Biological Management of Apple Replant Disease

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Apple Replant Disease

Apple replant disease (ARD) is a condition characterized by poor growth and delayed cropping of apple trees planted on previous orchard sites.

ARD may be caused by a complex of pathogenic fungi, bacteria, and nematodes (Mazzola and Manici, 2011).

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- ARD may be caused by a complex of pathogenic fungi, bacteria, and nematodes (Mazzola and Manici, 2011).
- ARD is a serious problem in about 60% of old orchard sites (Mai et al., 1994)
- ARD more common in coarse or sandy soils

Primary causal agents of ARD in Northeastern U.S.

- *Pathogens*
  - *Nematodes, Oomycetes, Fungi, Bacxteria*
  - *Pratyenchus, Xiphinema, Meloidogyne*
  - *Phytophthora, Fusarium, Cylindrocarpon*
  - *Pseudomonas, Actrinobacteria*
- *Soil chemistry*
- *Soil drainage*
- *Soil nutrient depletion*

(Merwin 2014)

http://www.apsnet.org/edcenter/intropp/lessons/Nematodes/Pages/LesionNematode.aspx

Visual symptoms of ARD

ARD Controls

- Targeted at reducing populations of parasitic organisms in orchard soil
- Soil fumigation once common
  - ~~Methyl bromide~~
  - Metam sodium ('Vapam')
  - Chloropiclin ('Vorlex', 'Telone')
- Post-plant nematicides
  - Nemacur, Vydate
- De-registrations and restrictions have reduced/eliminated most uses
- MANY environmental and health concerns with use

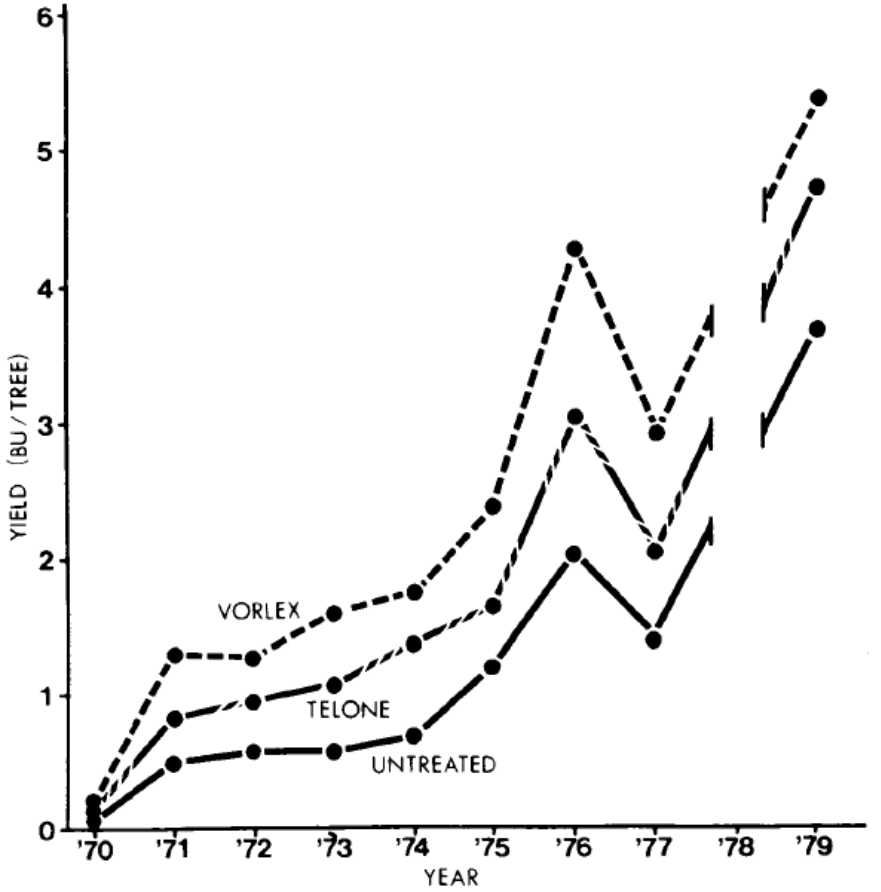


Fig. 7. Yield responses of McIntosh apple trees on M.7 rootstock to preplant soil fumigation.

Abawi, G. S. (1981). "Controlling replant diseases of pome and stone fruits in northeastern United States by preplant fumigation." Plant Disease 65(11): 359.

Alternative pre-plant ARD control strategies

- Complete orchard removal (incl. roots) followed by:
- Fallow/alternate crop
  - 3+ years
  - Corn? Must re-amend soil prior to replanting and be wary of herbicide carryover
- Row shifting
- Pre-plant cover crops
- Pre-plant fertilizer amendments

http://www.slideshare.net/ipoucd/ppt-fruitapplesoilhealthmerwincornell2014eng

Pre-plant cover crops

- Erosion Control
- Added Organic Matter
- Nitrogen Fixation
- Recycles Unused Nutrients
- Beneficial Organisms
- Weed Control
- Alleviate Soil Compaction
- Pollinator Support
- Feed Source

Cover Cropping: Buckwheat

Buckwheat

- Plant in spring immediately after pulling orchard
- Weed suppression
- Prevents soil erosion
- Nutrient scavenger
- Pollinator support

Cover Cropping: Legumes

- Provide nitrogen fixation
- Pollinator support
- Kill prior to replanting (?)
  - Hairy Vetch
  - Crimson Clover
  - Red Clover
  - Field Peas
  - Birdsfoot trefoil

http://msue.anr.msu.edu/news/effective_termination_of_red_clover

Cover Cropping: **Sorghum x Sudan** grasses

- Plant year after removal
- Prevent soil erosion and add organic matter
- Some reports of nematicidal properties (Merwin 1995)

Cover Cropping: Brassicas

- Allopathic, may help with weed control.
- Alleviate Soil Compaction
- Substantial evidence of nematicidal properties
  - *Brassica napa*, *B. juncea* (canola, oilseed rape)

Sample Cover Crop Regime

Fall Y1- Clear vegetation if needed, remove stumps and rocks

- Winter Rye to ↑ soil OM, control erosion

Spring Y2

- Buckwheat, plow under follow with
- Sudangrass ↑ soil OM, mow & leave

Spring Y3

- *Brassicas*, plow under follow with
- Winter Rye

Soil test
Lime
Adjust preplant mineral nutrients (P, Mg, Ca, Zn, B)

Northeast SARE Project:
Biological Management of Apple Replant Disease

Evaluate the effects of two commercial biopesticides against a water-treated control on tree growth, crop yield, and nematode populations in two ARD-affected Vermont orchards planted in 2011.

(a.i: *S. lydicus* WYEC 108)

(a.i.: *P. lilacinus*)

NORTHEAST SARE
Sustainable Agriculture Research & Education

MONSANTO BioAg™

Experimental Orchard Locations

SOUTH BURLINGTON, VT

- University of Vermont Horticulture Research & Education Center (HREC)
- Windsor Adams loamy sand soil
- A previous orchard was maintained on the planting site from 1990 through 2009.
- ‘Royal Empire’/B.9 planted 2011
- Tall spindle training system

  1210 trees/acre

Experimental Orchard Locations

SOUTH HERO, VT

- Commercial orchard in South Hero, VT (SHVT)
- Amenia and Kendall silt loam soils.
- The previous orchard was maintained on the site from 1900 to 2009.
- ‘McIntosh’ / EMLA-26 rootstock
- Central leader training
- 345 trees per ace.

Methods

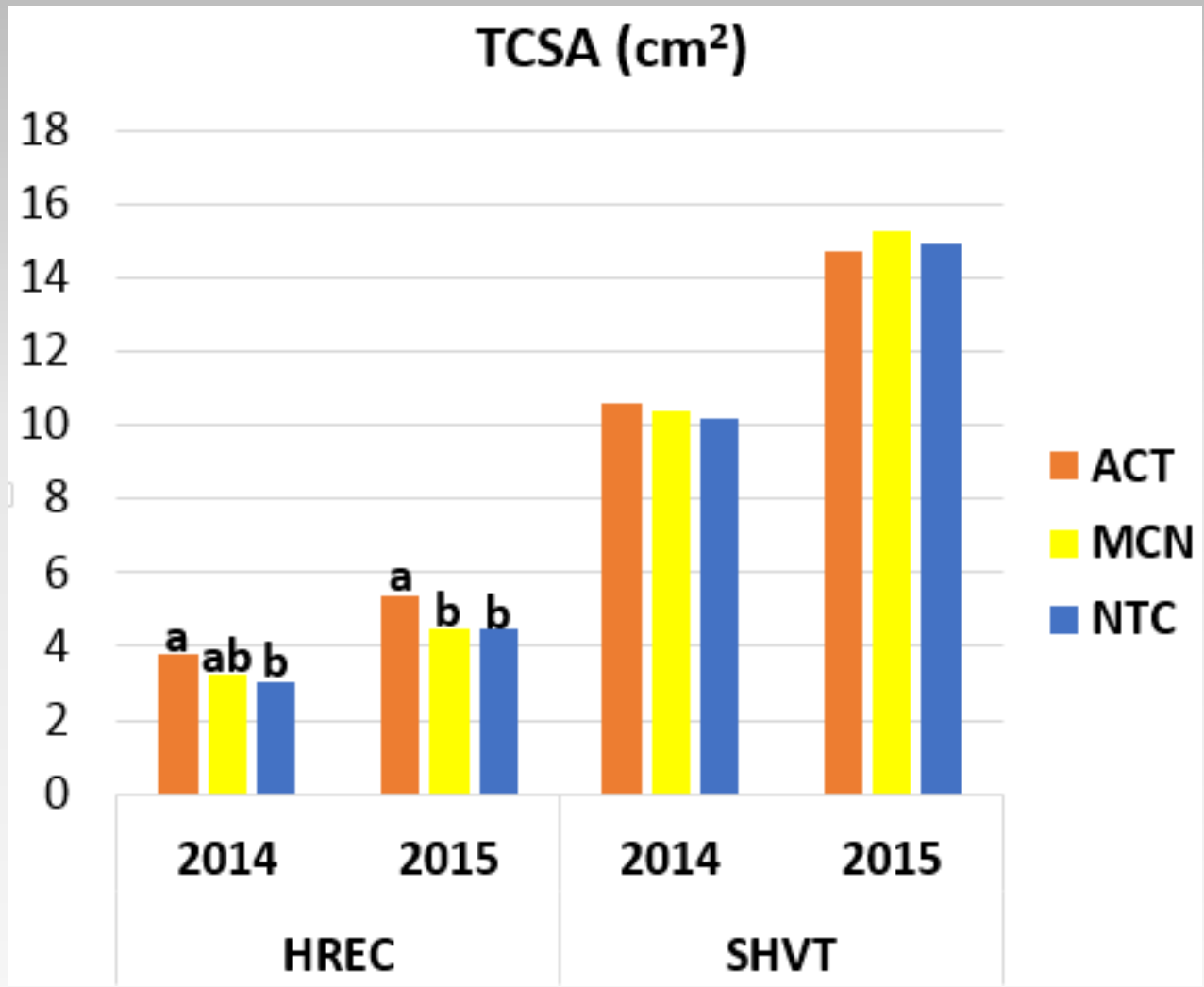
Treatments

- Non-treated control, water (**NTC**)
- Actinovate AG (a.i:*S. lydicus* WYEC 108) at 0.84 kg*ha^{-1} (**ACT**)
- MeloCon (a.i.: *P. lilacinus*) at 4.4 kg*ha^{-1} (**MCN**)

Treatment Application Dates			
HREC		SHVT	
2014	2015	2014	2015
May 14	May 14	May 12	May 14
June 4	June 3	June 4	June 3
July 1	July 8	July 1	July 8
July 30	August 10	July 30	August 10

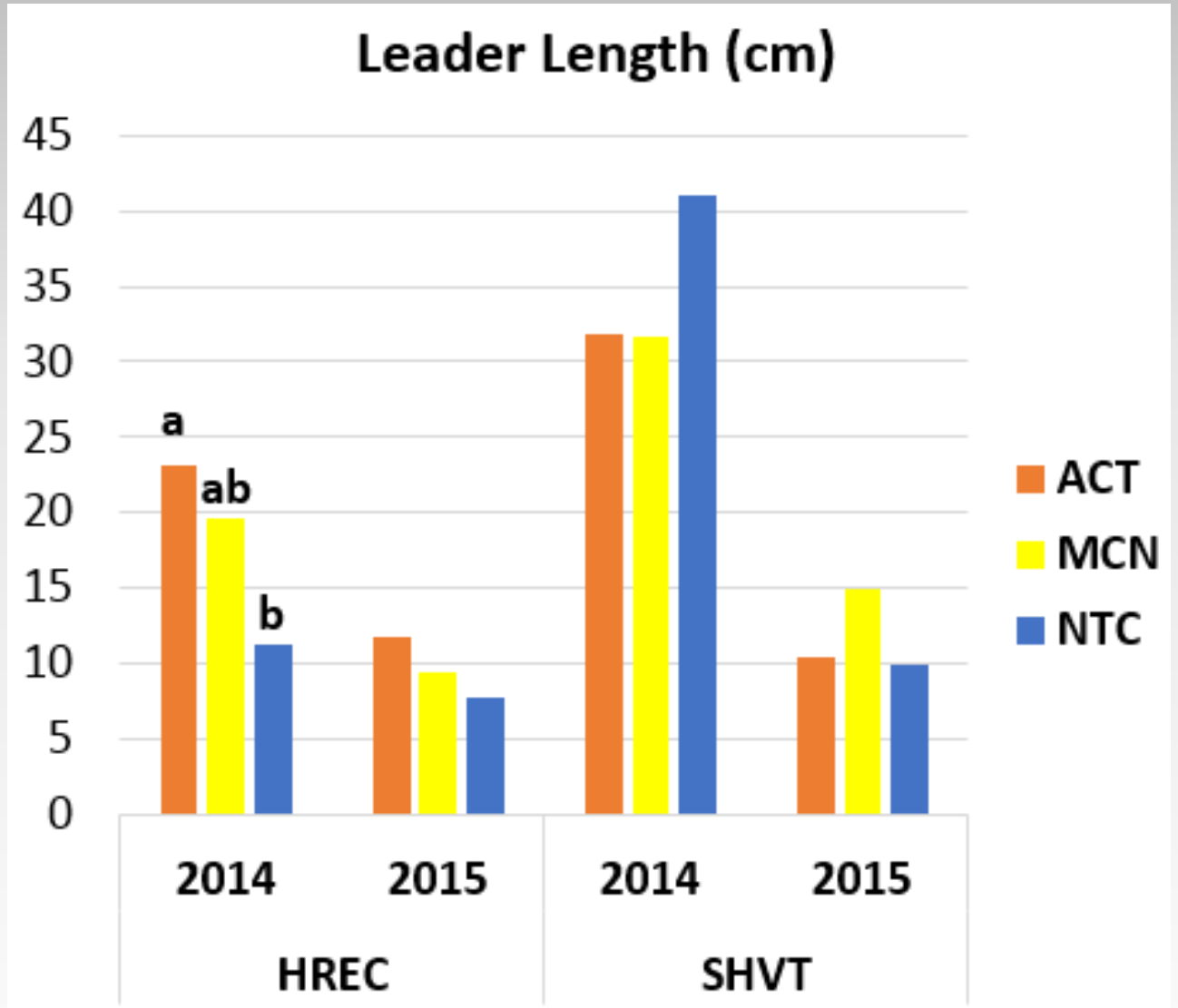
Tree Growth: TCSA

- Actinovate > TCSA than control (2014) or control & Melocon (2015) at HREC only



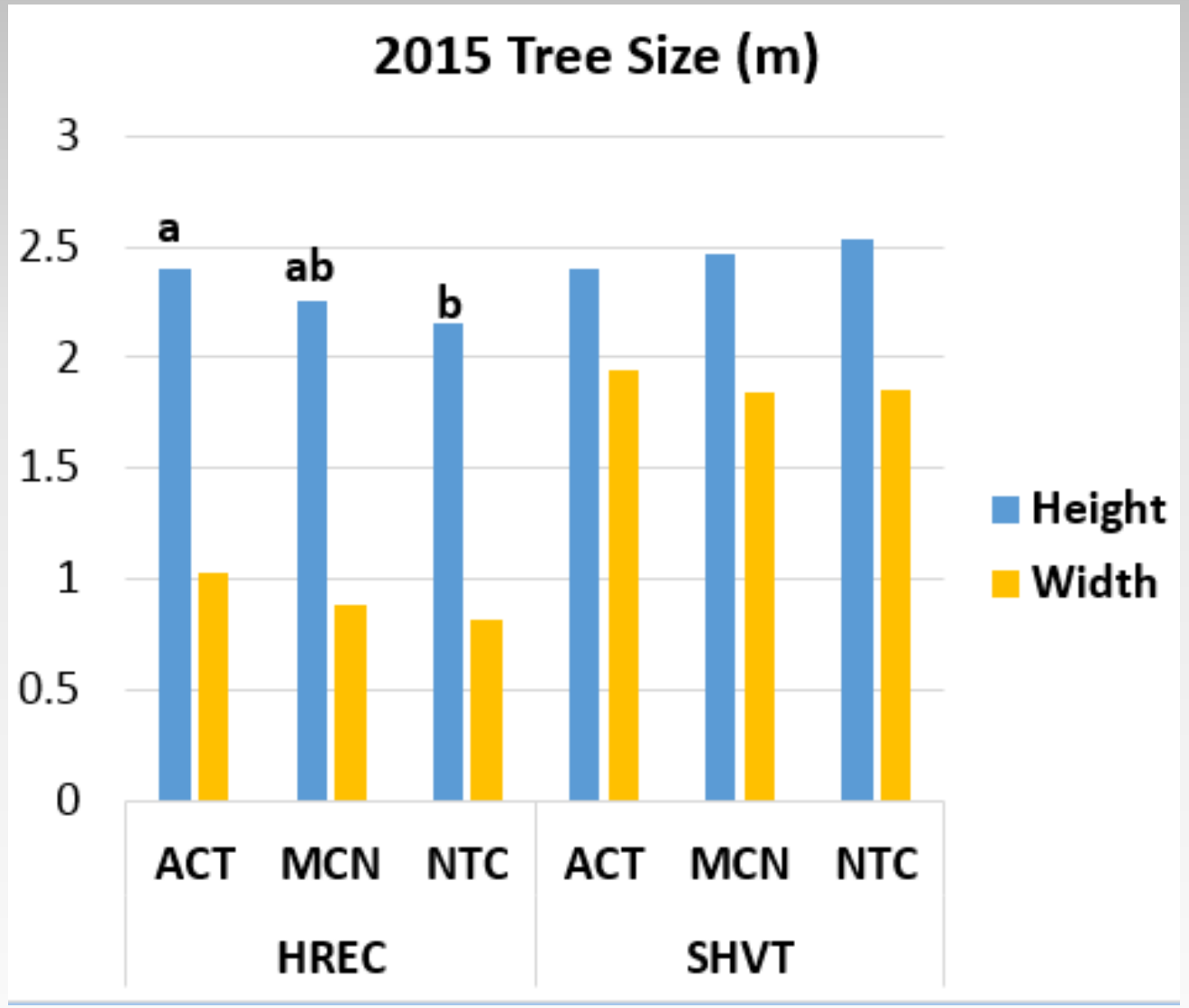
Tree Growth: Central leader growth

- Actinovate > leader growth than control at HREC only (2014)

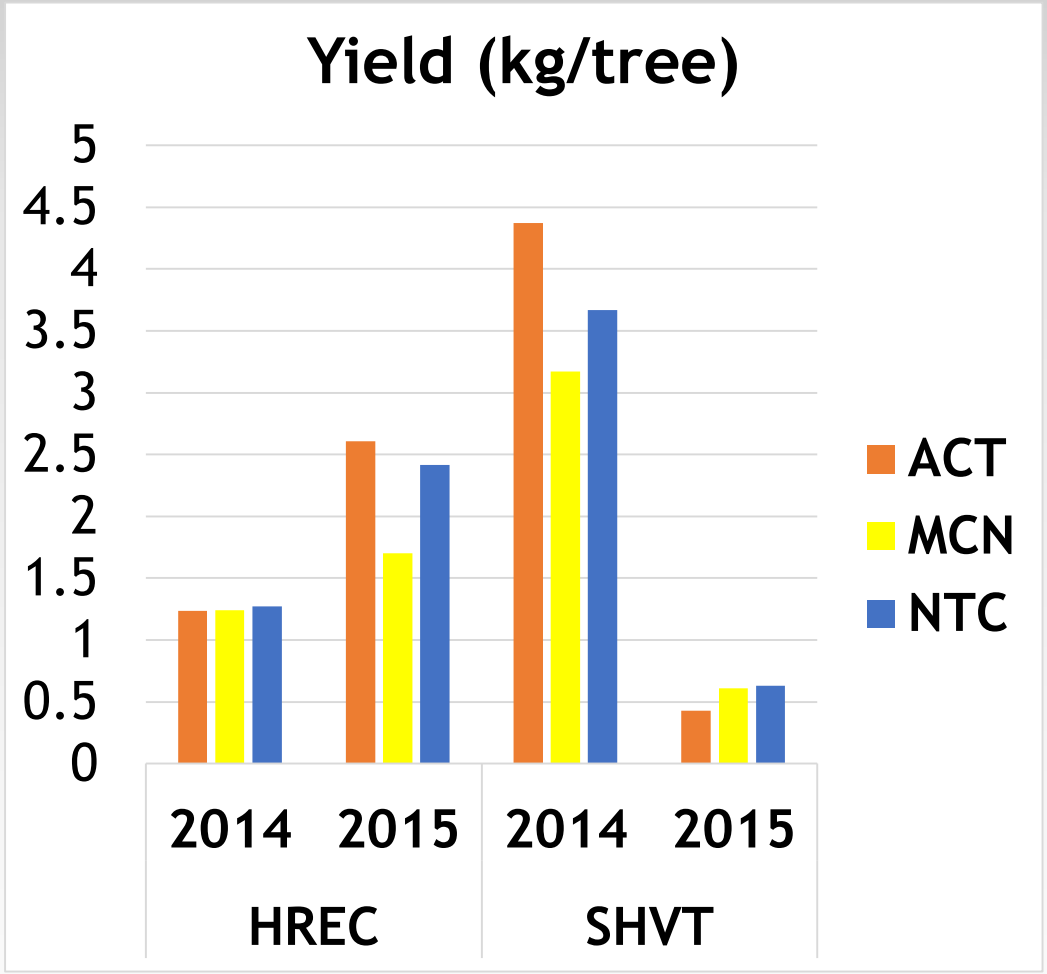


Tree Growth: Canopy Height & Width

- Actinovate > tree height than control at HREC only

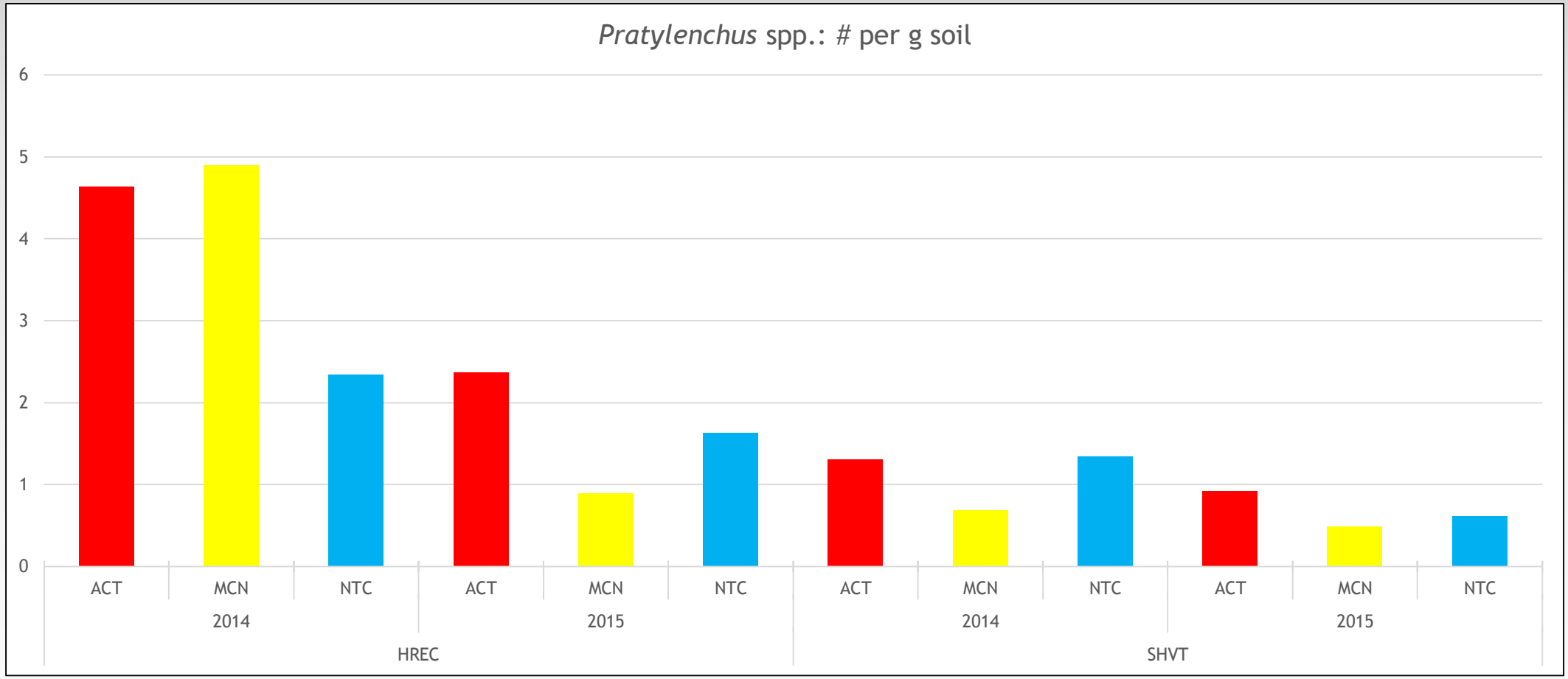


Crop Yield

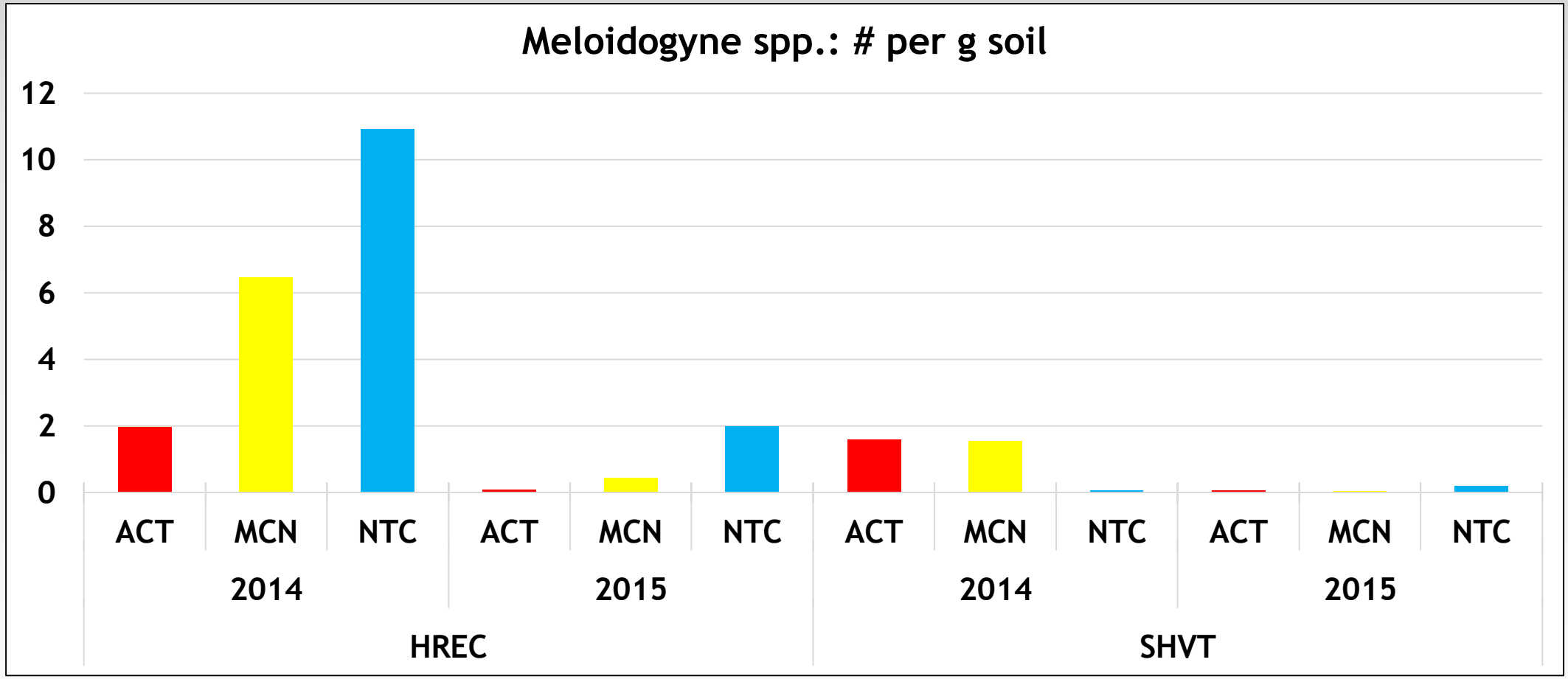


- No differences by treatment
- Nutrition:
  - No differences by treatment for majority of minerals
    - Inconsistent & not biologically important differences in Al & Fe assimilation
  - HREC: Generally good nutritional status
    - Low K, Cu
  - SHVT: Low nutrient assimilation for most minerals
    - Effects of treatments limited by low nutrient availability?
    - ARD caused more by nutrient depleted soil than biotic factors?

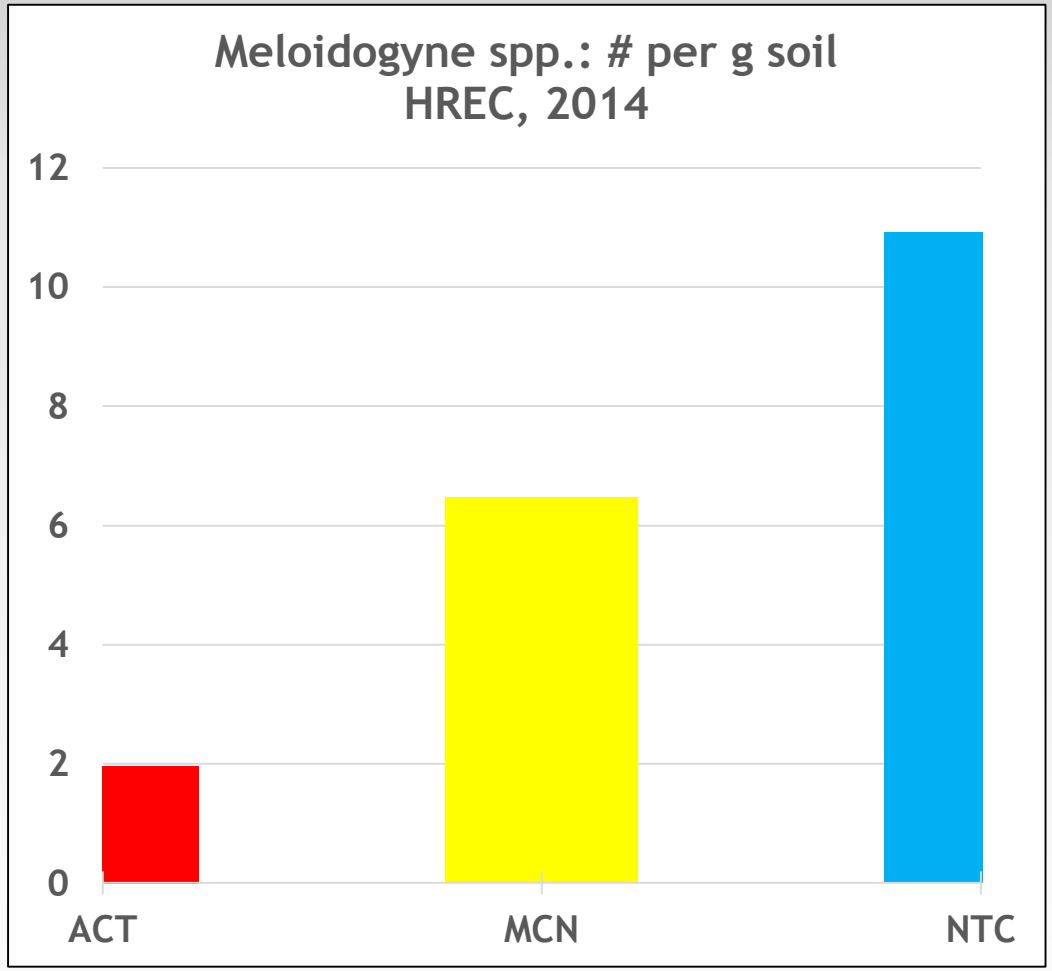
Nematodes

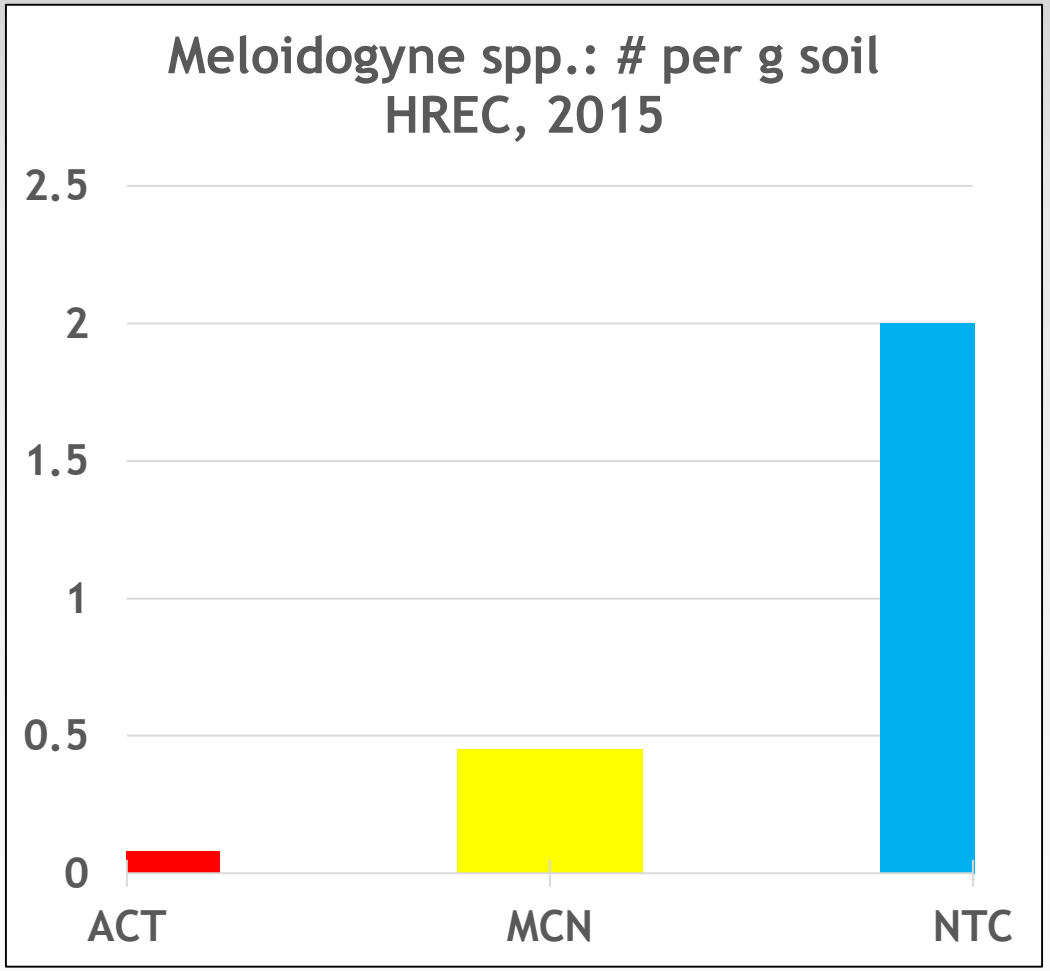

Pratylenchus spp.: # per g soil
6
5
4
3
2
1
0
ACT
MCN
NTC
ACT
MCN
NTC
ACT
MCN
NTC
ACT
MCN
NTC
2014
2015
2014
2015
HREC
SHVT

Nematodes


Meloidogyne spp.: # per g soil
12
10
8
6
4
2
0
ACT
MCN
NTC
ACT
MCN
NTC
ACT
MCN
NTC
ACT
MCN
NTC
2014
2015
2014
2015
HREC
SHVT

Meloidogyne spp: HREC





Economic Return:

- Products are not inexpensive
- Total yield (bu/ac) * $20/bu
  - Less treatment costs
  - ~$800/ac for each trt (material only)

Site	TRT	Cum Gross$	% Net of NTC
HREC	NTC	$ 4,679.42	100%
HREC	ACT	$ 3,288.85	70%
HREC	MCN	$ 2,140.81	65%
SHVT	NTC	$ 1,554.80	100%
SHVT	ACT	$ 149.84	10%
SHVT	MCN	$ (227.64)	-152%

2016 UVM Apple Program

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