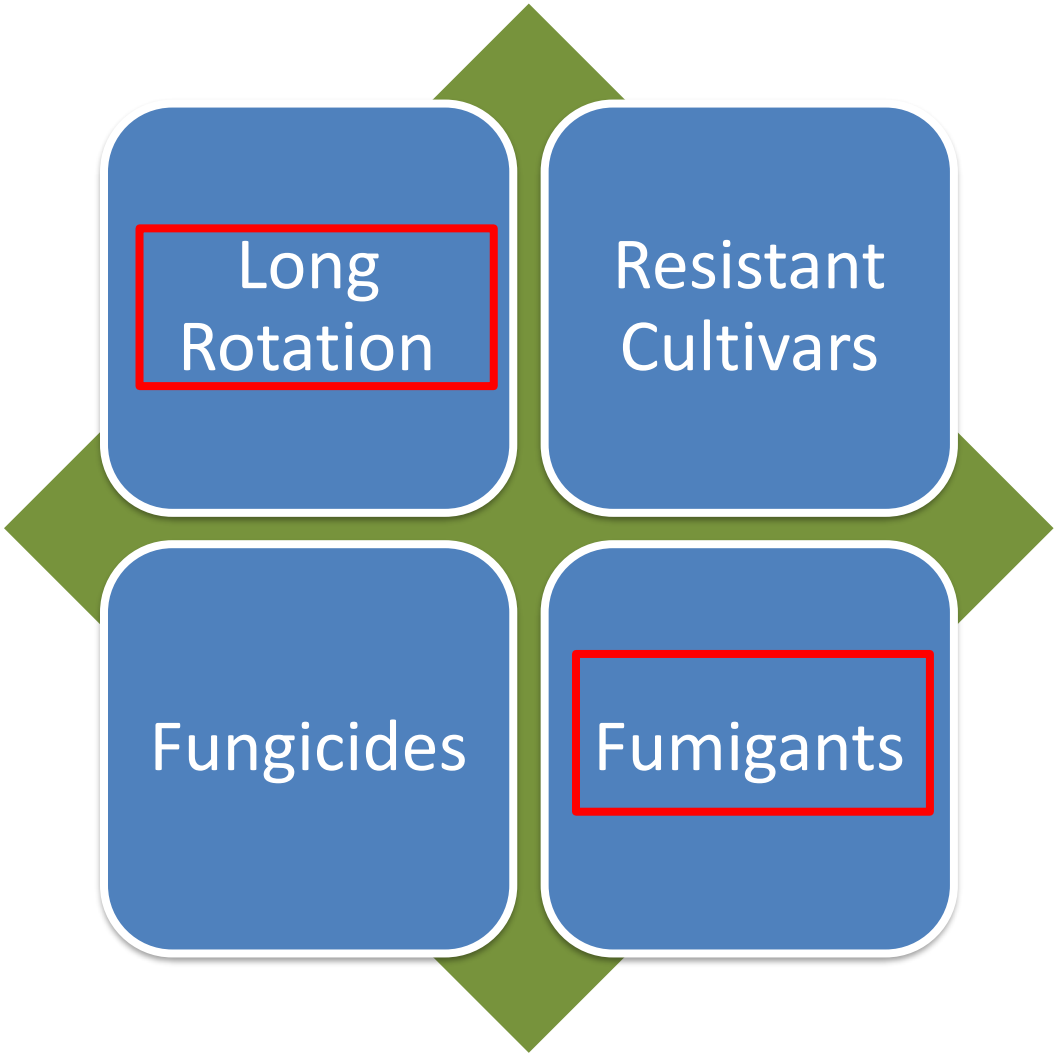
Traditional integrated disease management



Many challenges have limited the effectiveness of crop rotation for all soilborne diseases

Figure 1. Illustration of conventional and sod-based peanut/cotton rotations.

Challenges: Land availability, rotational crops value, pathogen survival > 10 years

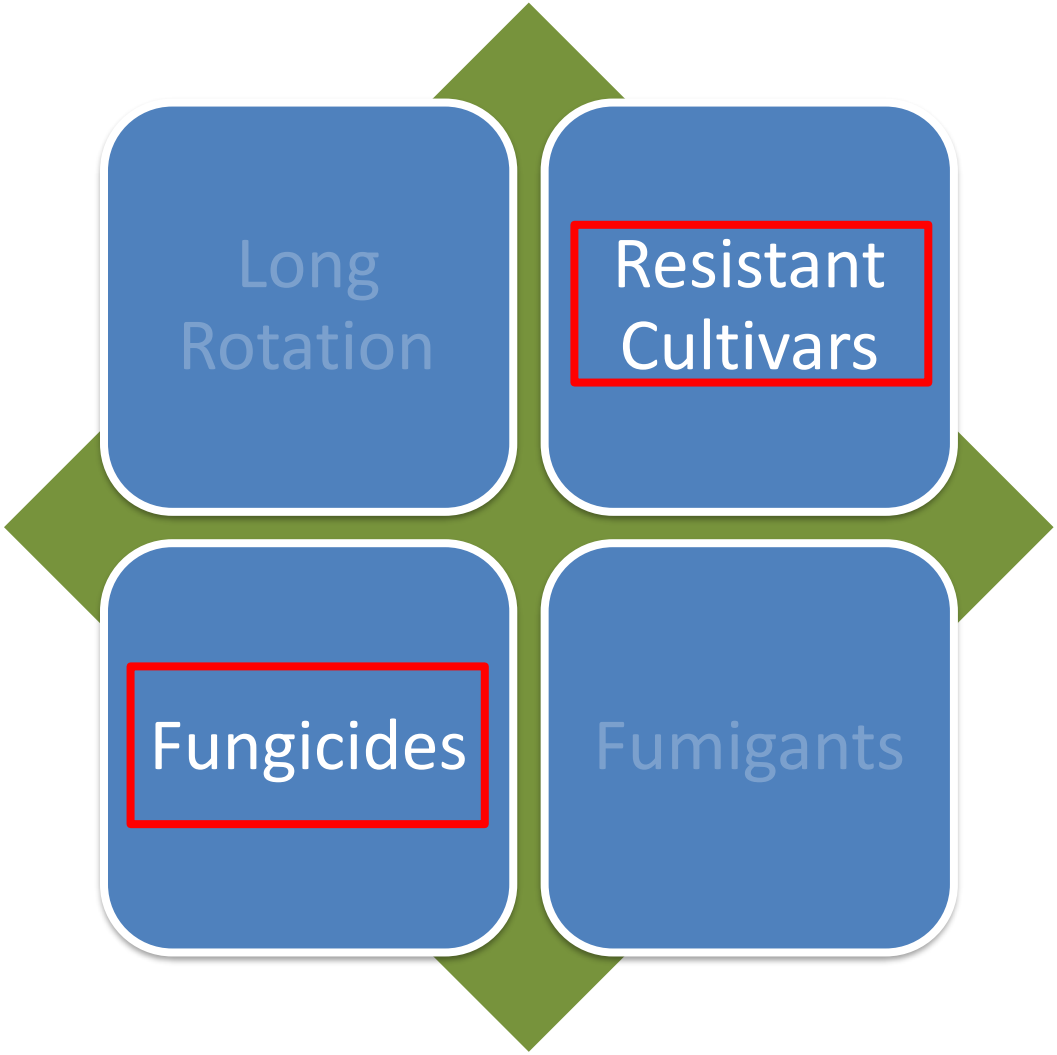
http://sodbasedrotation.com/

Fumigation costs mean the disease must be present to see a return on investment.

- Chloropicrin
  - Can significantly reduce FW
  - Can have no effect on FW
  - No effect on nutsedge alone
  - There is additive effect with fungicides

https://site.extension.uga.edu/crispcoag/files/2020/02/J-Freeman-GWA-2020.pdf

Inconsistencies & challenges lead to investigating other management techniques



Race structure limits varietal resistance for FW

Triploids/Seedless

- Races 0 and 1
- Many cultivars now

Melody
(Unidentified)

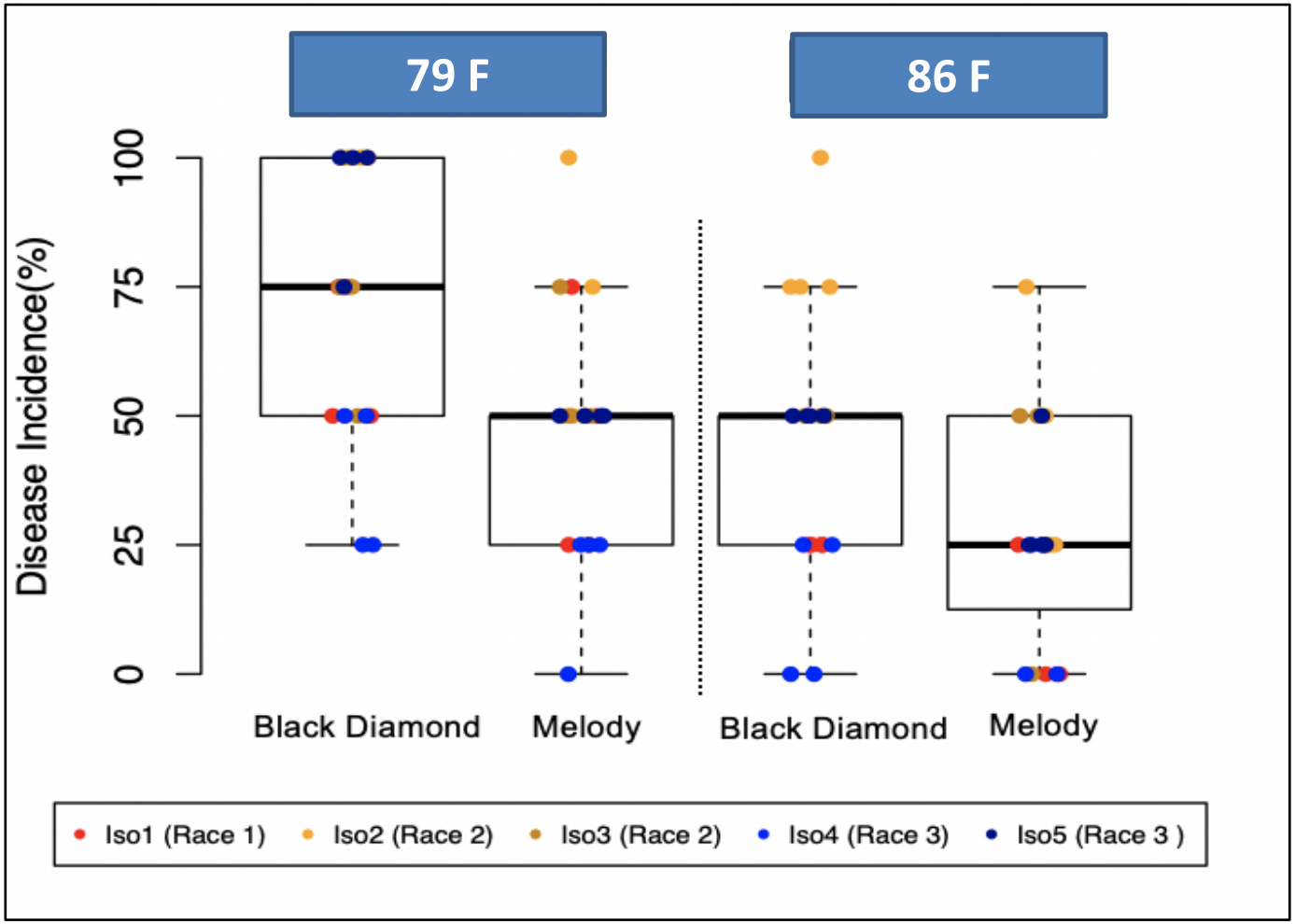
Diploid/Seeded

- Races 0 and 1 edibles
- Race 2, non-edibles

Jubilee
(not susceptible)

Currently commercial cultivars lack resistance for Race 3

Host resistance can reduce disease



Melody on average had 25% less disease incidence than Black Diamond

Higher temperatures lead to lower disease

Temperature effect on Fusarium oxysporum f.sp. niveum disease incidence in watermelon seedlings. Z. Xu and N. Dufault; 2020 APS Southern Division Meeting

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Fungicides

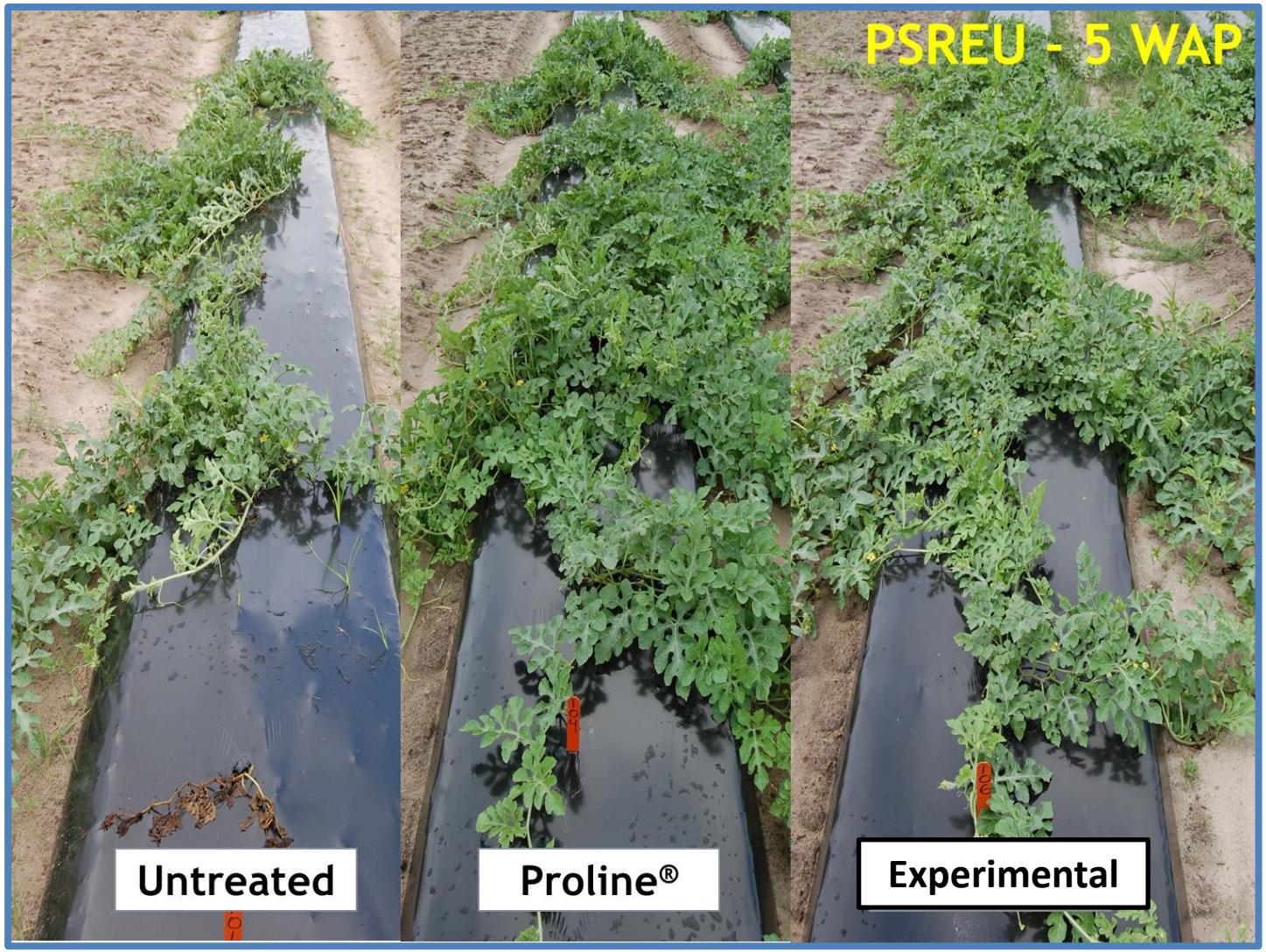
Fungicides must reach the soil and roots/crown

Drench

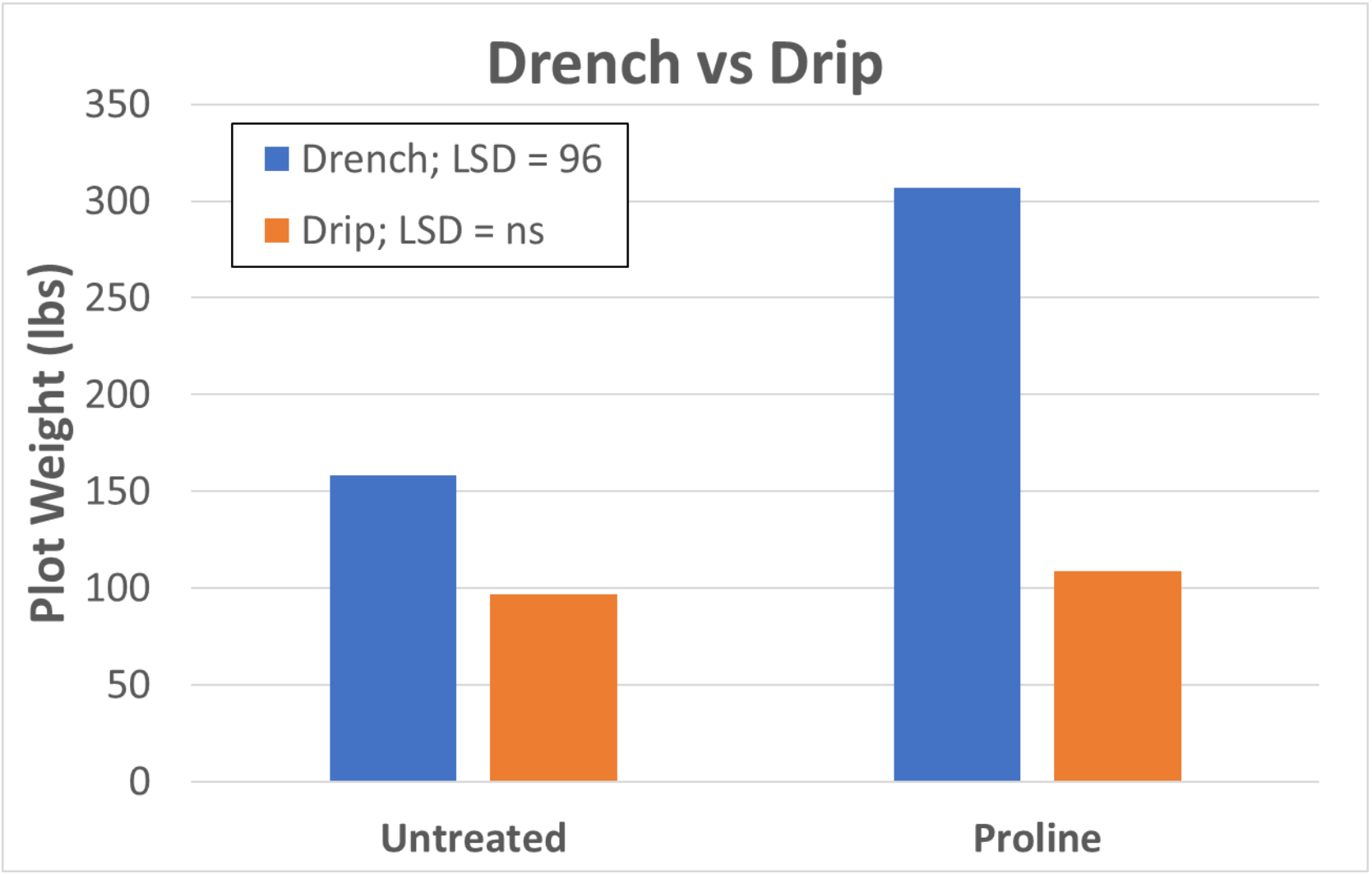
Drip

Ultimately the labels decided for us: DRIP

Fungicides can manage FW in the field



However, drip treatments did not perform well.



Proline applied at 5.7 fl oz per Acre or 100 gallons

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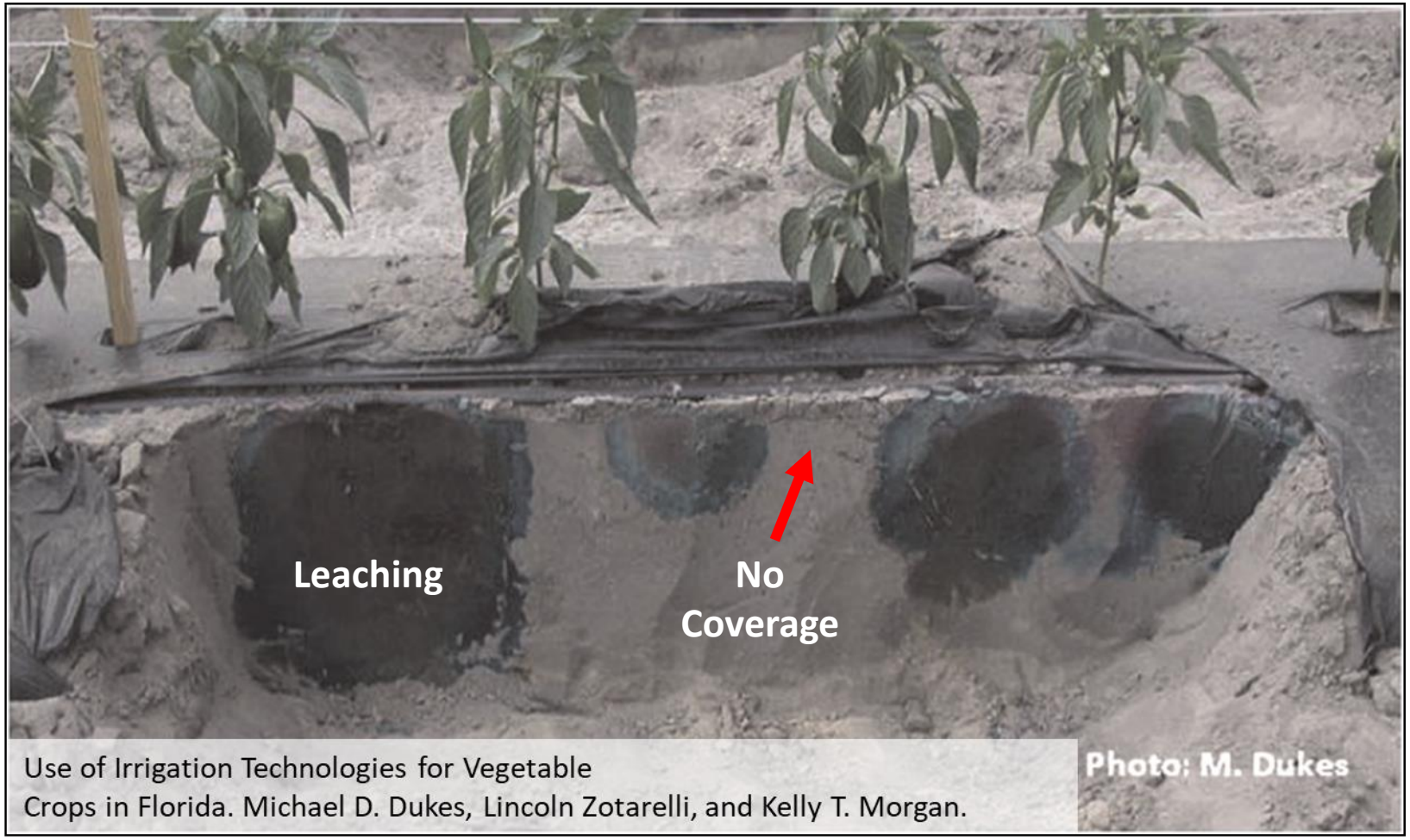
Drip applications are not uniform & can leach product

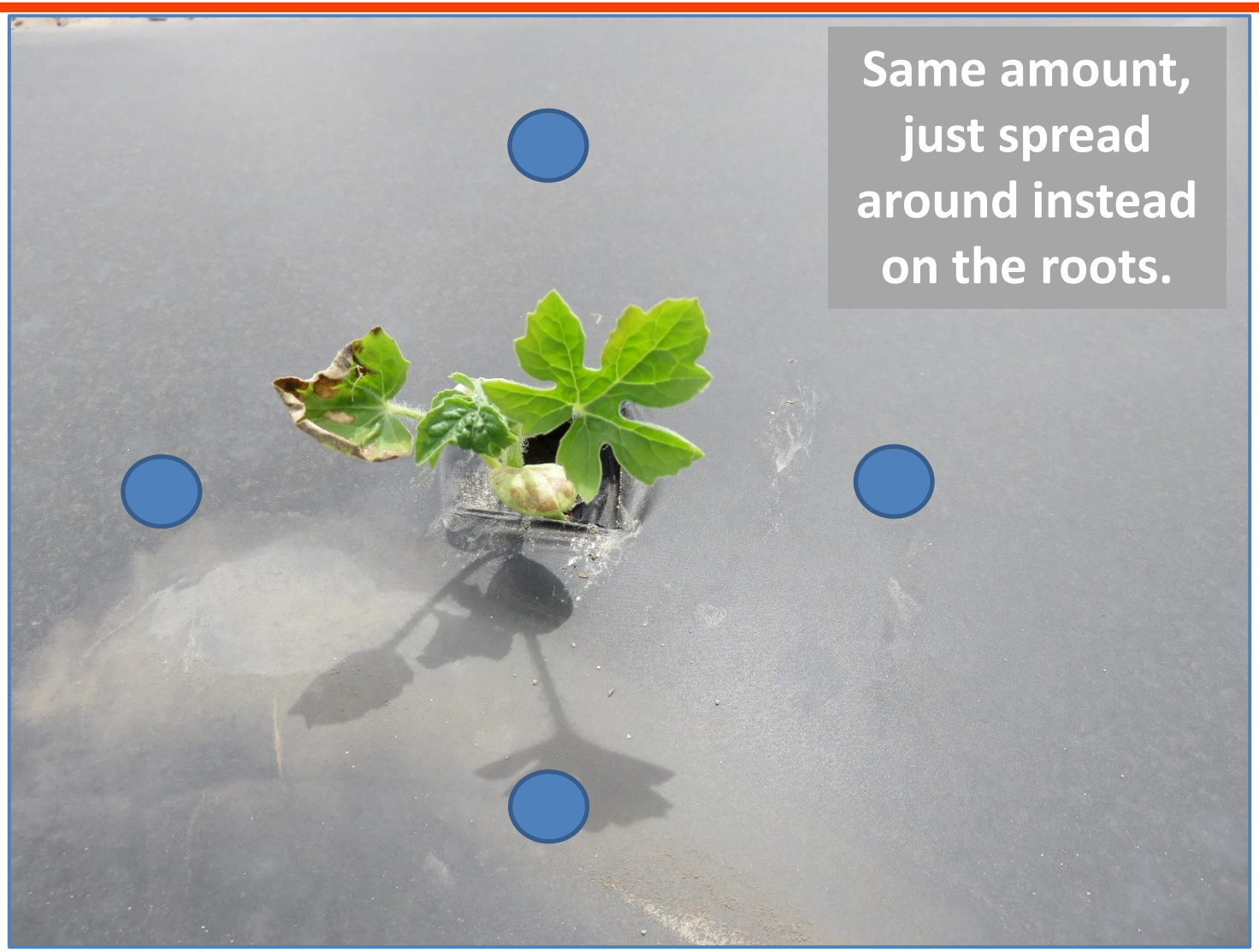


Use of Irrigation Technologies for Vegetable Crops in Florida. Michael D. Dukes, Lincoln Zotarelli, and Kelly T. Morgan.

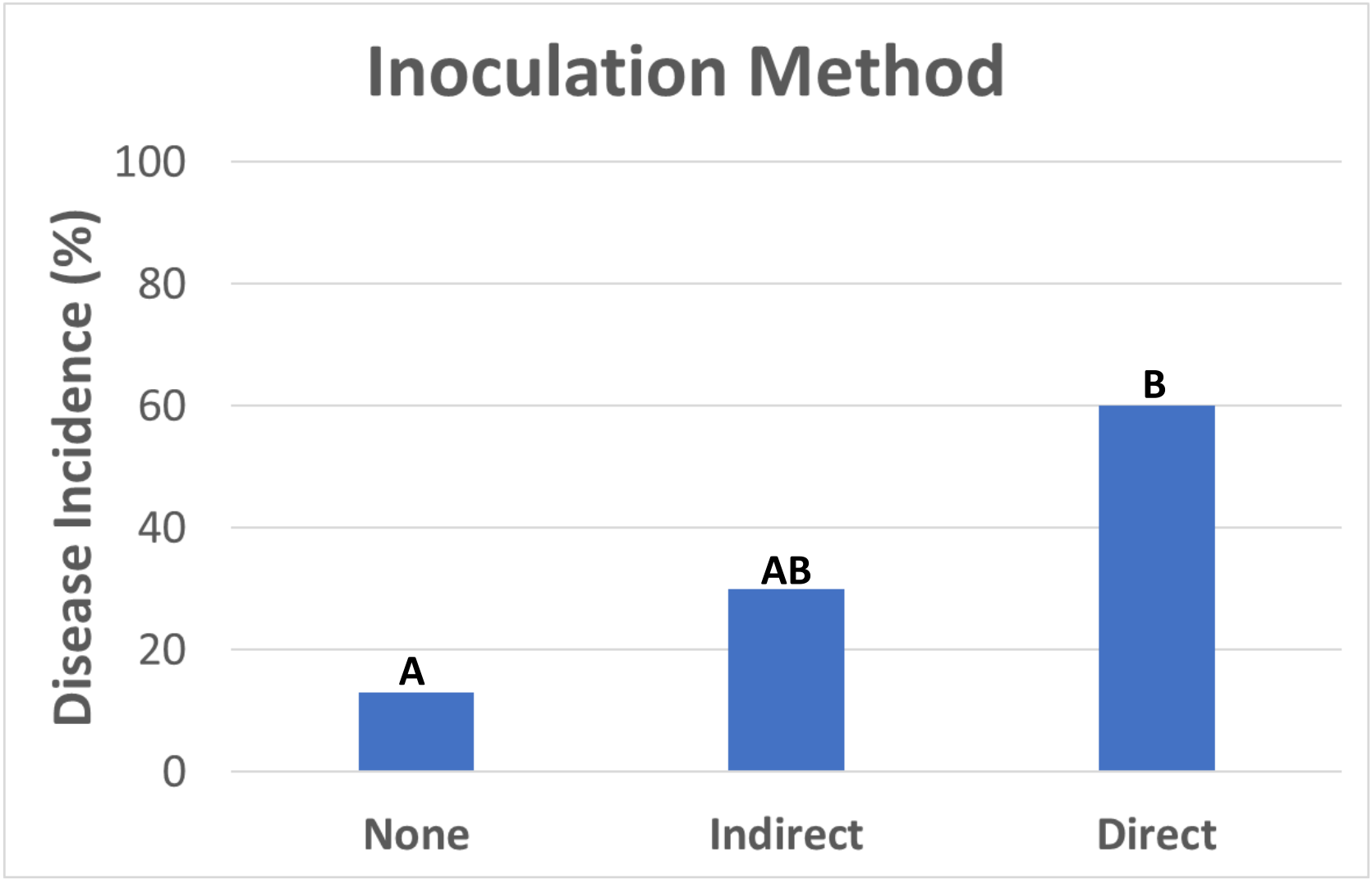
Pathogen placement/quantity impacts disease

Inoculations were directly on roots

Pathogen will be dispersed in fields



Indirect inoc. had lower disease then direct.



HSD = 41

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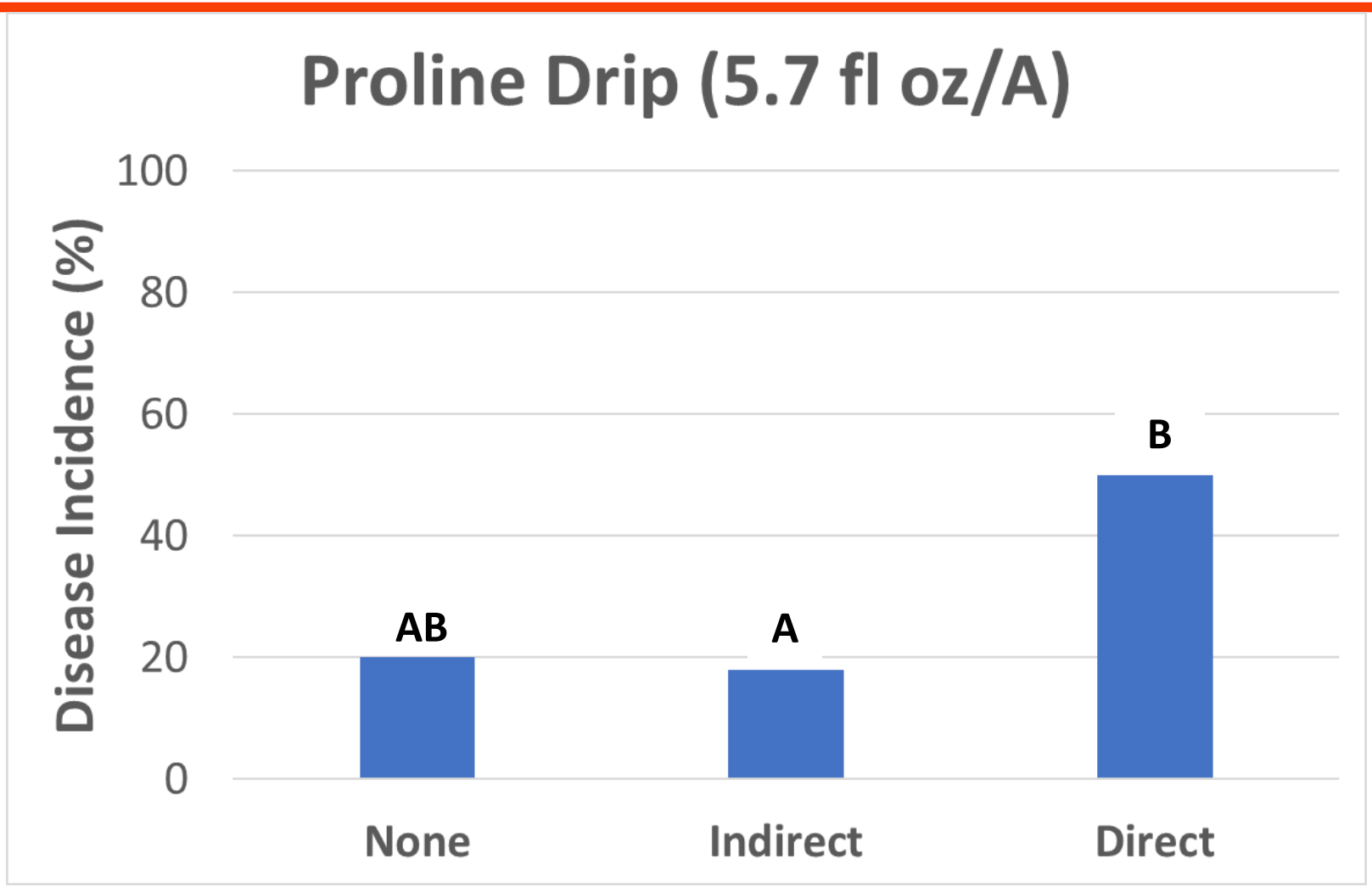
Drip applied fungicides effectively lowered disease with the indirect method.



HSD = 41

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Fungicides can manage the pathogen, but…

- Inoculum concentrations and location relative to the plant is critical
- Fungicides only protect the tissue/soil they touch

Pesticides can help but should not be used alone for soilborne diseases.

How can we improve or add management techniques?

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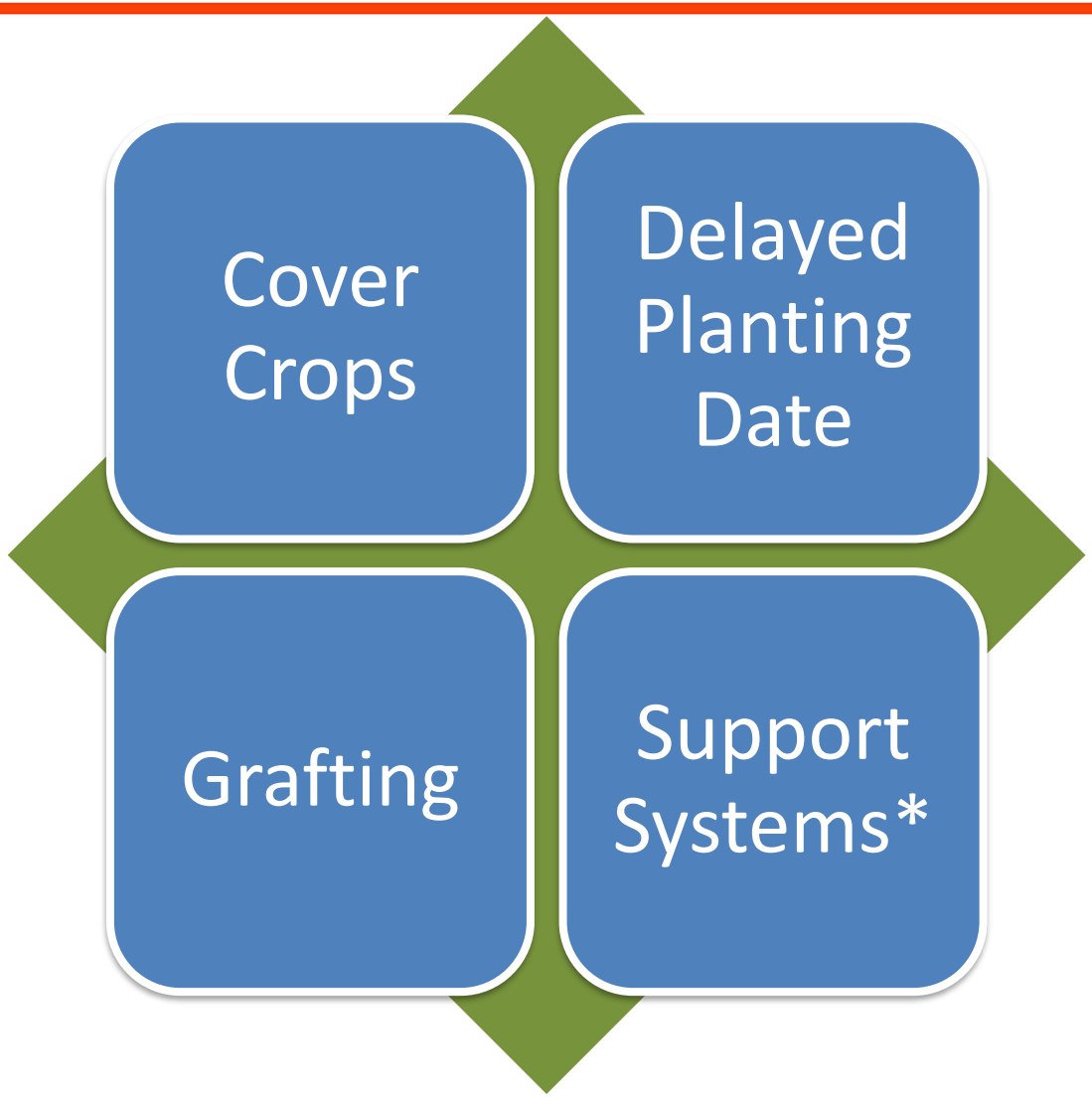
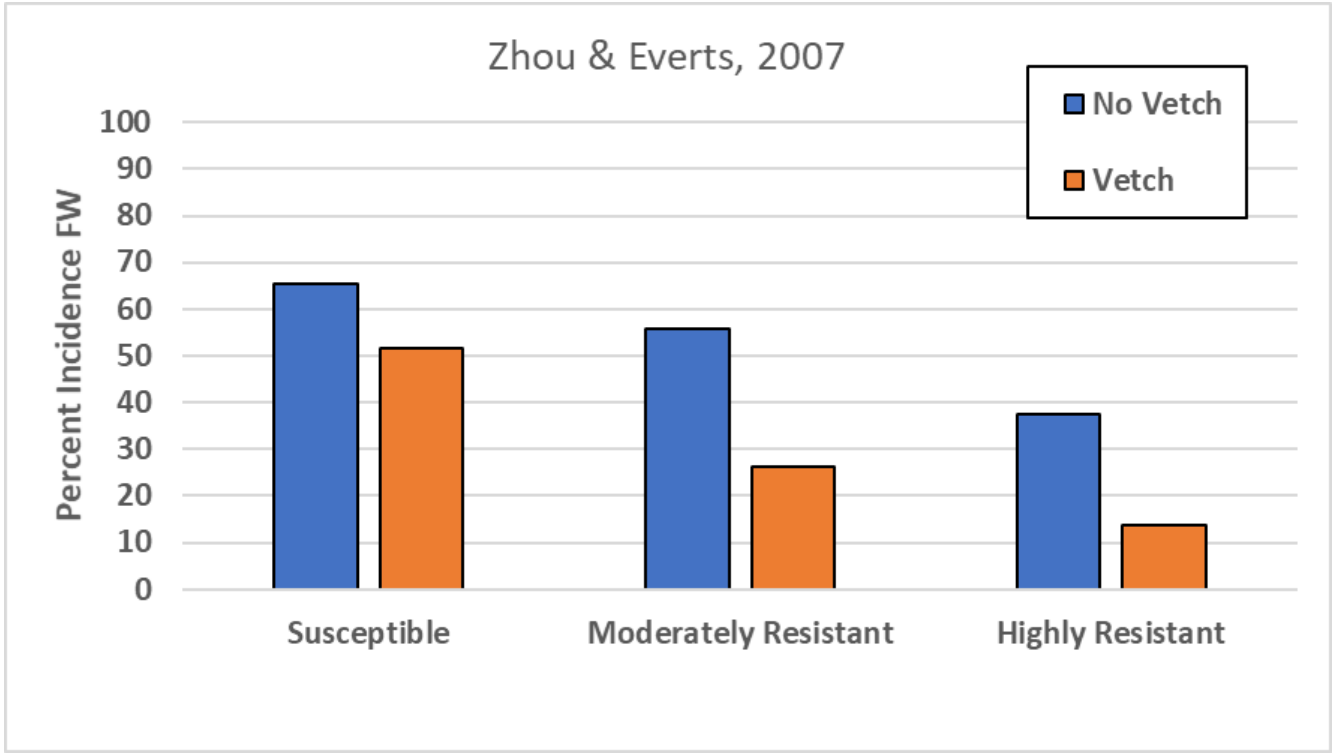
Non-chemical FW management include:



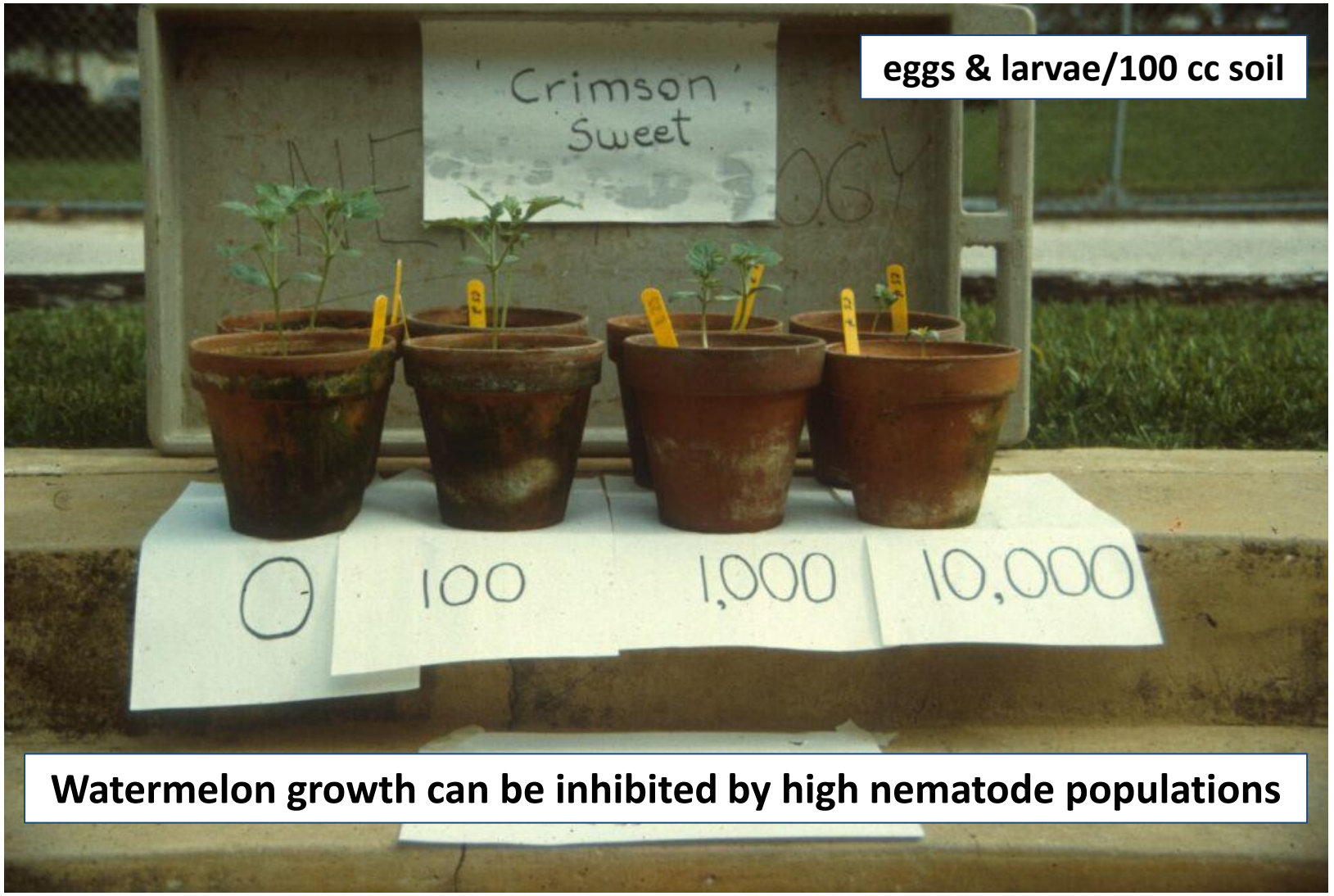
*Support systems are being developed to better interpret novel management success; this will not be discussed here.

Soil amendments do suppress FW

- Hairy Vetch (*Vicia villosa)*
- Vetch efficacy dependent on cultivars
- Trials were with FW race 1



Hairy vetch concerns: toxic and nematodes.



Noling, 2017


Delayed Planting Date

Delayed planting reduced disease in GA & SC

Disease Incidence reduced between 40 and 75%

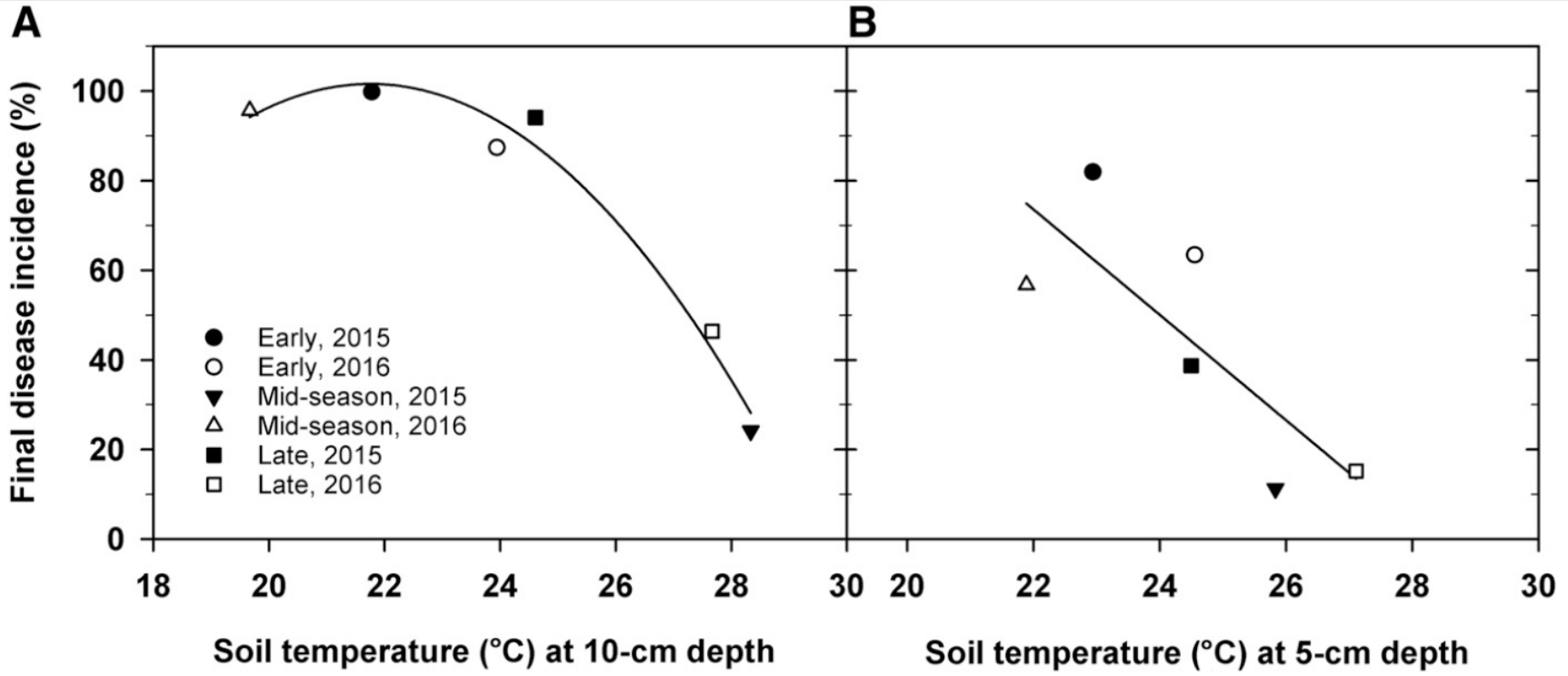
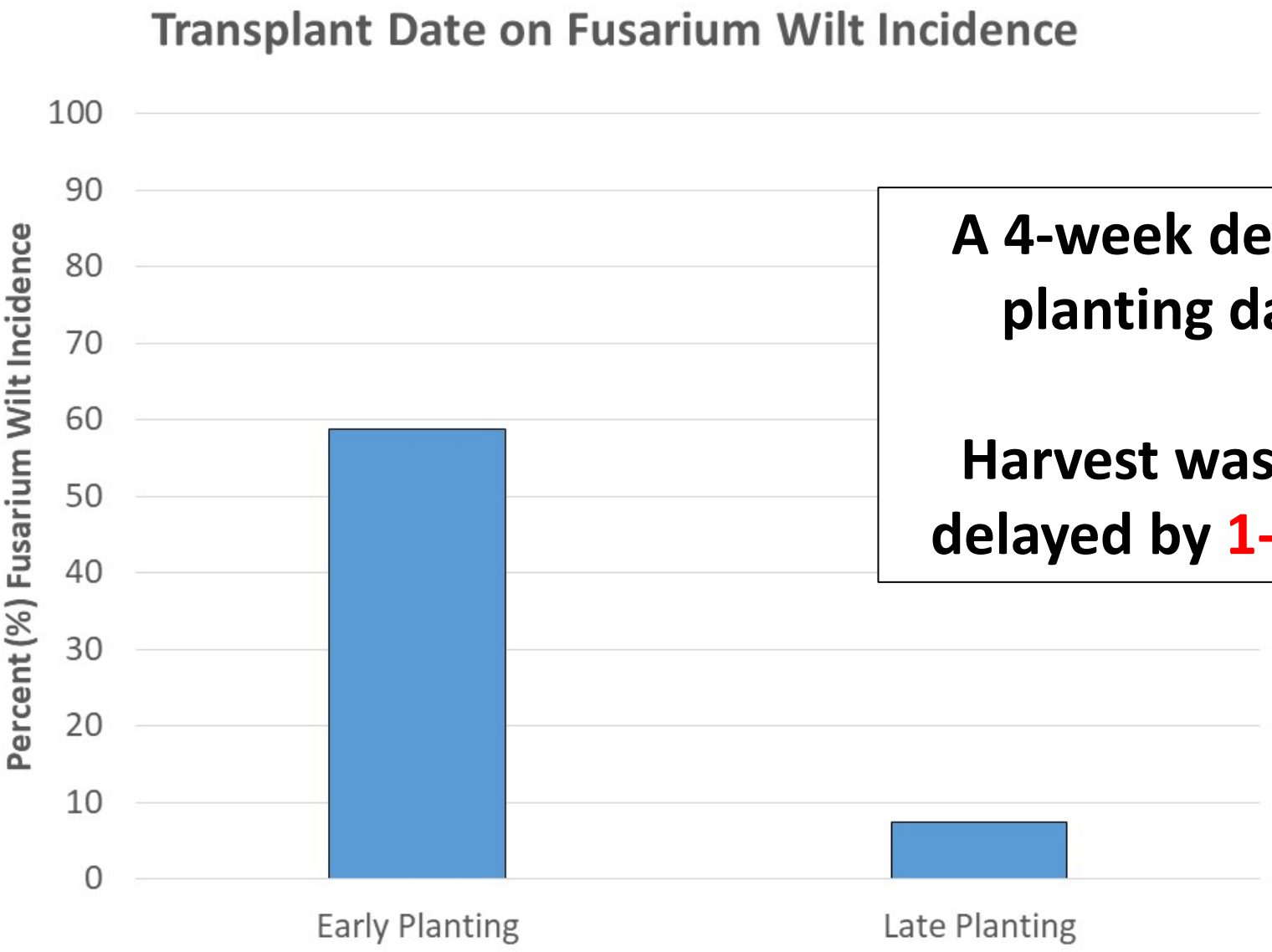


Fig. 1. Relationships between Fusarium wilt incidence at the end of the season and mean soil temperature during the 4 weeks after transplanting. The regression line was quadratic **(A)** for Georgia (adjusted $R^2 = 0.96$) and linear **(B)** for South Carolina (adjusted $R^2 = 0.54$).

https://doi.org/10.1094/PDIS-04-18-0709-RE

Similar results from delayed plantings were seen in Florida (2016, 2017 & 2019).



A 4-week delay in planting date.

Harvest was only delayed by 1-week.

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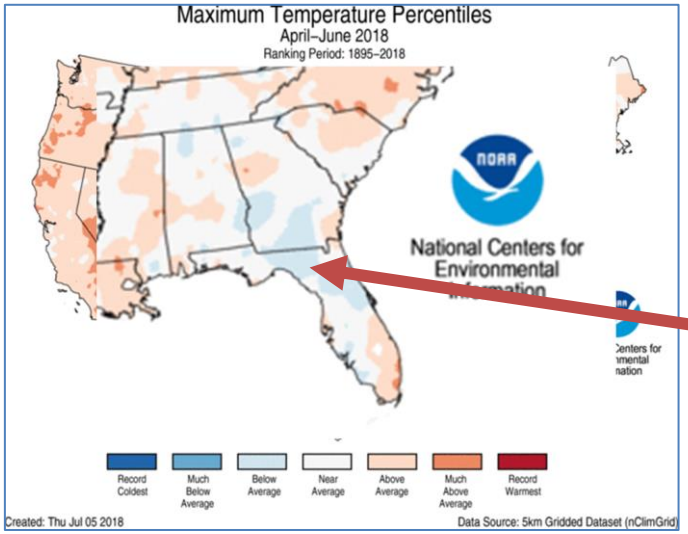
Reduction not present in “cool” climate years



Live Oak, FL – April Planting

Year	AVG Temp (F)
2017	75.6
2018	70.5

Treatment	2017		2018	
	Incidence (%)	Yield (lb/A)	Incidence (%)	Yield (lb/A)
Un-inoculated	0	36526	9	32371
Race 2[a]	5	35371	23	17233

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Delayed planting works most years.

What economic impact does harvest 7 - 10 day later have?

https://doi.org/10.21273/HORTTECH05006-21

Grafting

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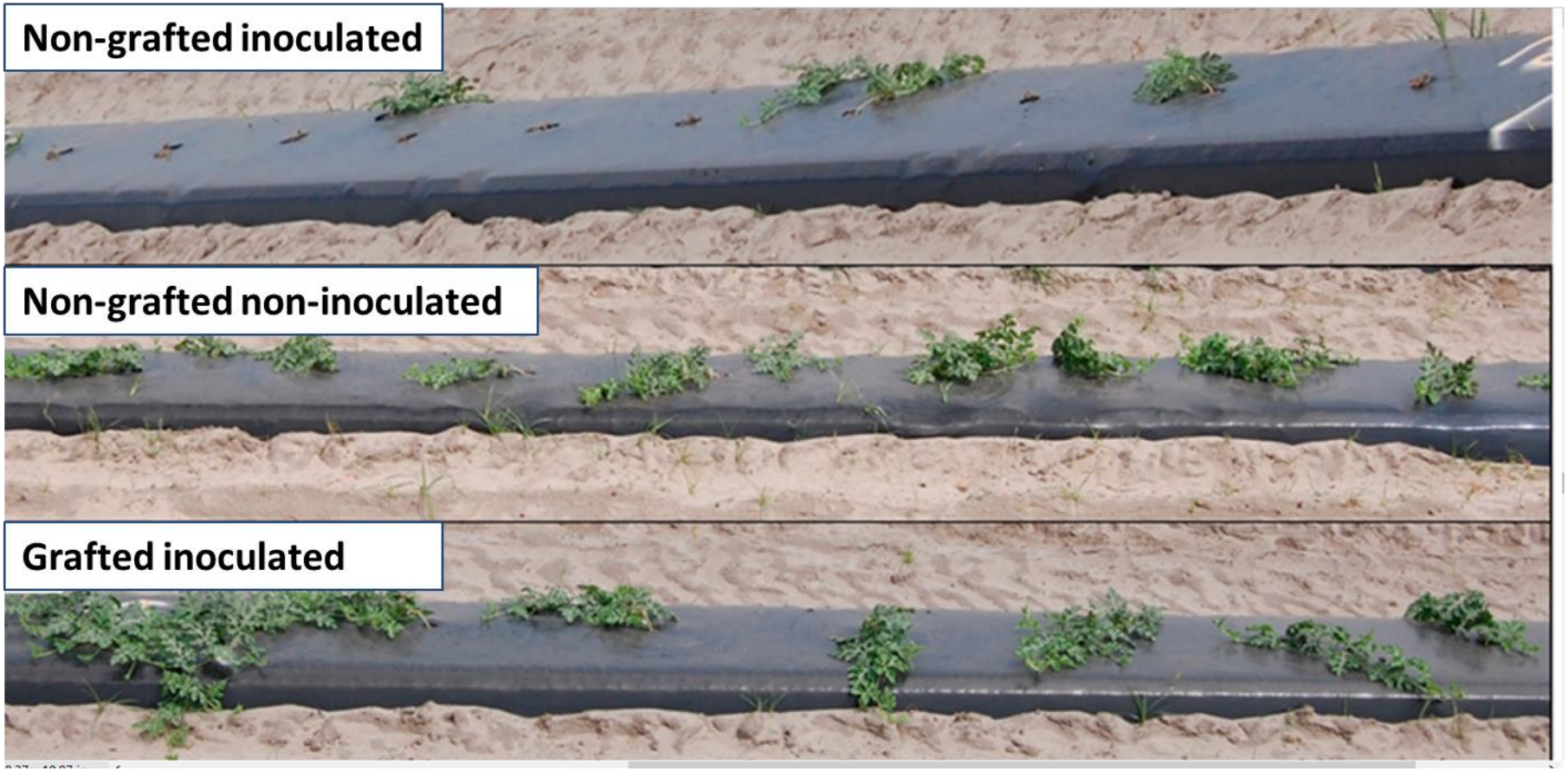
Grafted transplant cost limits their use.

DOI: https://doi.org/10.21273/HORTSCI12842-18



It works, but what if the disease is NOT present?

https://programs.ifas.ufl.edu/watermelon-grafting/

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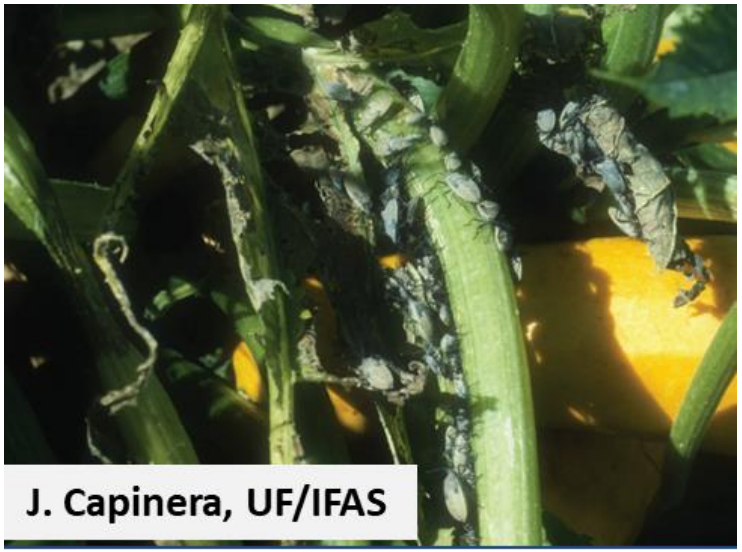
Rootstock pests and pathogens are a concern

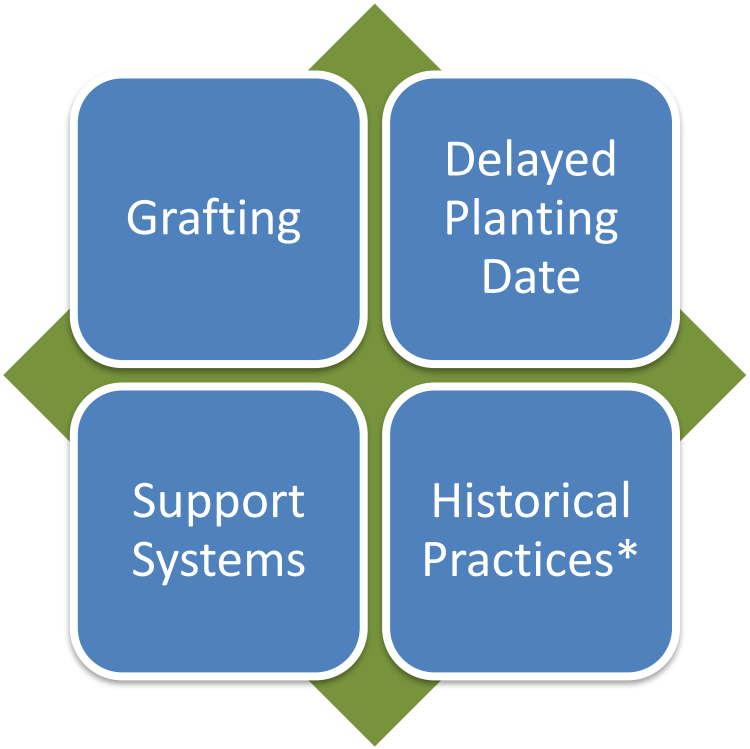
Root knot Nematode



Squash Bug

Disease presence & risk is critical to management selection and integration

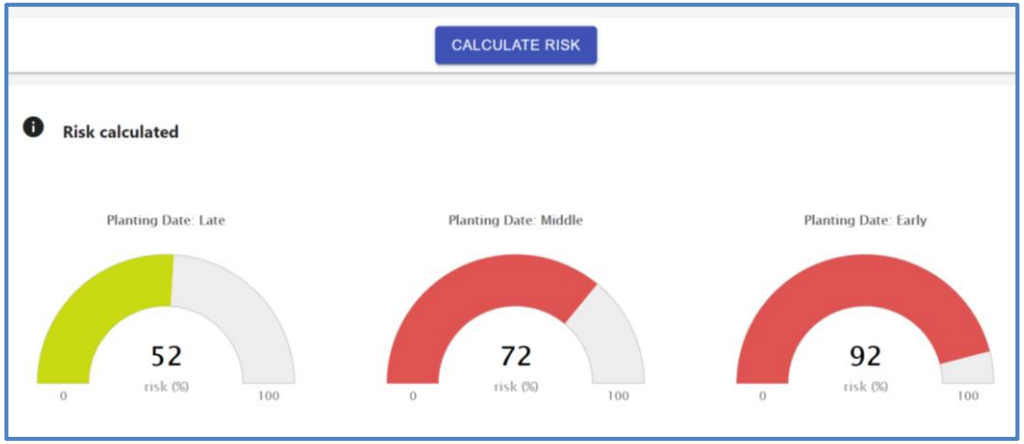
https://www.fool.com/investing/2018/11/11/3-great-stocks-for-low-risk-investors.aspx



*Historical practices include cover crops and cropping history.

Management decisions are made months before planting

Prototype bioassay



Risk tool; Agroclimate

- Bioassay
  - assess fields before planting
  - indicates presence
- Risk tool
  - Field history
  - Use of preplant tools

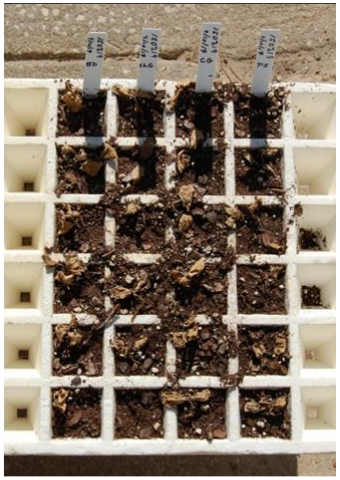
https://doi.org/10.32473/edis-pp364-2022

More detailed identification is needed!

Race 0

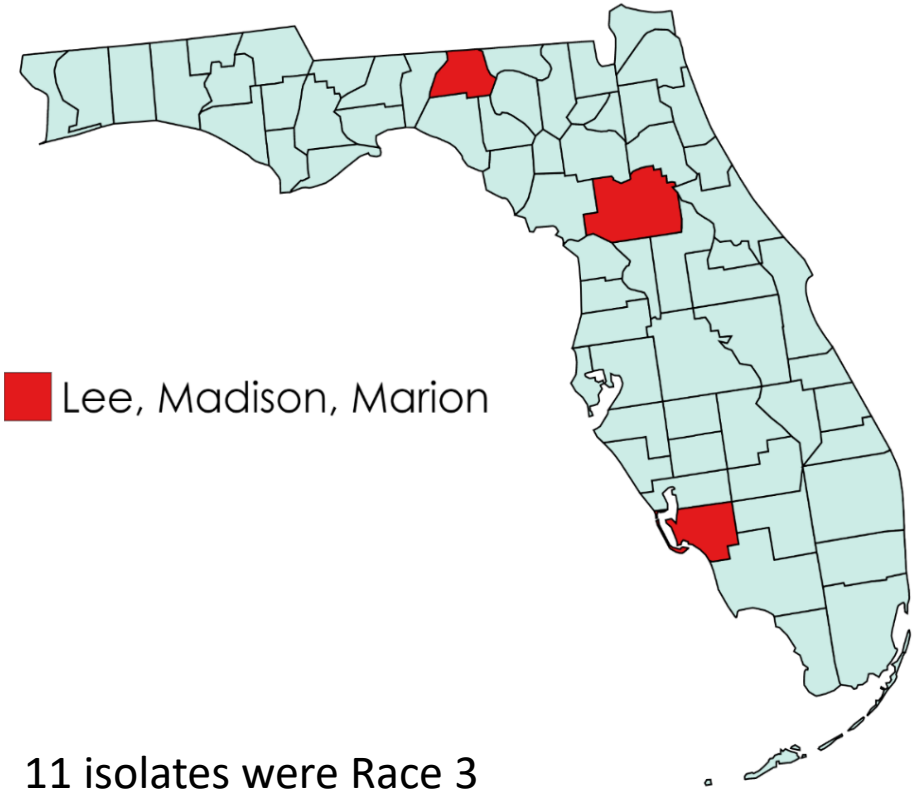
Race 1

Race 2



Race 3

Amaradasa et al. 2018. Plant Disease



Lee, Madison, Marion

11 isolates were Race 3

Created with mapchart.net ©

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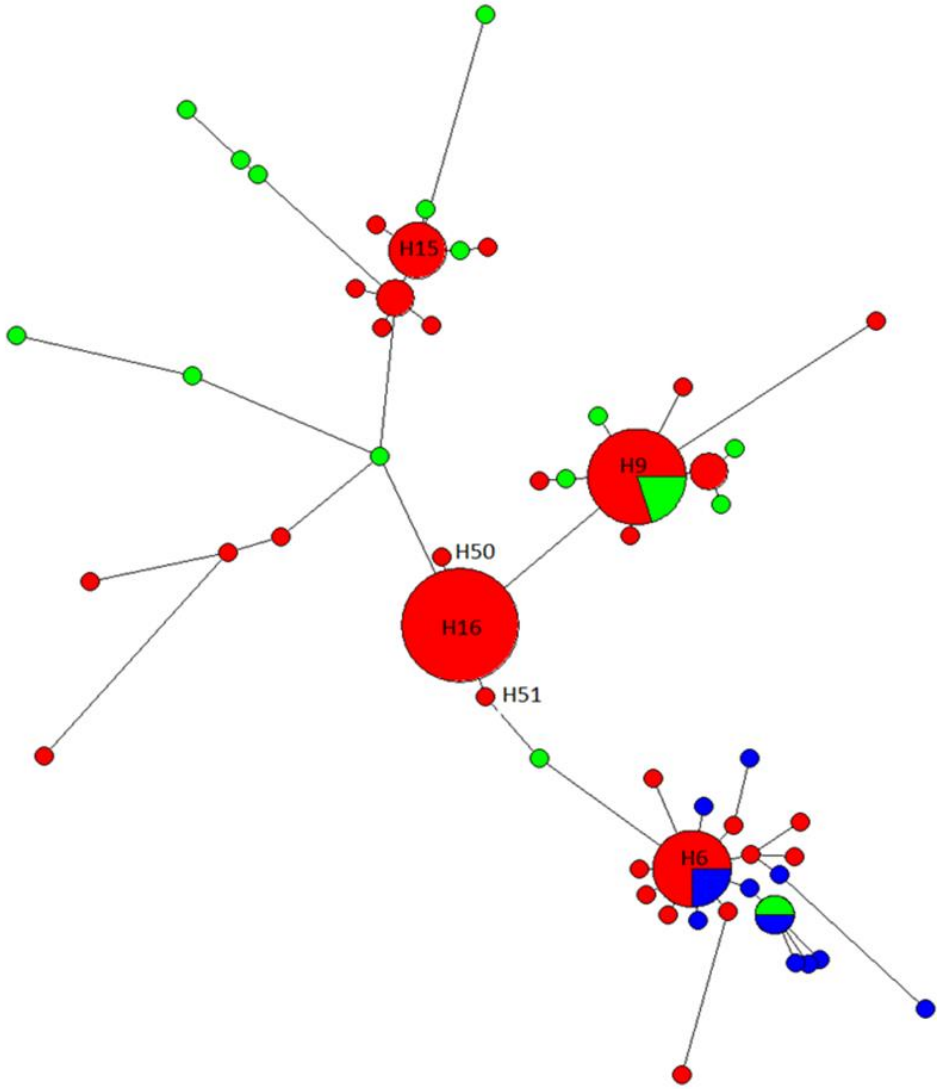
Florida's FON population is diverse & there appears to be species movement among regions



Central

Northern

Southern

55 haplotypes

AMOVA	Variation	*P* value
Between	25%	<0.001
Within	75%	--

•https://doi.org/10.1371/journal.pone.0248364

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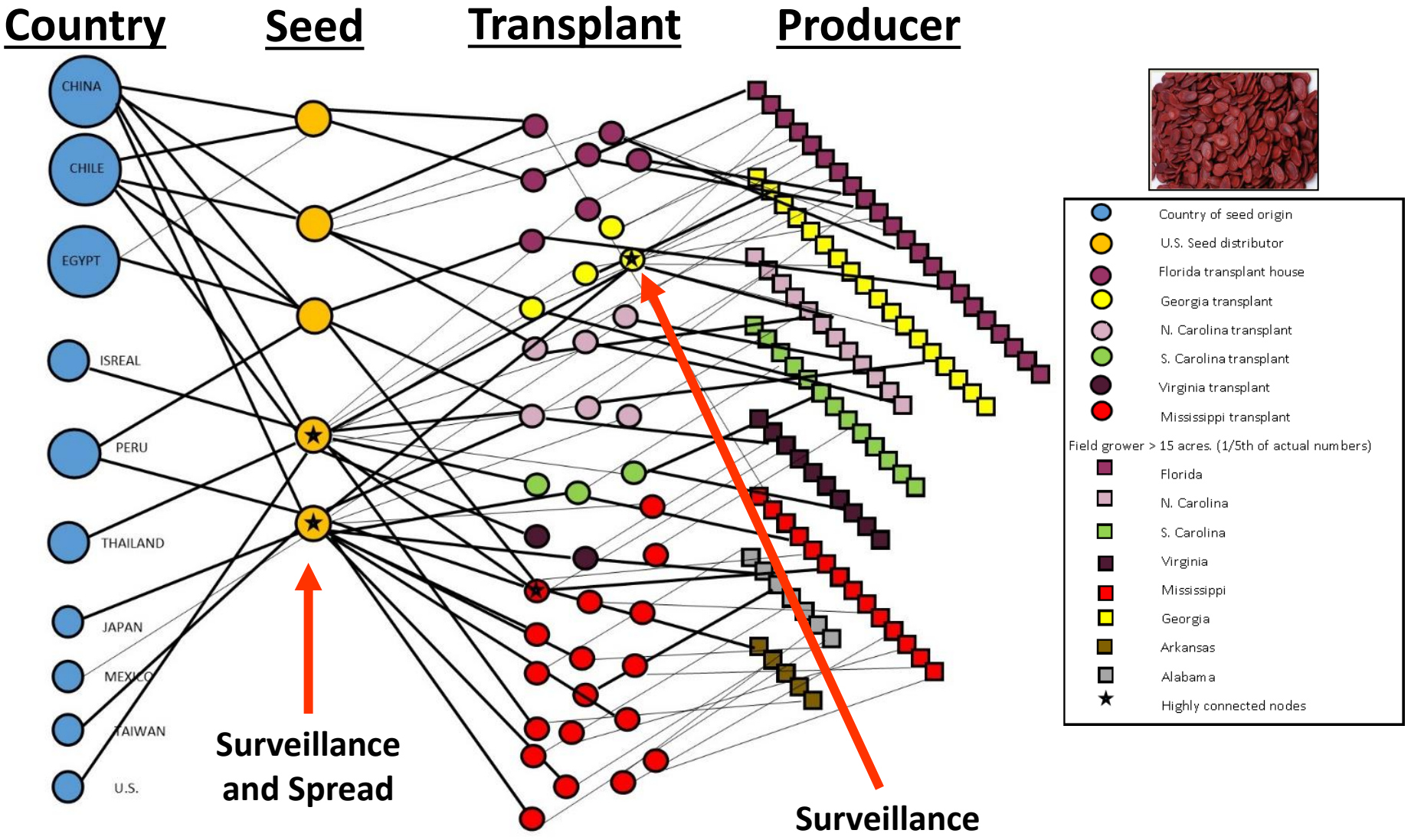
Understand how the pathogen is moving



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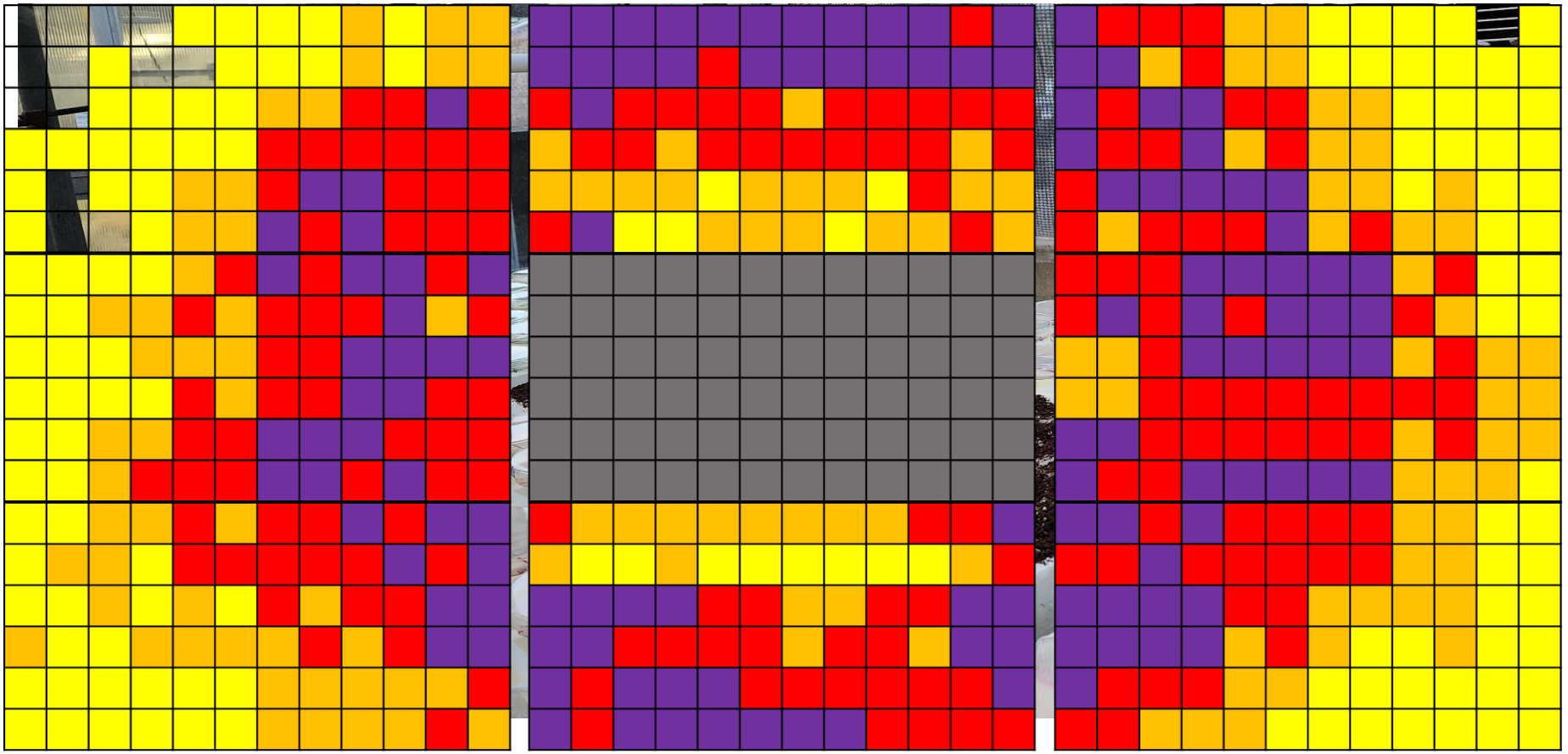
Greenhouse dispersal and management

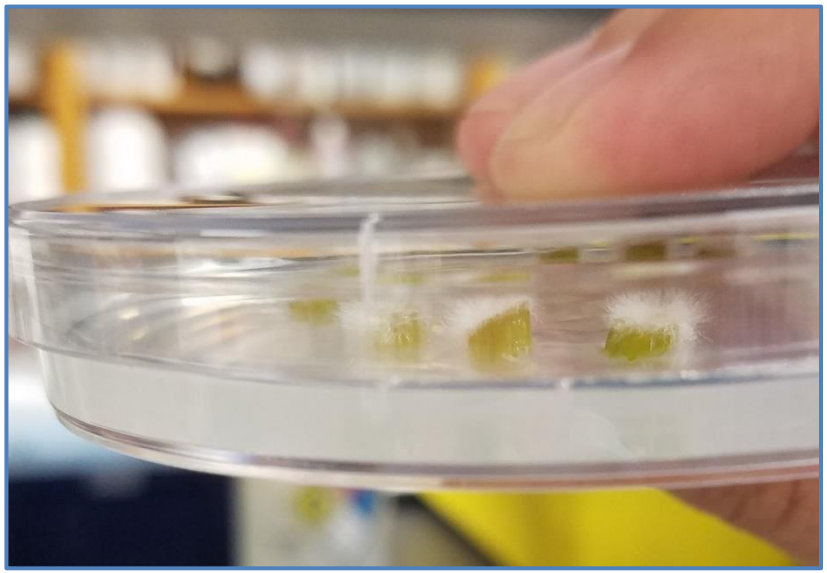
White cell indicates no spores



Splash dispersal of spores is possible to all neighboring trays.

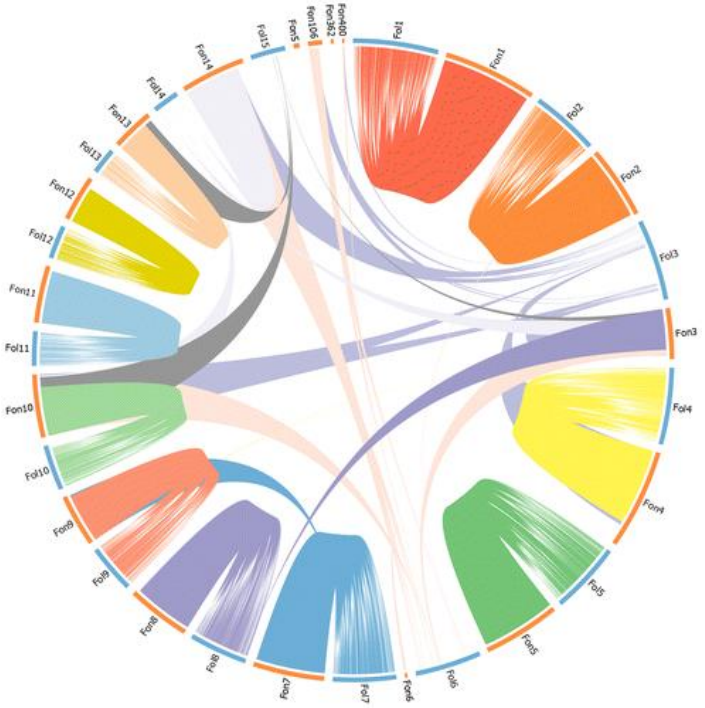
Improved monitoring and identification

Identify the pathogen



Avoid killing plant and know the race/population

Improved genetics



Molecular identification

Published in: James C. Fulton; Jeremy T. Brawner; Jose C. Huguet-Tapia; Katherine E. Smith; Randy Fernandez; Nicholas S. Dufault; PhytoFrontiers™ 2022, 2, 3-9. • DOI: 10.1094/PHYTOFR-04-21-0031-SC

All techniques can effectively manage Fusarium wilt, but concerns exist.

Pesticides work

Do not use alone

Delayed Planting

Useful but economics

Race 3 Present

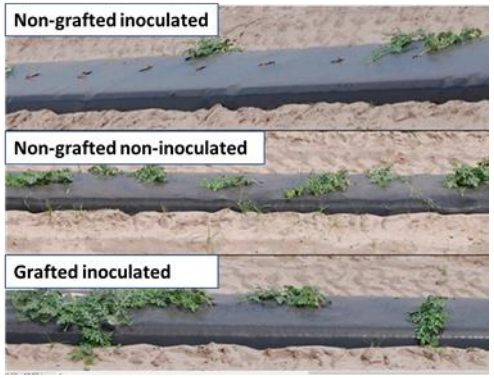
Effects resistance

Soil amendments work

Zhou & Everts, 2006.

Correlated to cultivar resistance

Grafting is effective



Further evaluations needed

Transplants

Healthy is key

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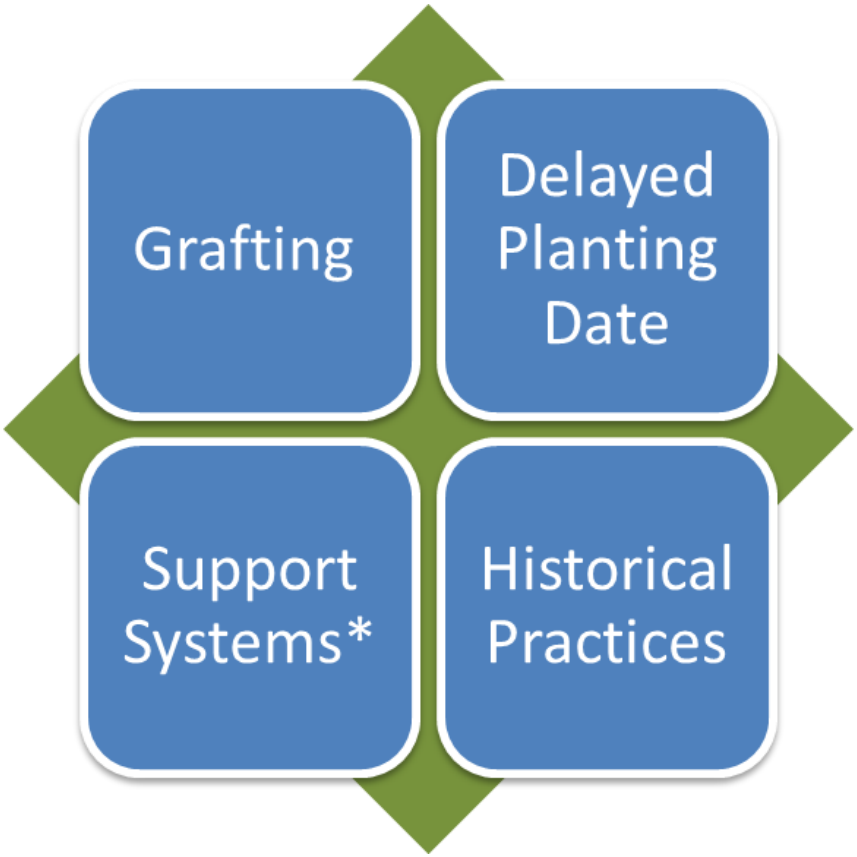
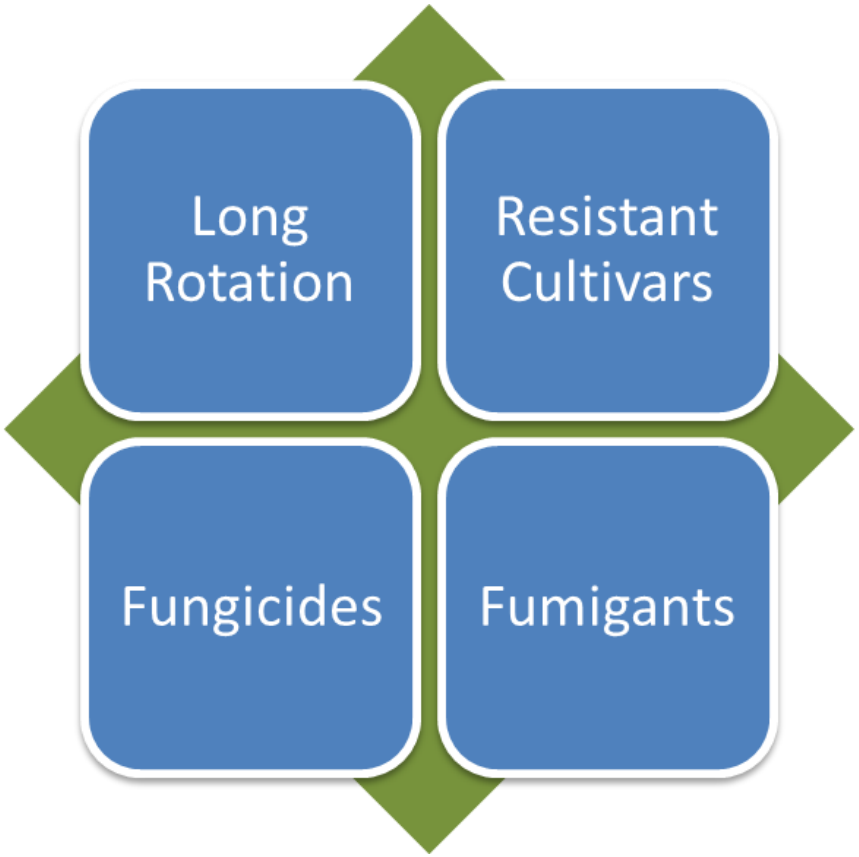
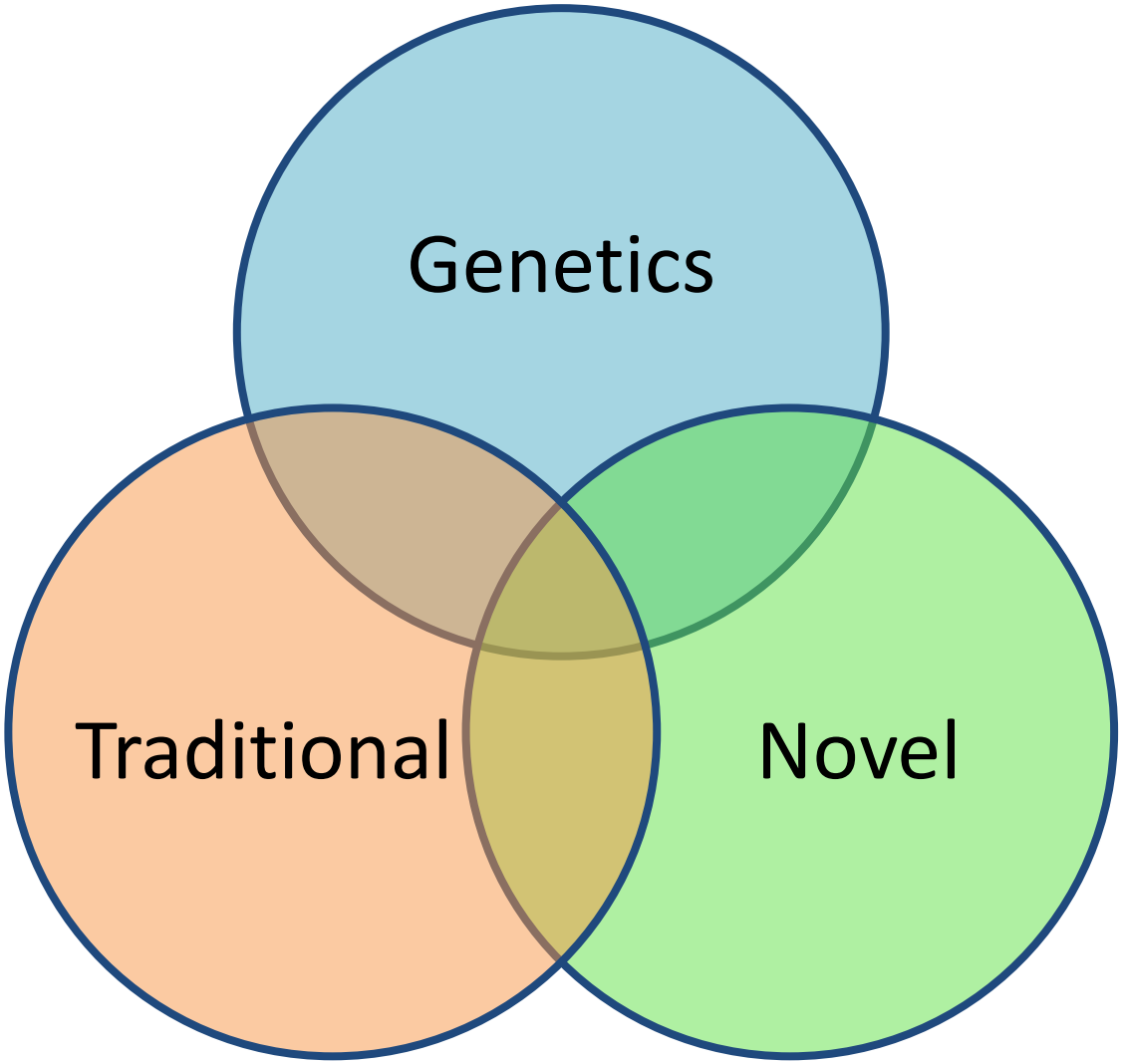
An integrated approach is needed!





Logical, efficient management is attained with accurate, rapid and specific diagnosis



Pathogen Management

Thank you for your attention

Literature Cited

Athearn, Kevin, Marina Burani-Arouca, Nicholas Dufault, Clyde Fraisse, Joshua Freeman, Robert Hochmuth, Tatiana Sanchez, Tatiana Borisova, Tyler Pittman, and Luke Harlow. "Watermelon Planting Decisions with Multiple Risks: A Simulation Analysis". HortTechnology 32.4 (2022): 377-381. < https://doi.org/10.21273/HORTTECH05006-21>. Web. 5 Feb. 2023.

K.L. Everts et al. 2014.Chemical management of Fusarium wilt of watermelon. Crop Protection 66:114-119.

Everts, K.L. and Himmelstein, J.C. 2015. Fusarium wilt of watermelon: Towards sustainable management of a re-emerging plant disease. Crop Protection 73:93-99.

Gatch, E. W., and du Toit, L. J. 2015. A soil bioassay for predicting the risk of spinach Fusarium wilt risk. Plant Dis. 99:512-526.

Gill, H.K and McSorley, R. 2017. Cover Crops for Managing Root-Knot Nematodes. UF/IFAS, EDIS. ENY063.

Himmelstein, J. C., Maul, J. E., and Everts, K. L. 2014. Impact of five cover crop green manures and Actinovate on Fusarium wilt of watermelon. Plant Dis. 98:965-972.

Hudson, O.; Waliullah, S.; Fulton, J.C.; Ji, P.; Dufault, N.S.; Keinath, A.; Ali, M.E. Marker Development for Differentiation of Fusarium oxysporum f. sp. Niveum Race 3 from Races 1 and 2. Int. J. Mol. Sci. 2021, 22, 822. https://doi.org/10.3390/ijms22020822

Keinath, A.P., Coolong, T.W., Lanier, J.D. and Ji, P. 2019. Managing Fusarium Wilt of Watermelon with Delayed Transplanting and Cultivar Resistance. Plant Dis. 103:44-50

Zhou, X. G., and Everts, K. L., 2007. Effects of host resistance and inoculum density on the suppression of Fusarium wilt of watermelon induced by hairy vetch. Plant Dis. 91:92-96.

Zhao, X., Liu, Q., Sanchez, M.T., and Dufault, N.S. 2018. Performance of Grafted Seedless Watermelon Plants with and without Root Excision under Inoculation with Fusarium oxysporum f. sp. niveum Race 2. HORTSCIENCE 53(9):1340–1346