Opportunities for the integration of more sustainable practices in the quest to control Verticillium Wilt in Peppermint

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Extension

HORTICULTURE AND LANDSCAPE ARCHITECTURE

Outline

- Verticillium Wilt
- Potential mitigation strategies
- Soil health
- Anaerobic soil disinfestation (ASD)
- SARE project
- Acknowledgements

News Paper Article

Sausalito News, Volume 35, Number 47,
22 November 1919

St. Joseph County, Indiana, Largest Producer of Mint.

With the Indiana mint growers realizing $250 to $300 an acre, reports given out by a county agent and a government crop estimator, show that St. Joseph county is the largest mint production county in the United States, and Indiana produces two-thirds of the mint of the United States. During the summer season, 3,425 acres of mint were under cultivation and produced a record-breaking crop. This year the yield near Nappanee has been unusually large and the farmers have received as high as $6.25 a pound for their mint.


WARNS OF DUST PERIL IN MILLS

TOGS FOR KIDDIES

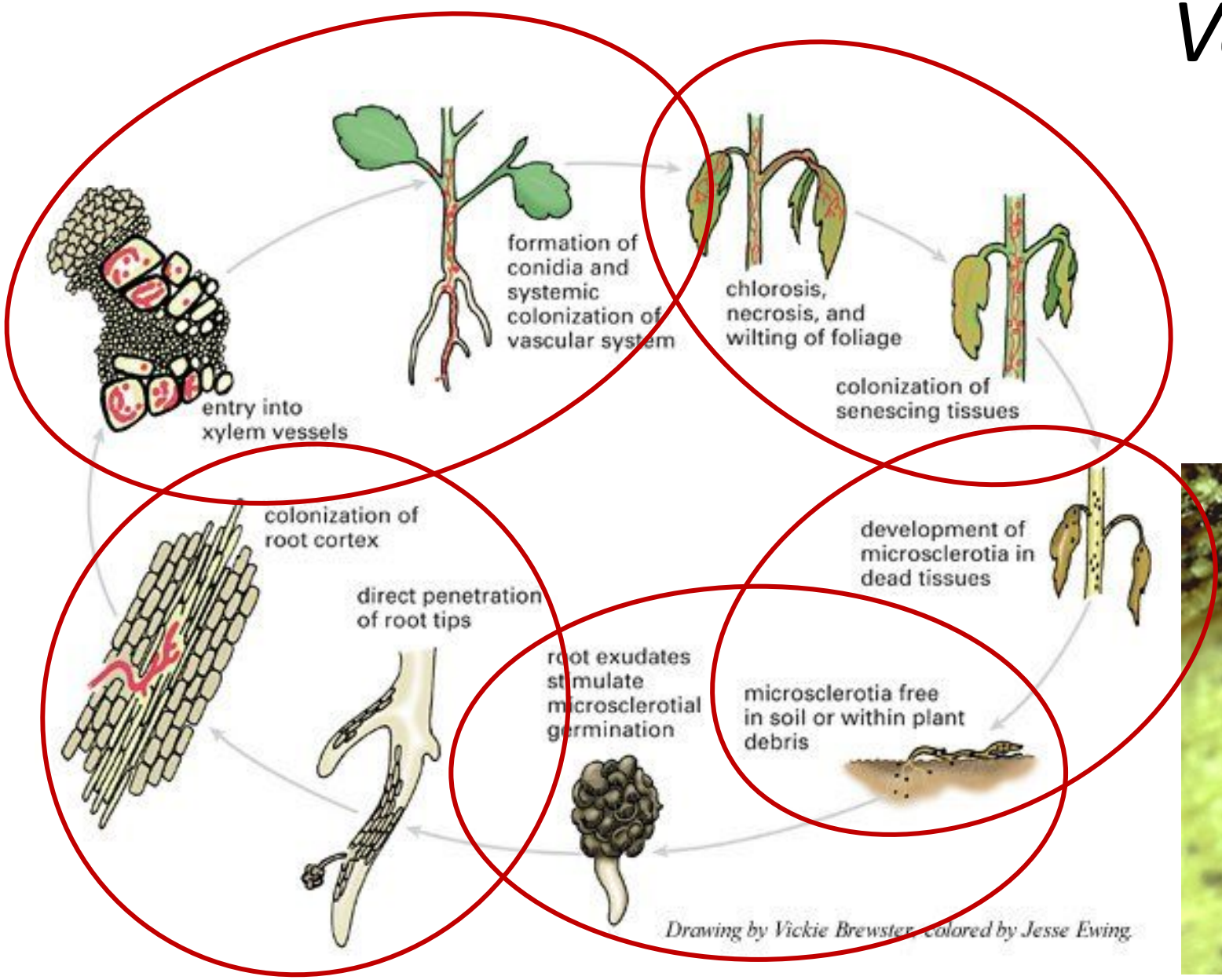
HOW THE TORNADO LEFT CORPUS CHRISTI, TEX.

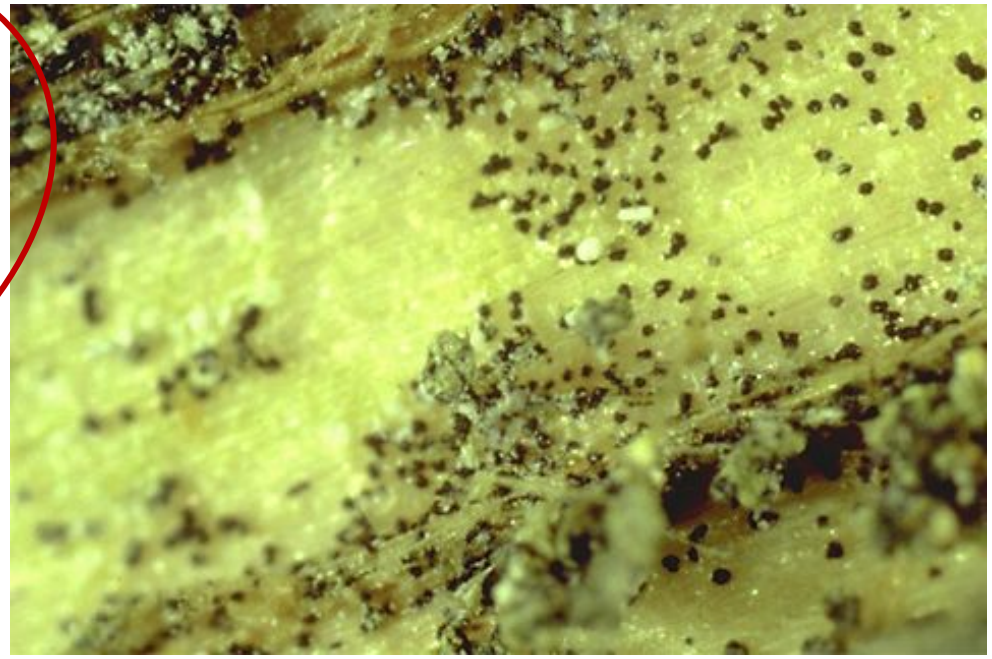
St. Joseph County, Indiana, Largest Producer of Mint.

INTERESTING FACT

In about 1835 peppermint plants were introduced to St Joseph County on the Indiana-Michigan border

Verticillium dahliae





Verticillium Wilt

Sources of infection

- Infected planting stock
- Microsclerotia in infected soil
- Contaminated soil & debris
  - Truck & tractor tires
  - Equipment
  - Etc.

Why is it so difficult to manage?

- *V. dahliae* microsclerotia can survive in soil for up to 10 years or more!
- The pathogen has a wide host range (400 crop species are susceptible)
  - Dicots are mostly symptomatic
  - Many alternative crops are asymptomatic hosts
  - Many weed species are also asymptomatic hosts

Potential factors that can affect incidence and severity

- Cultivar (host) resistance
- Strain (VCG) of *V. dahliae*
- Time field is in production
- Pathogenic nematodes (*Pratylenchus penetrans*)
- Crop history
- Decline in soil quality

Practices that can help reduce risks

- Start with a clean field
- Plant verticillium-free root stock
- Manage weeds
- Manage nematodes, especially *P. penetrans* (root lesion nematode)
- Avoid using tillage for weed control
- Crop rotations for 5-years or longer
- Rotate with non-host crops
- Avoid susceptible agricultural crops in rotation
- Clean equipment, vehicles and shoes between fields
- Avoid using contaminated irrigation water
- Chemical fumigation
- Find new (virgin) land for production
- **Improve soil health**

Soil Microbiomes

- *Vast majority are not pathogens!*
- Perform essential agroecosystem services
  - nutrient cycling
  - mitigate biotic and abiotic plant stress
  - pollutant detoxification
- Are highly diverse, with many different types of microbes in soil
- Most are chemoheterotrophs - use organic (carbon) compounds as an energy source
- Aerobic vs. anaerobic metabolism
  - some are facultative (can do both)

https://fertilgold.com/2018/04/04/microorganisms-the-living-engine-of-soil-part-1/

Biofumigation

- Originally coined to describe the process of growing and incorporating certain *Brassica* crops into soil (Kirkegaard et al., 1993)
- Contains glucosinolates (GSL) that break down into isothiocyan chemicals
- ITCs are known to kill or suppress some soilbo odes and weed seeds
- Additional mechanisms, includi mic soil microbial communities now recognized (Hoagl
- Varying result re biofumigants
- Ma ssion of parasitic nematodes and Verticillium, Rhizoctonia, usarium
- nd Scott found that mustard (Ida Gold, Pacific Gold, Kodiak, and Caliente 199) significantly reduced *V. dahliae* CFUs and improved mint hay yields in microplots

Variability in effectiveness in field trials

Potential factors for variation in effectiveness of biofumigation

NOT implying that biofumigant cover crops do not have value!

- Not likely to fully eradicate pathogens in high organic matter soils
- Provide soil health benefits and CAN contribute to an integrated pest management plan

Anaerobic Soil Disinfestation (ASD)

- Soil revitalization strategy developed as an alternative to methyl bromide fumigation independently in Japan and The Netherlands (1990s and 2000s)
- Controls range of soil-borne pathogens (including *V. dahliae*) and nematodes across a range of crops
- Beneficial soil microbes break down the added carbon source, depleting oxygen in the soil and producing toxic byproducts that kill soil borne pathogens as well as weed seeds
- Facilitate recolonization of beneficial soil microbes that enhance plant growth

ASD being used to control Verticillium wilt in California strawberry field

ASD: Researched as an alternative treatment in U.S.

- Effective in mediating Verticillium wilt in U.S. strawberry production systems, which is also caused by *V. dahliae* (Shennan et al., 2014 & 2017)
- The Effects of Anaerobic Soil Disinfestation on Weed and Nematode Control, Fruit Yield, and Quality of Florida Fresh-market Tomato (Di Gioia et al., 2016)
- Evaluated as a tool for managing root-knot nematode in lettuce and clubroot disease in mustard greens (Testen and Miller, 2019)
- Optimizing anaerobic soil disinfestation to manage emerging soil borne diseases in tomato protected culture systems in the North Central Region (SARE project; Sally Miller, The Ohio State University)

ASD: Three Steps

STEP 1: Incorporate organic material (labile carbon source)

- provides carbon source for soil microbes

STEP 2: Irrigate soil to saturation

- soil pores are filled with water, reducing available oxygen

STEP 3: Cover with oxygen impermeable tarp for weeks

- create anaerobic (no oxygen) conditions and stimulate anaerobic decomposition of incorporated organic material
- more effective with warmer soil temperatures and longer tarping periods
- tarping period of 3 weeks at temperature consistently greater than 85°F should be effective for most pathogens

Source: UC ANR

SARE project: Our research goals

NIFA|USDA award number: 2018-38640-28416; NCR-SARE subaward number: 7179-315

- Can ASD eliminate *V. dahliae* in Indiana mint fields and stop the vicious cycle of Verticillium wilt?
- Are there locally available substrates that are effective in ASD that will make this approach feasible in Indiana mint fields?
- What are the mechanisms (chemical and biological) responsible for effective *V. dahliae* suppression in muck and mineral soils?

SARE project: What are we proposing?

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- Greenhouse potted studies evaluating various locally available substrates
  - Ethenol
  - Composted poultry manure
  - Mustard cover crop (Caliente 199)
  - Distillers dried grains with solubles (DDGS); co-product of ethanol production
  - Control: metam sodium (active ingredient of Vapam)
- On-farm trials in fields with history of Verticillium wilt
  - 2 locations with muck soils
  - 2 locations with mineral soils
- Quantify *V. dahliae* populations in soil and mint tissues across mint farms, fields, practices, etc.

Challenges of ASD strategy

- Vast mint acreage
- Effective treatment depth
- ASD will have to be integrated in a broader IPM and soil revitalization program
- Improved soil health is critical to the successful eradication of Verticillium wilt

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INDIANA MINT COUNCIL

NORTH CENTRAL SARE Sustainable Agriculture Research & Education

USDA

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Thank you

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