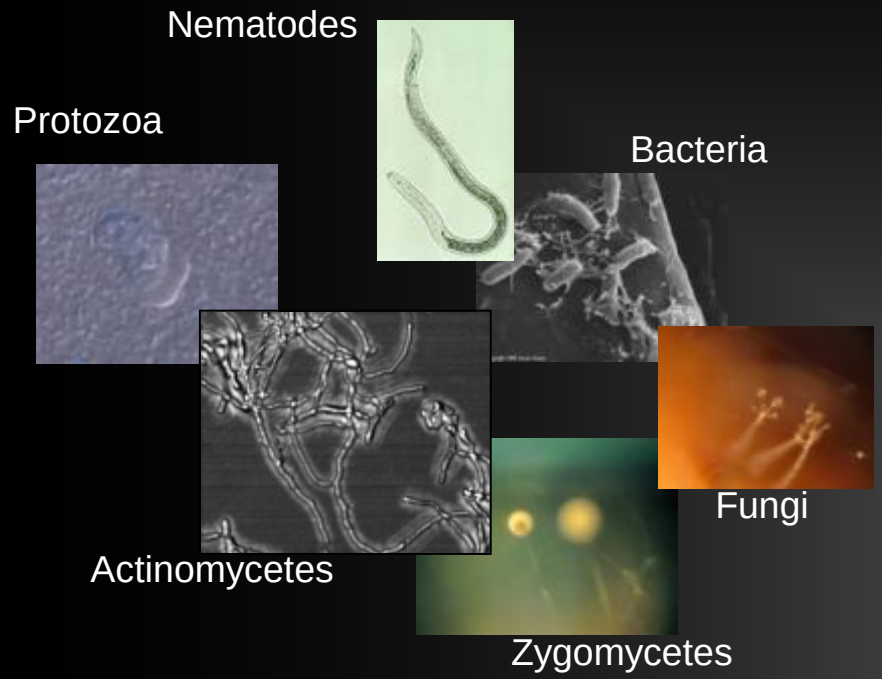
Managing Soil Biology for Multiple Orchard Benefits



Mark Mazzola

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Effective Management of Soil Biology Requires Identification of Specific Goals

Weed control

Fertility Management

Disease suppression

Direct Growth Promotion

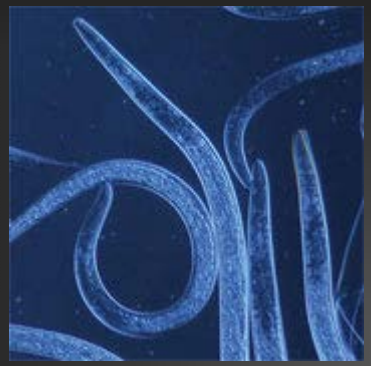
System resilience

Efforts to Manage Soil Biology have Typically Employed an Inundative Release Approach

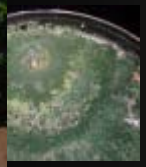
Root boring weevil-weed control

MN Dept. Ag.

“beneficial” nematodes



Mycorrhizal fungi



T. Volk

Trichoderma-biological disease control

Azospirillum bio-fertilizer

Alternative Strategy: Manage the native soil biology

Advantages:

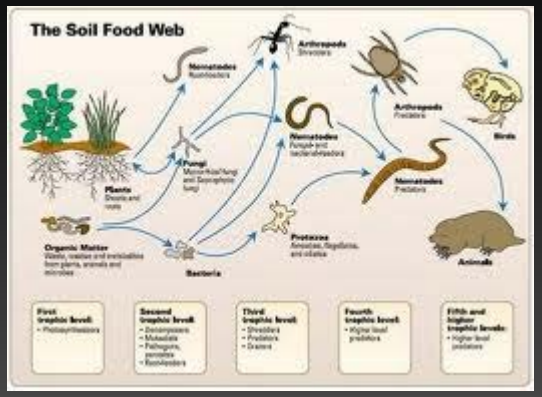
- All soils possess beneficial microbial elements
- The resident biology is adapted to the site
- Expression of functional mechanisms optimal in native soils

Management-induced proliferation of *Trichoderma* spp.

Alternative Strategy: Manage the native soil biology

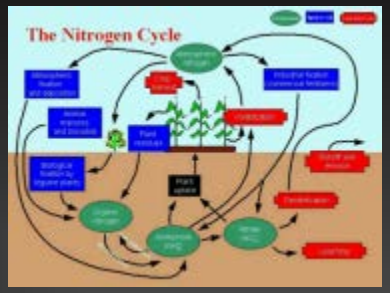
Obstacles:

- Knowledge-based strategy
- Functional population required
- Functional mechanism
- Non-target effects



Management goals:

1. Management of native soil biology for enhanced orchard system efficiency



2. Management of native soil biology for disease/weed suppression

Management of native orchard soil biology:

Manipulation strategies

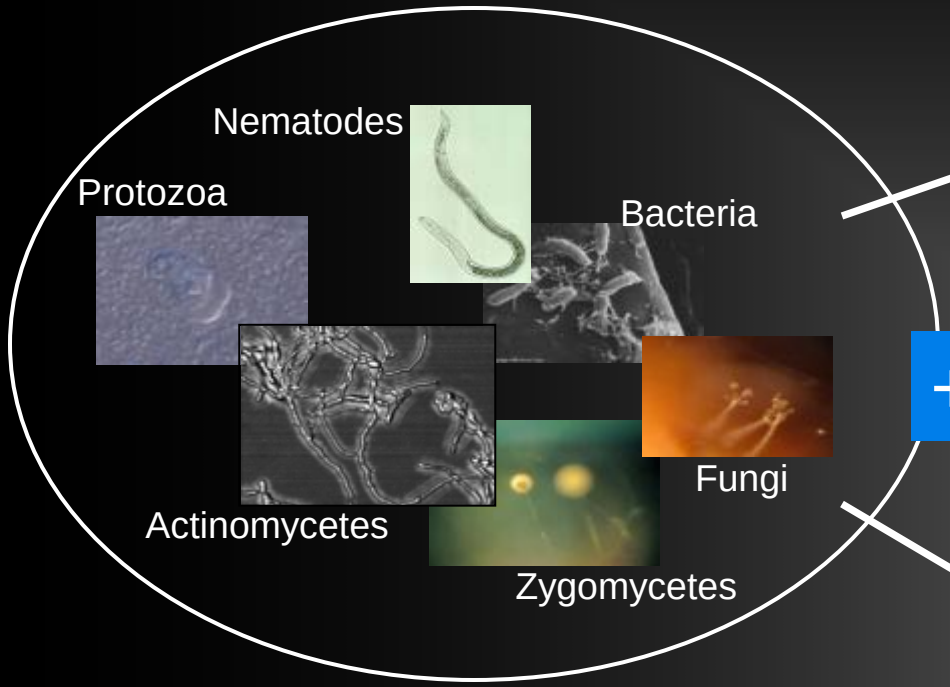
Tillage

Bio-based amendments

Cropping systems

Green manures

Management of native soil biology for enhanced orchard efficiency



Fine root development

+ Amendment type

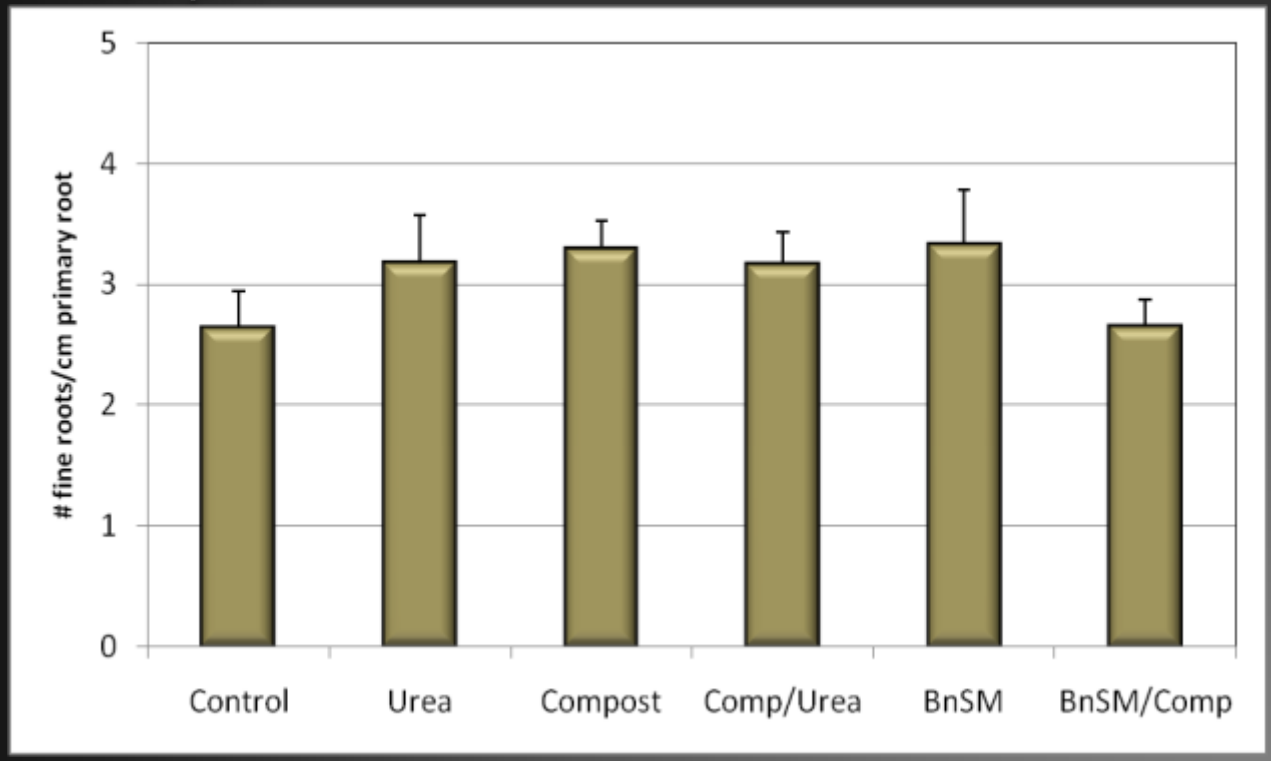
Volatilize

Nitrogen loss

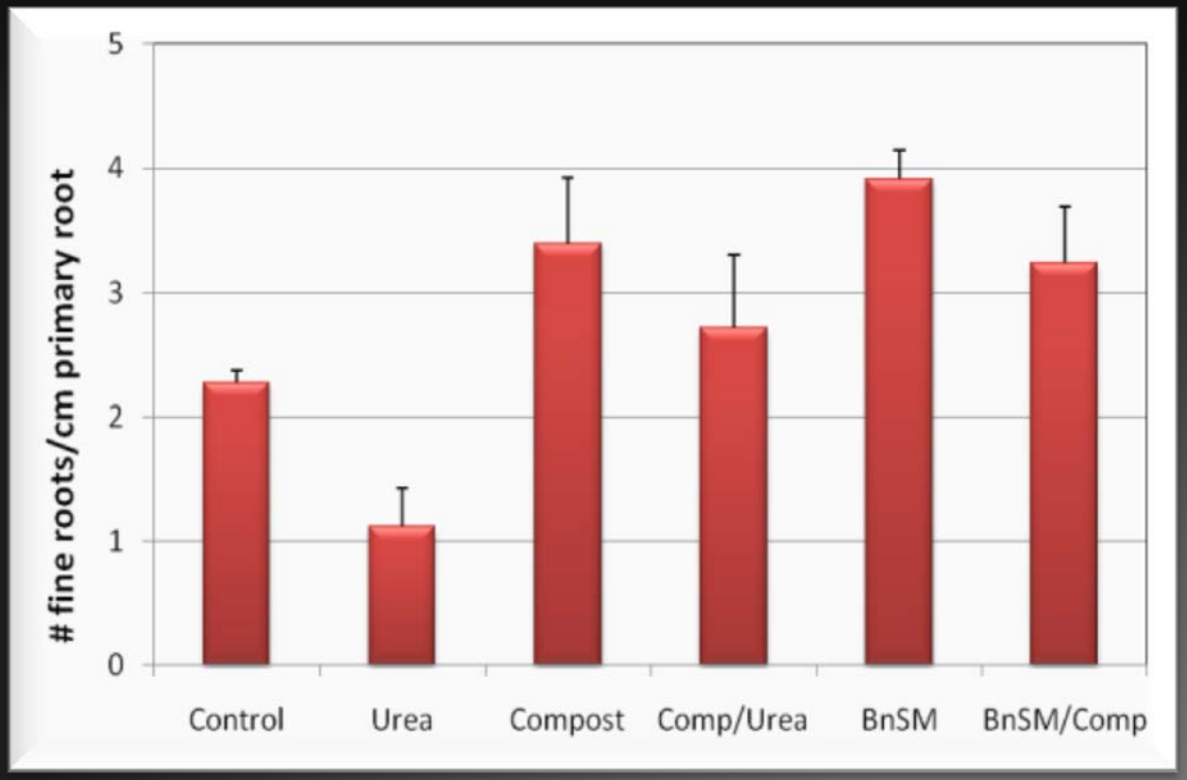
Leach

Effect of N amendment on root development in pasteurized orchard soil

Amendment (N 70 lb/acre)
Urea
Urea+compost
Brassica napus seed meal
B. napus seed meal+ compost
Compost



N amendment type differentially effects root development in native orchard soil



Positive and negative effects of amendments on fine root development are indirect and likely function through the resident soil biology

Microbial-induction of lateral root development

Control

Pseudomonas fluorescens SS101

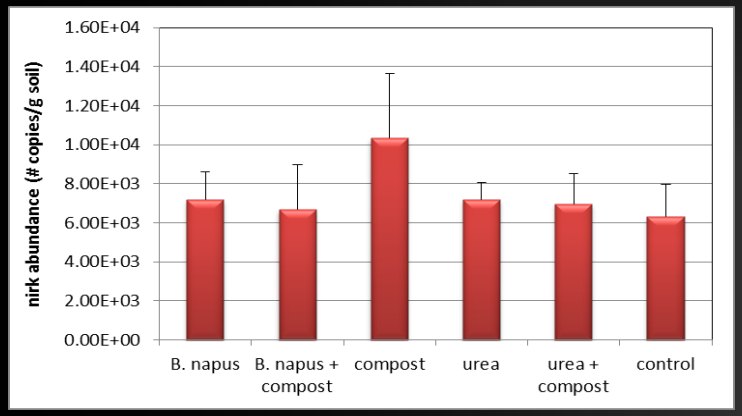
Streptomyces sp. 71

Amendment type may alter biological attributes influencing nitrogen cycling/retention

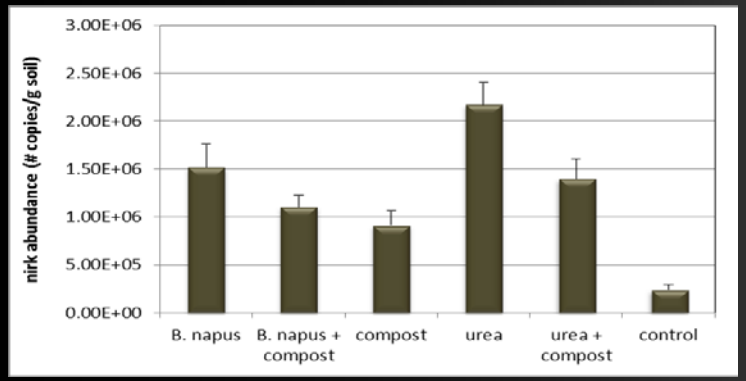
Bacterial *nirk:* denitrification; loss of N through volatilization

NO

N_2O



Orchard 1: 4.5% organic matter (organic)



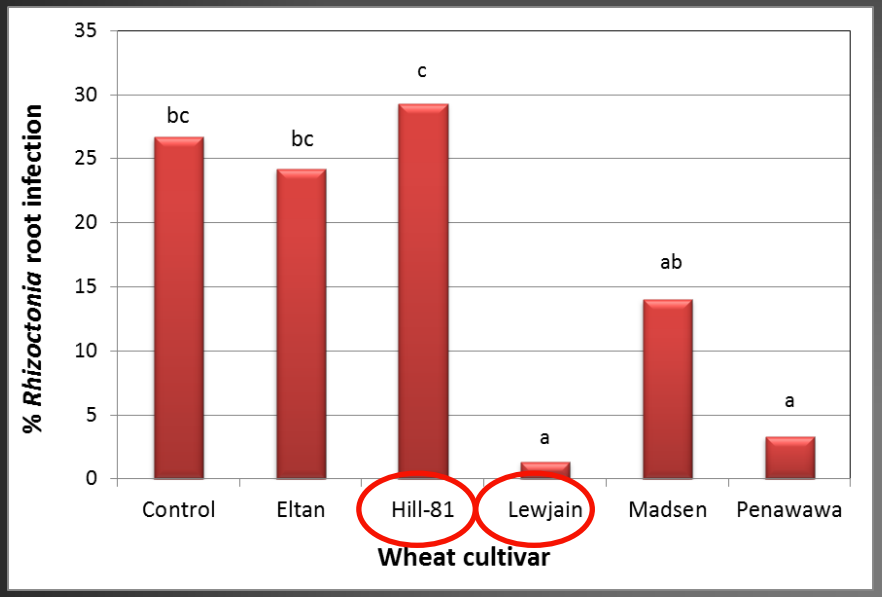
Orchard 2: 1.2% organic matter (conventional)

Modification of orchard biology for induction of disease suppressive soil: *Rhizoctonia solani*

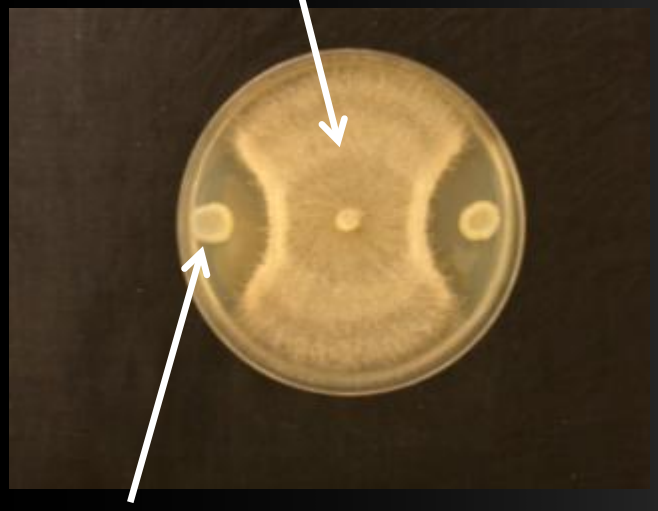
+ *Rhizoctonia solani*

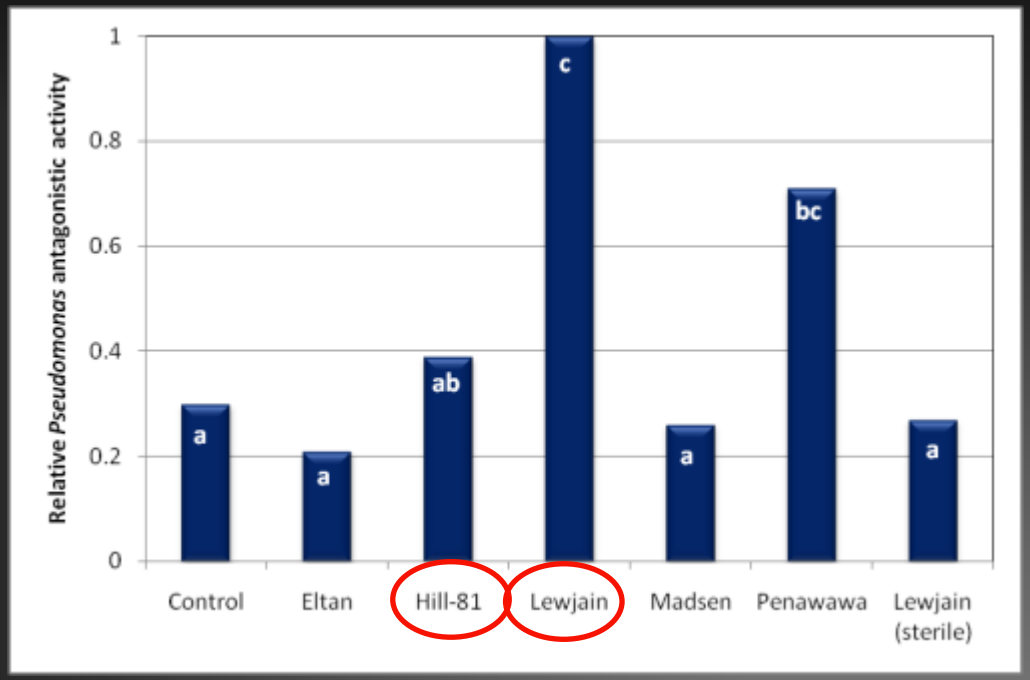
1 of 5 different wheat cultivars

Incidence *R. solani* root infection



Response directly related to antagonistic activity of fluorescent *Pseudomonas* spp. from wheat cultivated orchard soils





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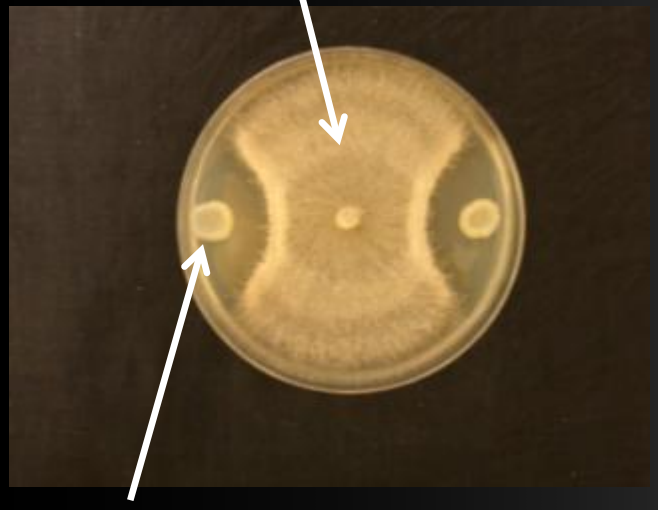
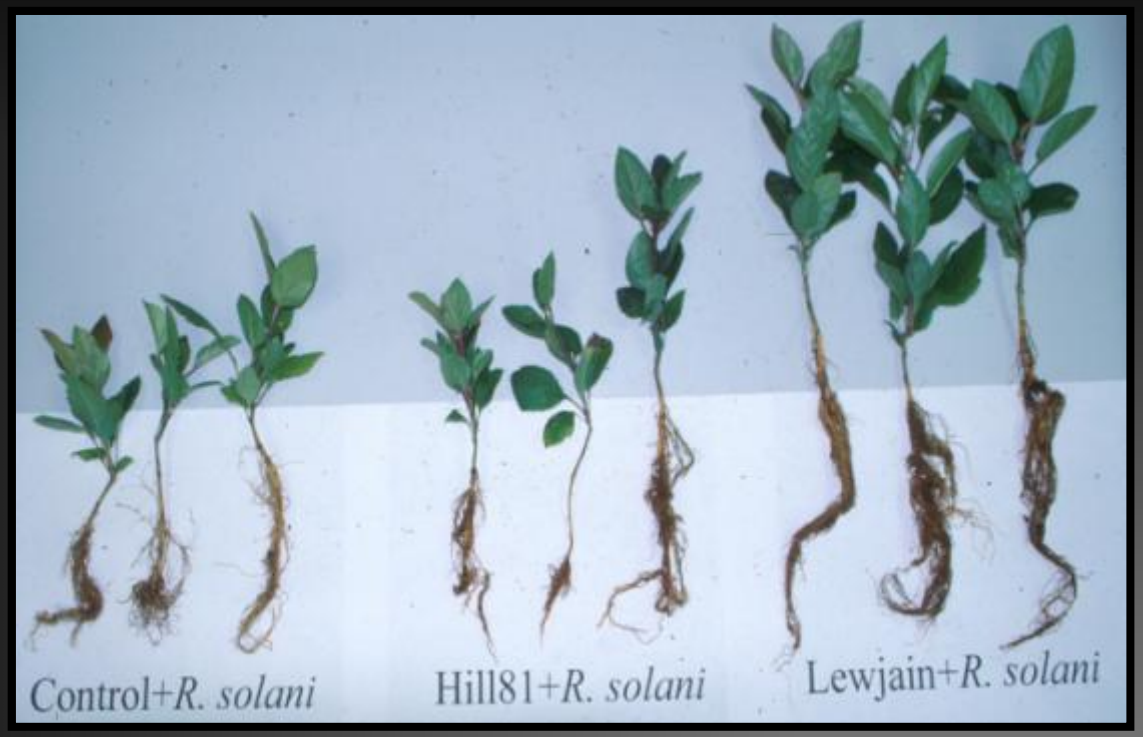
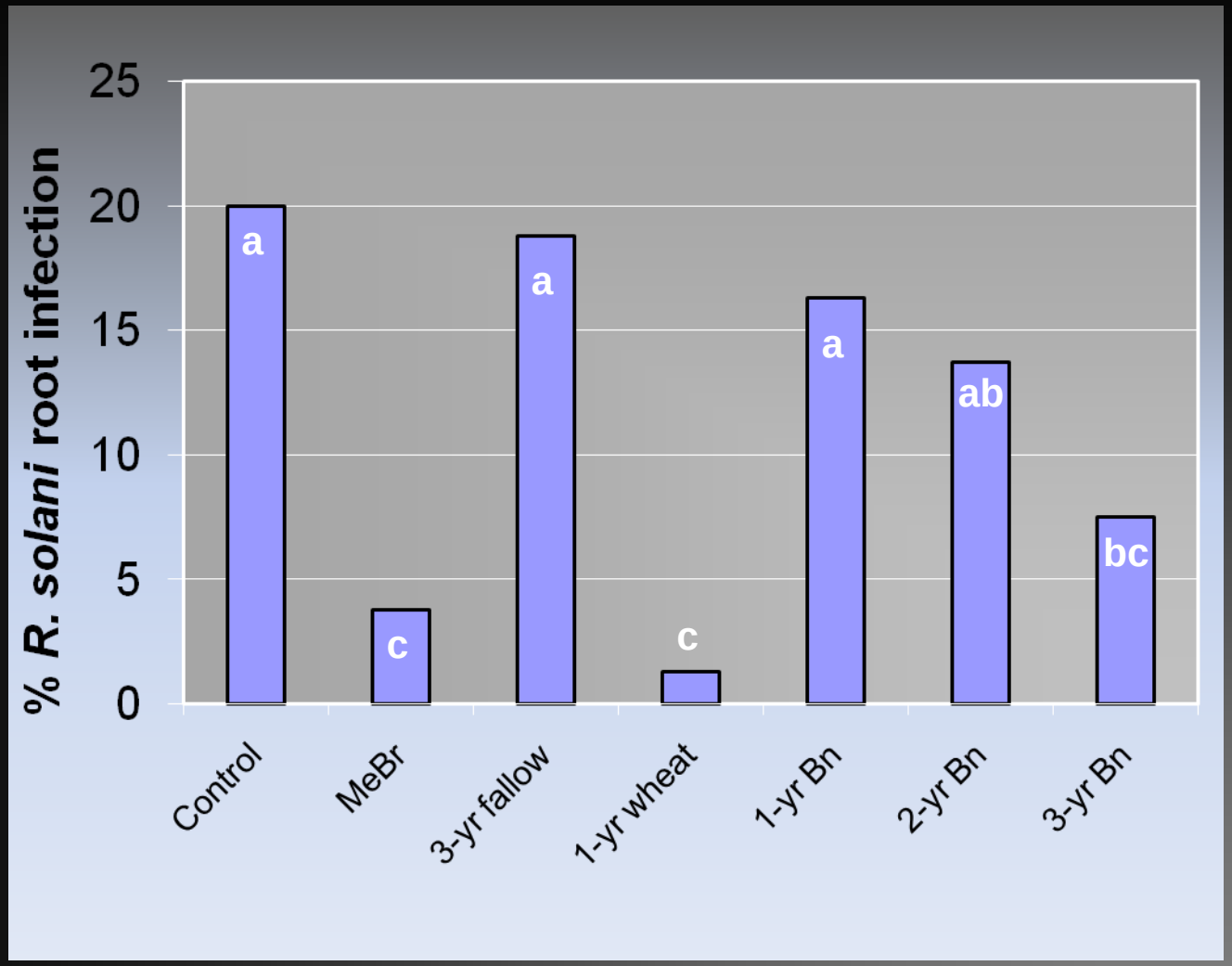




Effect of pre-plant wheat cropping or canola green manure on *R. solani* infection of Gala/M26 roots



Bn=canola green manure; MeBr=methyl bromide fumigation

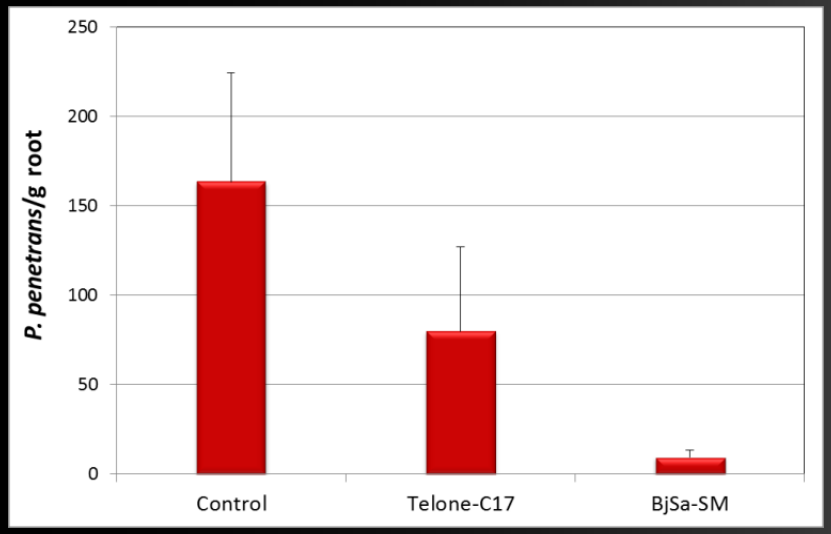
Mazzola and Mullinix 2005

Stimulation of biologically resilient soil systems

Brassica juncea +
Sinapis alba seed meal

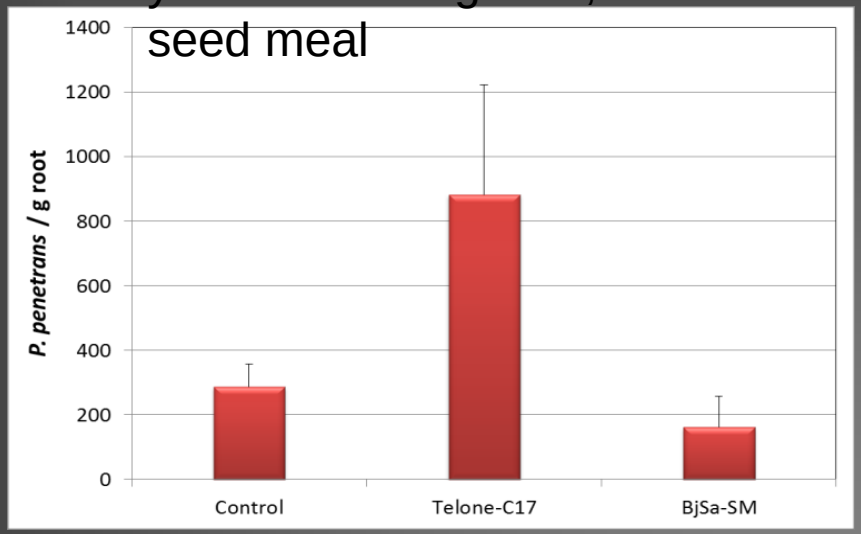
October 2010

Pratylenchus penetrans (lesion nematode)



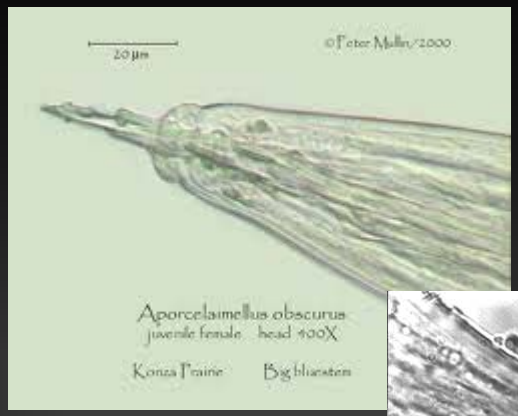
October 2011

Nematodes rebounded in second year after fumigation, but not after seed meal



Nematode pathogens and parasites elevated in seed meal treated soils

Arthrobotrys
(nematode trapping)

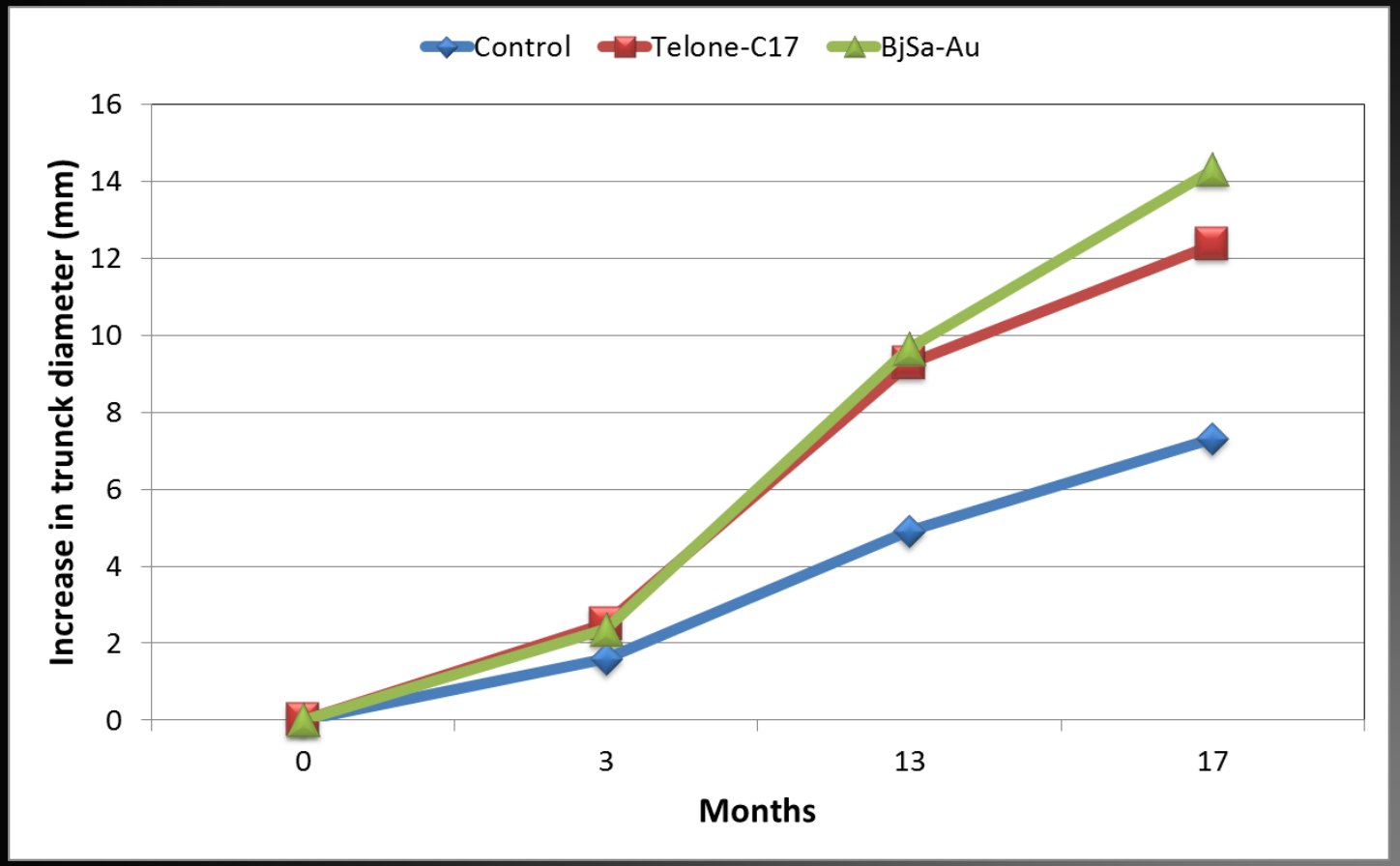


Aporcelaimellus
(predatory nematode)

Plectosphaerella cucumerina
(parasitic fungus)

Brassica SM formulation for replant disease control in organic systems

Orchard planted May 2010



Concluding comments:

- Soil biology is a resource that can be used to address various orchard management issues
- Effective use continues to require tools to predict or define the beneficial state
- Knowledge of not only who is there but who is functioning will be instrumental to the successful management of this resource