Soil health impacts on plant disease development & IPM

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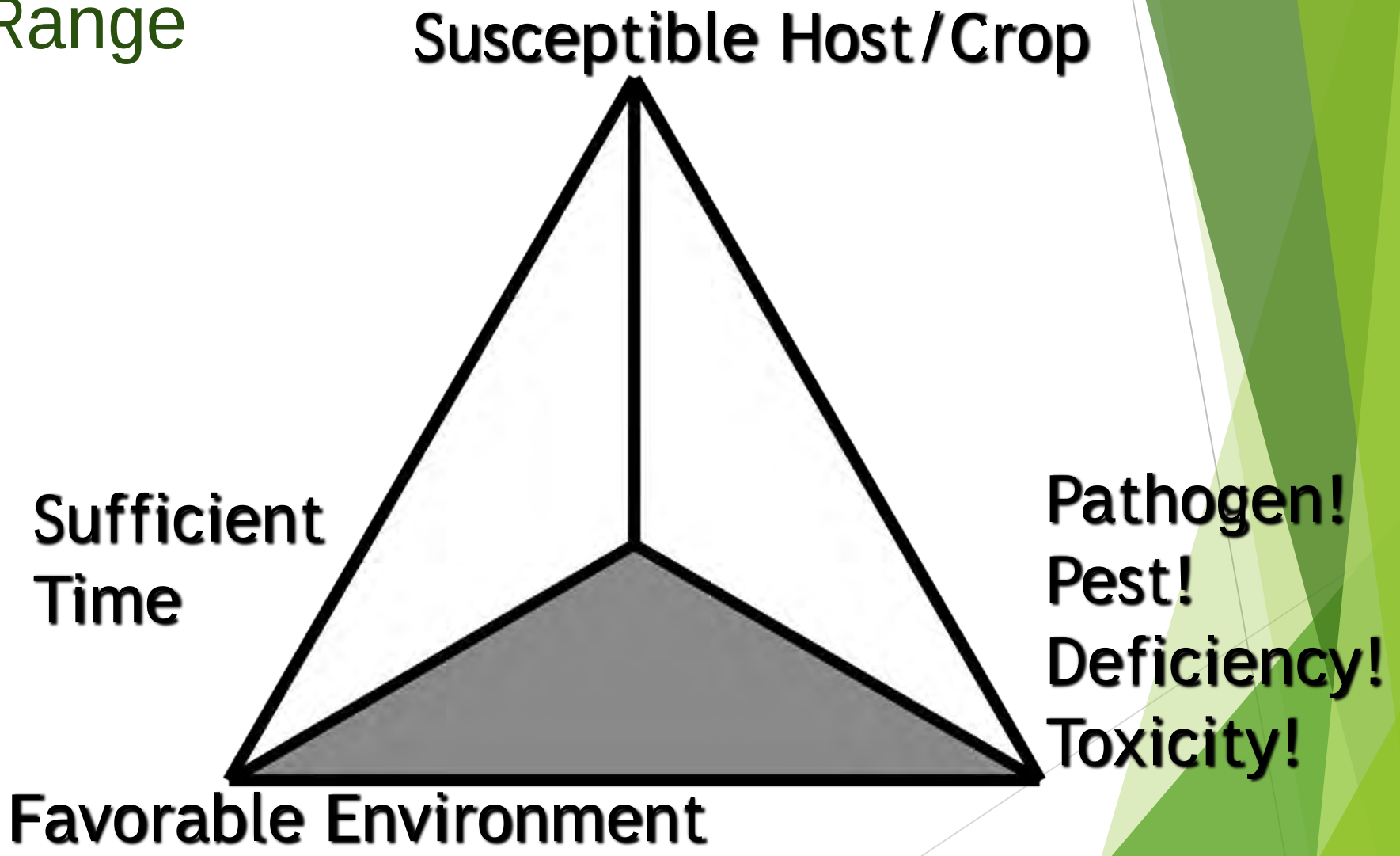
Overview

- Objectives
- Disease pyramid
- Definitions
- Soil health & insect management
- Soil health & plant disease development
- Soil health & nematodes
- References

Objectives

- "The primary reason to monitor is to improve your ability to make good pest management decisions."
  - IPM in Practice, 2001 ed.
- Provide a framework for considering soil ecology as a factor in insect pest and plant disease development
- Provide a starting point to incorporate monitoring 'soil health' using tests already available

Disease pyramid vs. IPM vs. Sufficiency Range



Soil health

- The capacity of a living soil to function, within natural or managed ecosystem boundaries, to sustain plant and animal productivity, maintain or enhance water and air quality, and promote plant and animal health.

-Doran, 2002

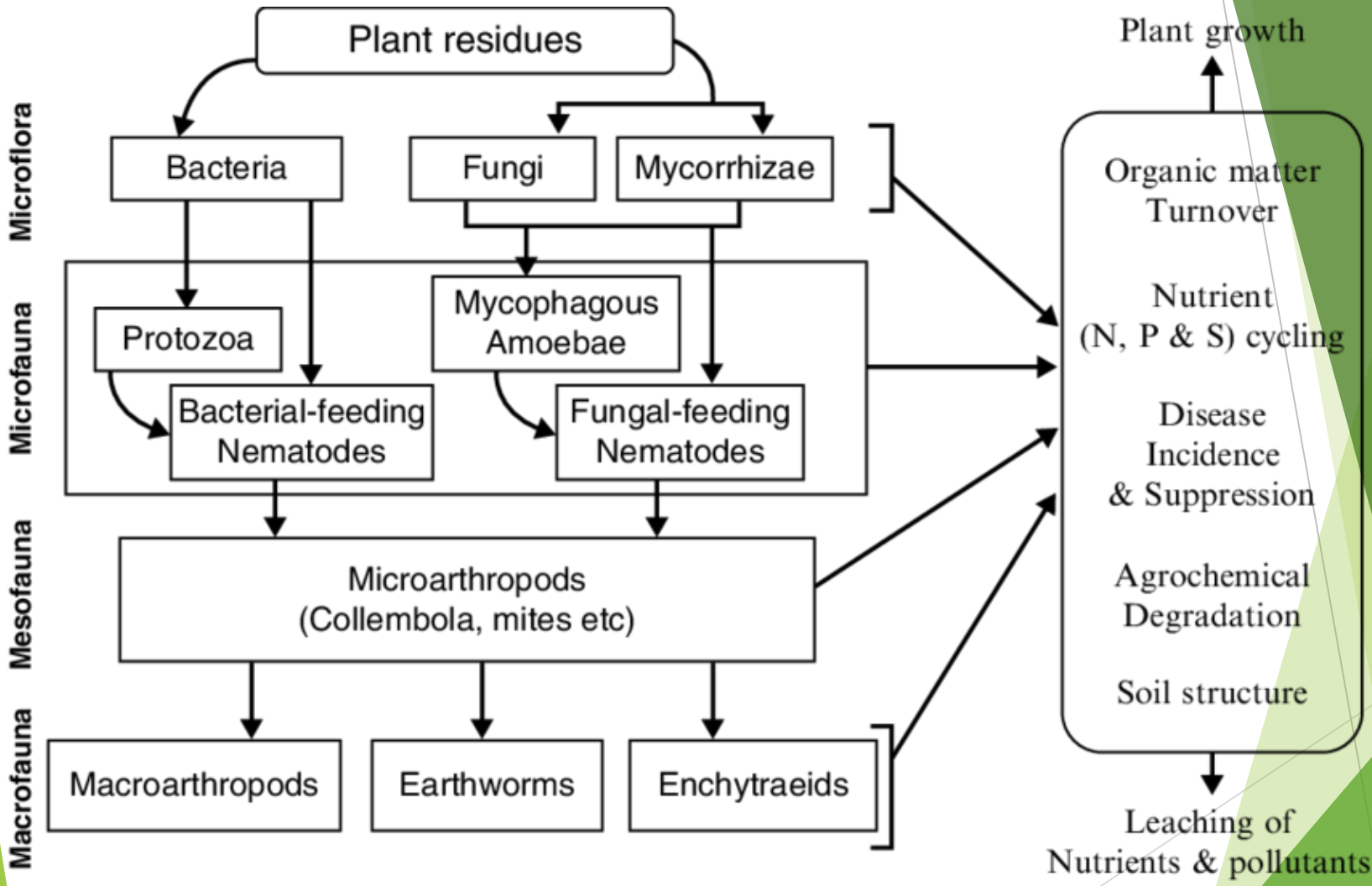
- Decrease/prevent soil erosion

-Sherwood & Uphoff, 2000

- Store water, cycle nutrients, remediate toxicants, suppress noxious/ pathogenic organisms

-Doran & Zeiss, 2000

Microbial food web



A detritus food web showing linkages between the different groups of soil biota, and indicating their role in soil biological functions of cropping systems (Gupta & Neate, 1999)

How soil health impacts insect pests

- Fertilization influences plant resistance by changing antibiosis, tolerance and preference (Altierri & Nicholls, 2003)
  - Changing phenology, phenotype & growth rate (plant)
    - Boll weevil/cotton
    - Corn earworm/maize
    - Black mustard/cabbage white
  - Nitrogen source (organic vs. conventional)
  - Changing oviposition, survival, reproduction & herbivory (pest)

How soil health impacts insect pests

Nutrients	Mite species	Crop	Numerical response of insect[a]
N	*Panonychus ulmi*	Apple	+
N	*Tetranychus telarius*	Apple	+
N	*T. telarius*	Beans	+
N, P, K	*Two-spotted spider mite*	Beans/peaches	+
N	*T. telarius*	Tomato	−
N, P	*T. telarius*	Apples	+/−
N, K	*Bryobia praetiosa*	Beans	+/−
N, Ca	*Heliothrips haemorrhoidalis*	Beans	+/−

[a] Symbols: (+) increase in density with increasing rates of fertilizer element; (−) decrease in density with increasing rates of fertilizer element. Slash separates the effects of fertilizer elements listed in nutrients column.

Nutrients	Insect species	Crop	Numerical response of insect[a]
N, P, K	*M. persicae*	Tobacco	+/∧/+
N	*Schizaphis graminum* (greenbug)	Oats/rye	−
N, lime	*S. graminum*	Oats	−
N	*R. maidis*	Sorghum	+
N, K, Ca	*M. persicae*	Brussels sprouts	+/∨/−
N, P	*Therioaphis maculate* (spotted alfalfa aphid)	Alfalfa	−/+

[a] Symbols: (+) increase in density with increasing rates of fertilizer element, (∧) highest density occurred at intermediate rates of fertilizer element; (−) decrease in density with increasing rates of fertilizer element; (∨) lowest density occurred at intermediate rates of fertilizer element. Slash separates the effects of fertilizer elements listed in nutrients column.

How soil health impacts insect choice

- Western corn rootworm attracted to maize through iron uptake (Hu et al, 2018)

How soil health impacts plant disease development

- General vs. specific (disease) suppression (van Bruggen & Semenov, 2000)
  - General: broad, functional antagonism
  - Specific: disease organism(s) endangered by population of key antagonist (e.g., takeall of wheat and flourescent pseudomonads)

Soil health impacts plant disease epidemiology

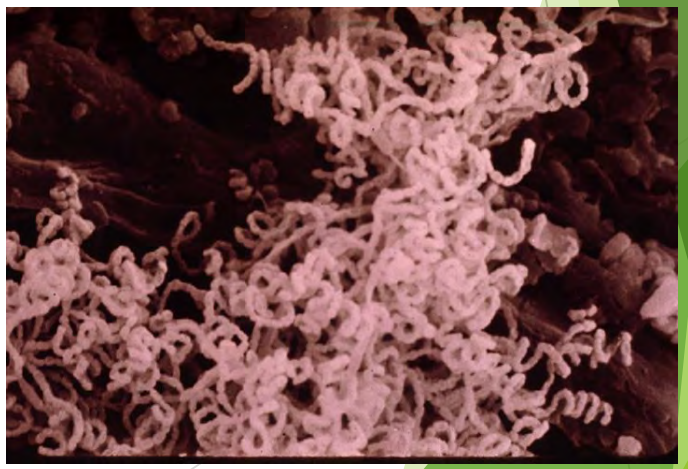
"Plant [...] disease outbreaks can be considered as indicators of instability and poor ecosystem health. Therefore, there is likely also a link between soil health, the ability of the biological community to suppress plant pathogens, the population density of plant pathogens in soil, and ultimately disease incidence and severity. For this reason, disease suppression could function as an indicator for a stable and healthy soil ecosystem." (van Bruggen & Semenov, 2000)

Suppressive soils

- Beneficial fungi
  - *Trichoderma* spp.
  - *Fusarium* spp. (incl. *F. oxysporum* strains)
  - *Gliocladium* spp.
  - *Penicillium* spp.
  - *Acremonium* spp.

- Beneficial bacteria
  - Pseudomonas spp.
  - Bacillus spp.
  - Burkholderia spp.

- actinomycetes



USDA-NRCS

How soil health impacts nematodes

- Direct resource competition or predation
- Known practices that decrease/suppress nematode populations
  - Rotate to non-host
  - Cover crop/green manure
  - Incorporate composts
  - Tillage that reduces compaction, increases drainage/raises temperature

-Abawi & Widmer, 2000

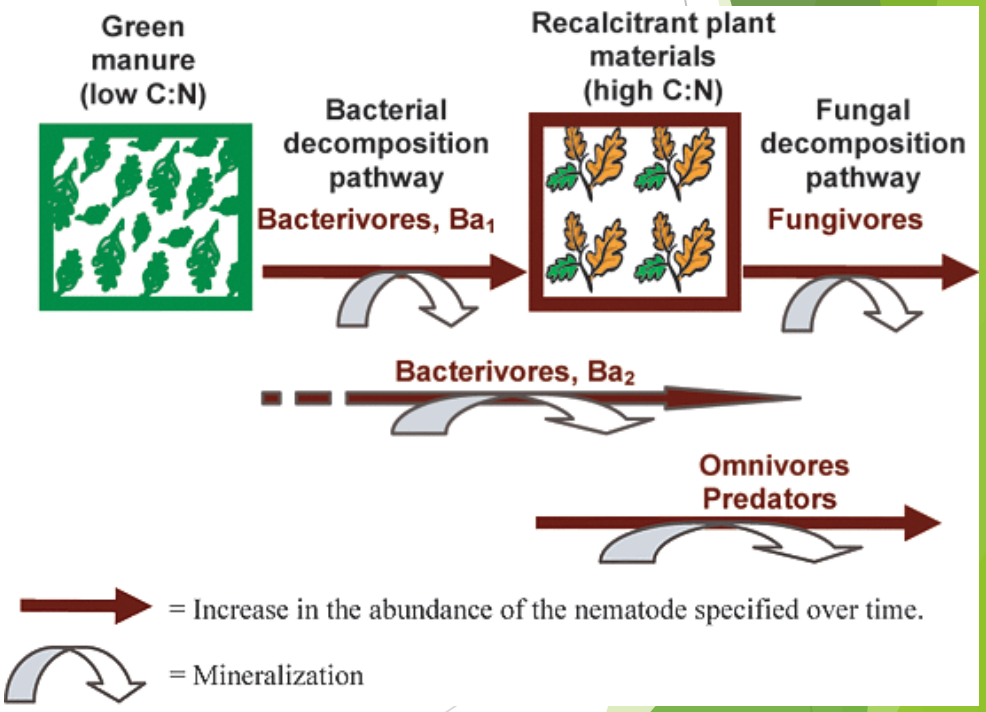
How soil health impacts nematodes

- Nematode successions
  - Stressed/sensitive vs. stable species (Wang & McSorley, 2018)
- Extinction of predacious nematodes
- Nematode maturity index
  - Developed for polluted soil
  - Inverse relationship to plant-parasite index

-van Bruggen & Semenov, 2000

Practical measures of soil health

- Soil pH
- Fungal & bacterial plant pathogen testing
- Forms of soil N
- Soil moisture monitoring
  - Van Bruggen & Semenov, 2000



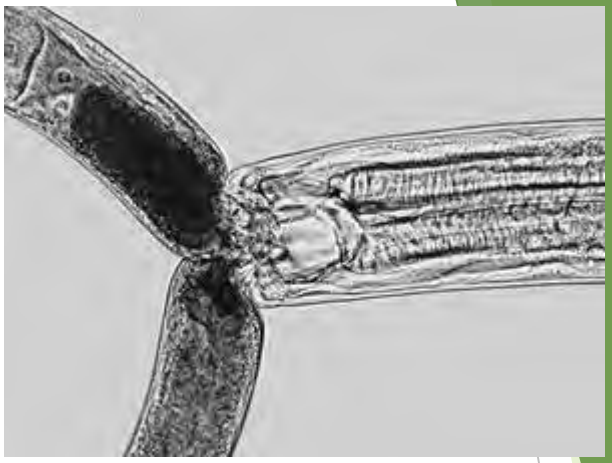
Wang & McSorley, 2018

Practical measures of soil health

- Depth of topsoil
- Leachable nutrients salts
- EC
  - Doran & Zeiss, 2000
- Maintain soil cover
  - Larkin, 2015
- Organic matter
- Record number tillage passes
  - Sherwood & Uphoff, 2000

Beneficial nematodes

Nuetzlinge.de



SAFS Newsletter, 2008

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Thank you!
Questions?

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