Managing Soil Biology for Multiple Orchard Benefits

Protozoa

Nematodes

Actinomycetes

Zygomycetes

Bacteria

Fungi

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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

“beneficial” nematodes

Mycorrhizal fungi

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.
Obstacles:

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

Alternative Strategy: Manage the native soil biology
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

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Fine root development

+ Amendment type

Volatilize

Leach

Nitrogen loss
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

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*

1 of 5 different wheat cultivars

Incidence *R. solani* root infection

![Graph showing percentage of Rhizoctonia root infection across different wheat cultivars]
Response directly related to antagonistic activity of fluorescent *Pseudomonas* spp. from wheat cultivated orchard soils

*R. solani*

*Pseudomonas* sp.
Response directly related to antagonistic activity of fluorescent *Pseudomonas* spp. from wheat cultivated orchard soils
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
Stimulation of biologically resilient soil systems

October 2010

*Pratylenchus penetrans* (lesion nematode)

October 2011

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

Brassica juncea + Sinapis alba 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
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.