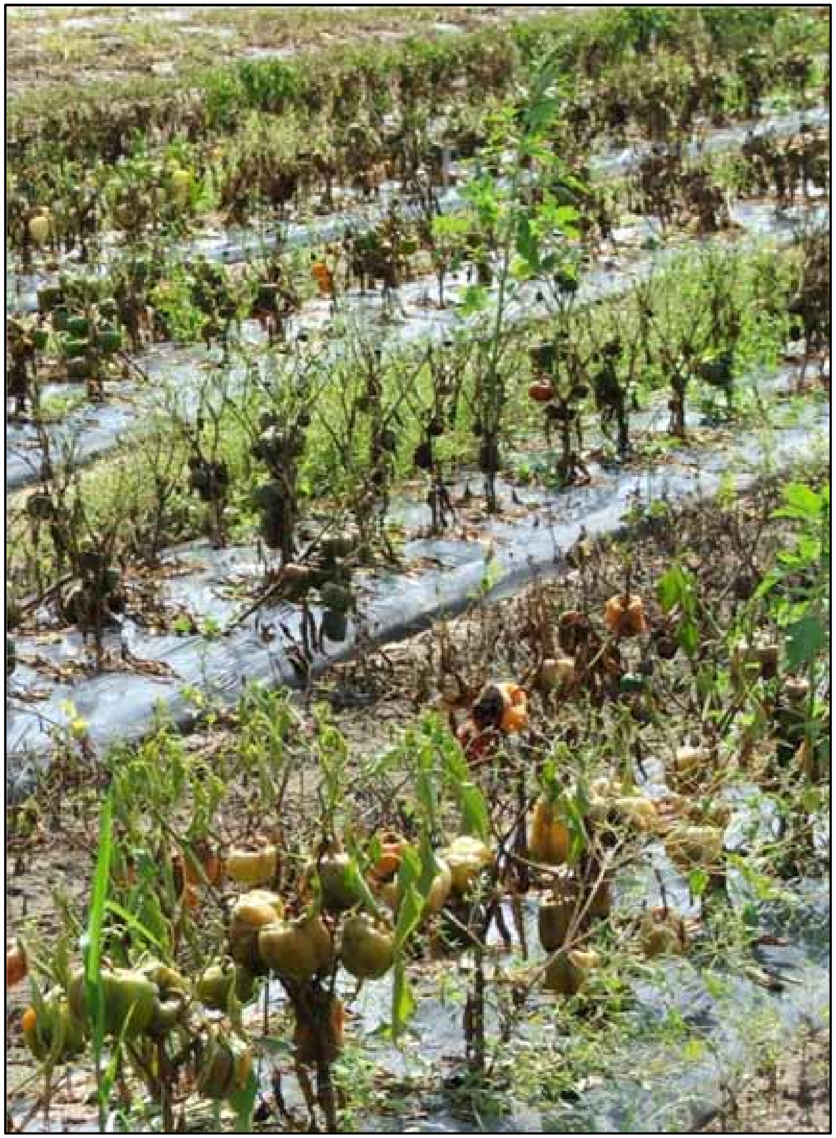
Identification, Assessment and Management of Soilborne Plant Pathogens in Vegetable Production Systems



Management of soilborne pathogens and diseases

George S. Abawi

Department of Plant Pathology and Plant-Microbe Biology

Cornell University

James A. LaMondia

The Connecticut Agricultural Experiment Station

Project LNE10-296

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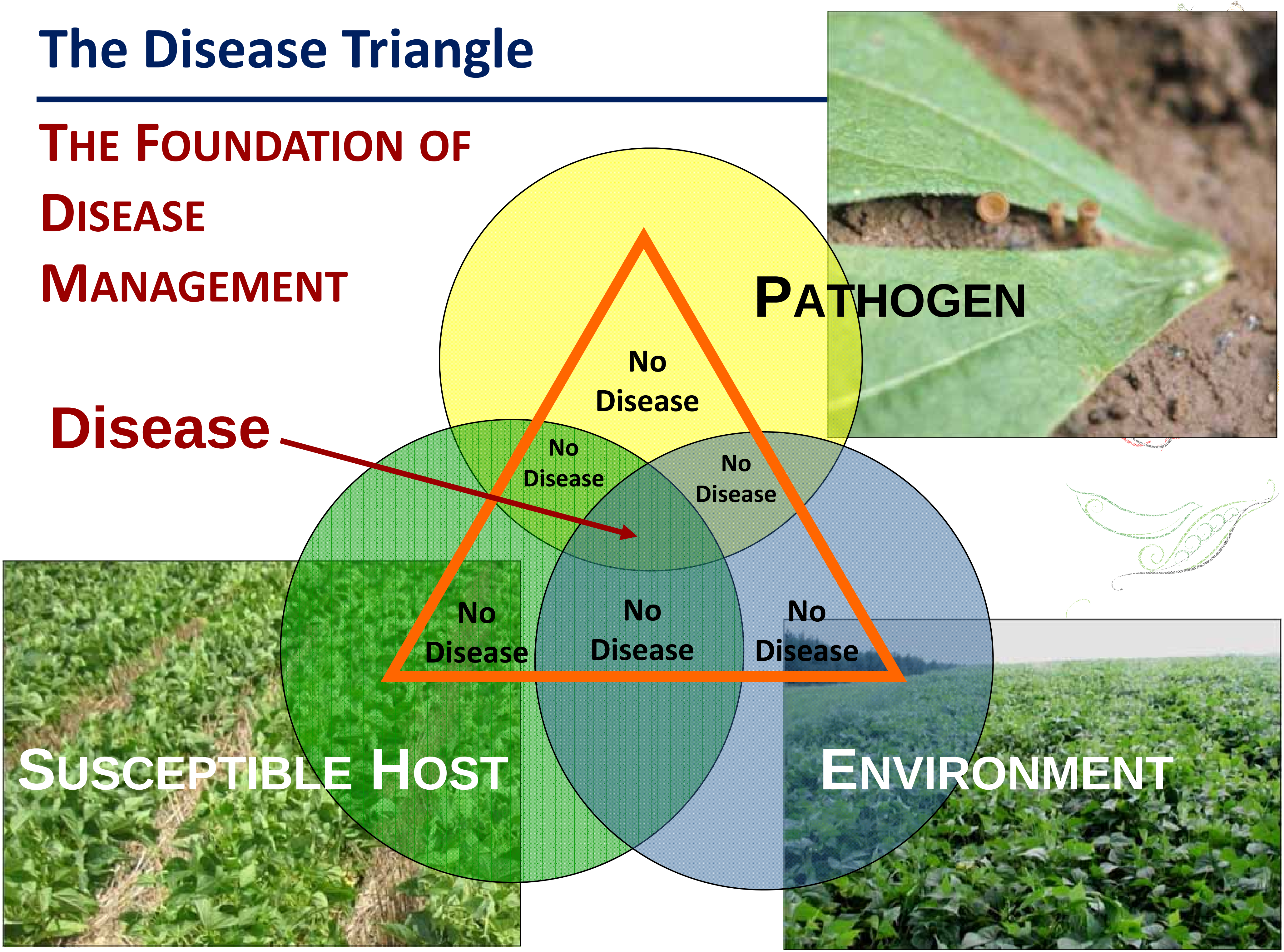
Soilborne pathogens and disease management

- All production practices impact soilborne pathogens.
- Pathogens and their diseases are most damaging in poor soils and on stressed hosts.
- Many pathogens have a wide host range and/or survive for several years in the absence of a host.
- Accurate diagnosis and monitoring of soilborne pathogen(s) is critical for determining management options.

The Disease Triangle

The Foundation of Disease Management



Principal management strategies

- **Exclusion/prevention** of pathogen infestation or spread
  - ✓ Quarantines and regulations
  - ✓ Phytosanitary certifications
  - ✓ Fungicide treatments
  - ✓ Sanitation practices
- **Eradication/reduction** in initial population of pathogens
- **Reducing rate** of pathogen population increase thus decreasing crop damage

General management strategies

- Cultural practices are often most effective
- Same strategies don't work in all systems or on all pathogens
- Must consider the pathogen(s) and cropping system to determine what combination of strategies are appropriate for your fields and farm

Short-term/in-season practices

e.g. seed trt, fungicide applications, resistant cvs.

Long-term practices

Improve soil condition, reduce inoculum

Management emphasizes…

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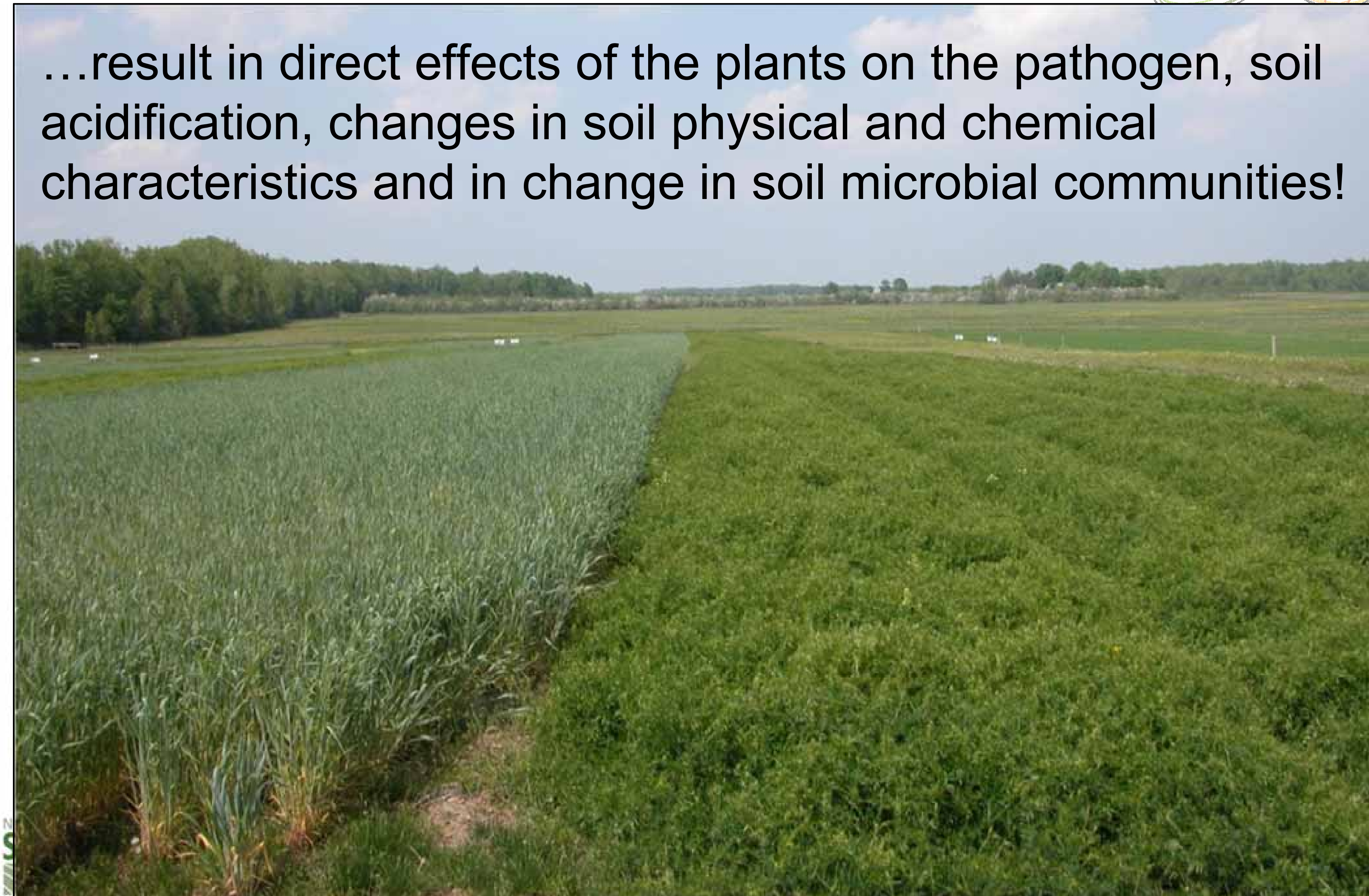
Crop rotation and cropping sequences



Crop rotation for disease management

- **Rotate out of plant families for 2 to 3 yrs**

  Most effective when implemented before there is a disease problem!

- **Efficacy depends on the pathogen**
  - ✓ **How long the pathogen can survive in the soil** (soil invader vs soil inhabitor)
  - ✓ **Host range** (including weeds and cover crops)
  - ✓ **Survival mechanisms** btwn susceptible hosts
  - ✓ Methods for managing **other sources of pathogen**

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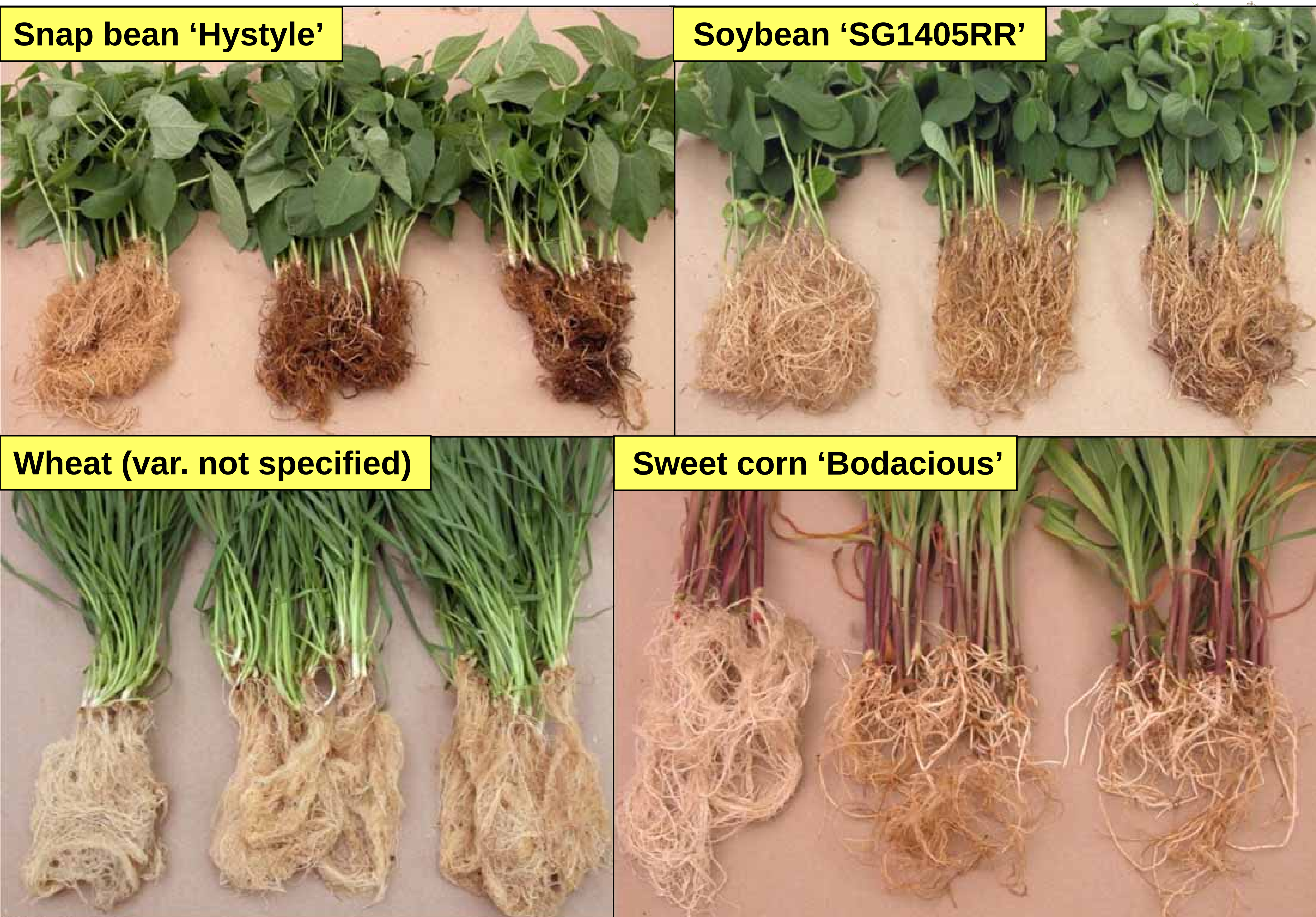
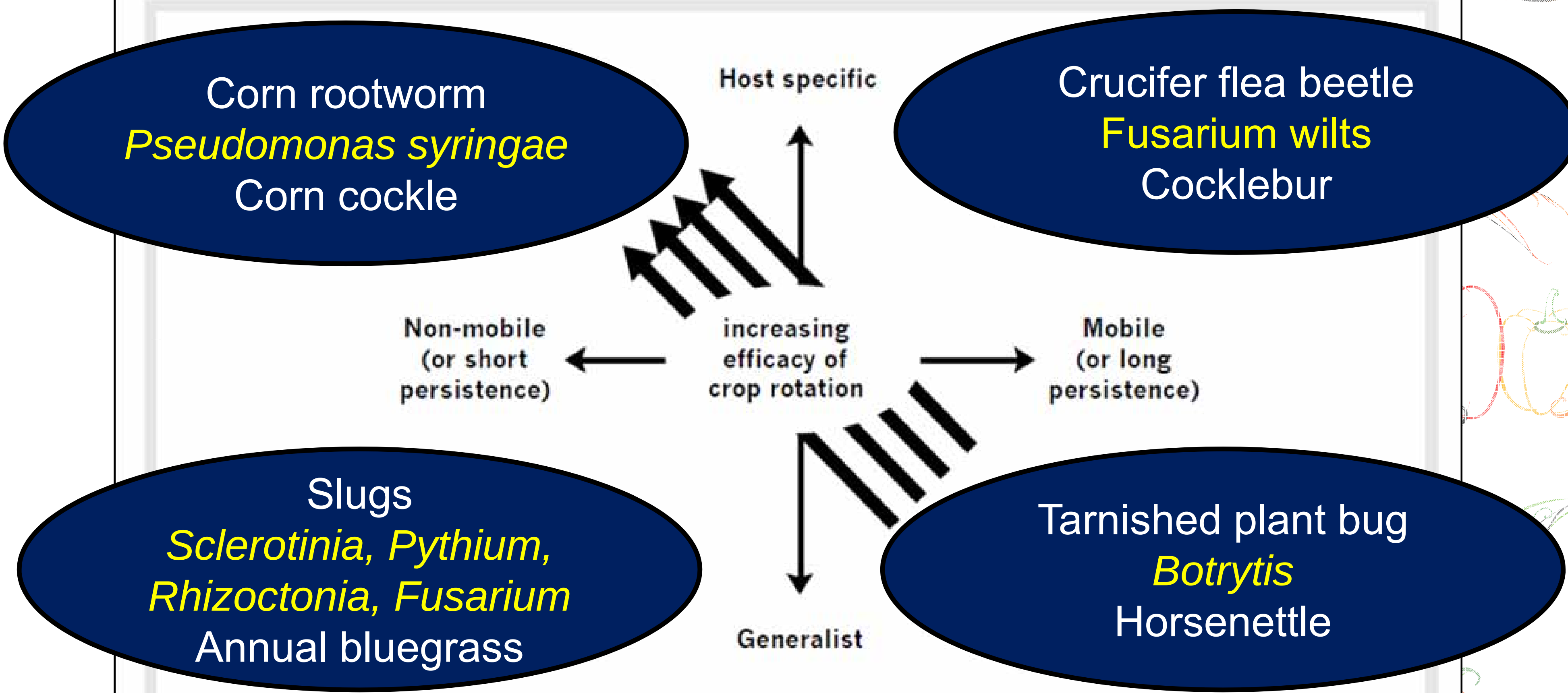

Snap bean 'Hystyle'
Soybean 'SG1405RR'
Wheat (var. not specified)
Sweet corn 'Bodacious'

Crop rotation for disease management



Note that persistence and mobility often vary in opposite ways, with non-persistent species having high mobility and vice versa. Mobility and persistence appear together in this diagram because they have similar effects on management choices.

Figure 3.2 The effect of host specificity, dispersal ability, and survival of dormant states (eggs, spores, seeds) on how well crop rotation controls pest organisms. Generalist pests are pest organisms that attack crops in diverse plant families or, in the case of weeds, thrive in a wide range of cropping systems. *Source*: Modified from reference 125.

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Adapted from: Crop Rotation on Organic Farms NRAES 177

Crop rotation for disease management

Efficacy also depends on….

- ✓ **Movement of equipment** within and between fields
- ✓ **Disease severity** and **environmental conditions**
- ✓ Other **cultural practices** employed can be **synergistic or detrimental** to disease management

  e.g. tillage spreading pathogens,
  decomposed green manures at planting

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Crop rotation for disease management

Allelopathy…

One organism produces biochemicals that influence the growth, survival and reproduction of other organisms, beneficial or detrimental.

Crop rotation for disease management

Plant – Pathogen Interactions

Beneficial Interactions

Hatch/germination factors, attraction to roots (could be delivered in conjunction with resistance)

Detrimental Interactions

Production of pesticidal/ toxic compounds that can be delivered by rotation crops, cover crops, intercropping or as a green manure

Crop rotation for disease management

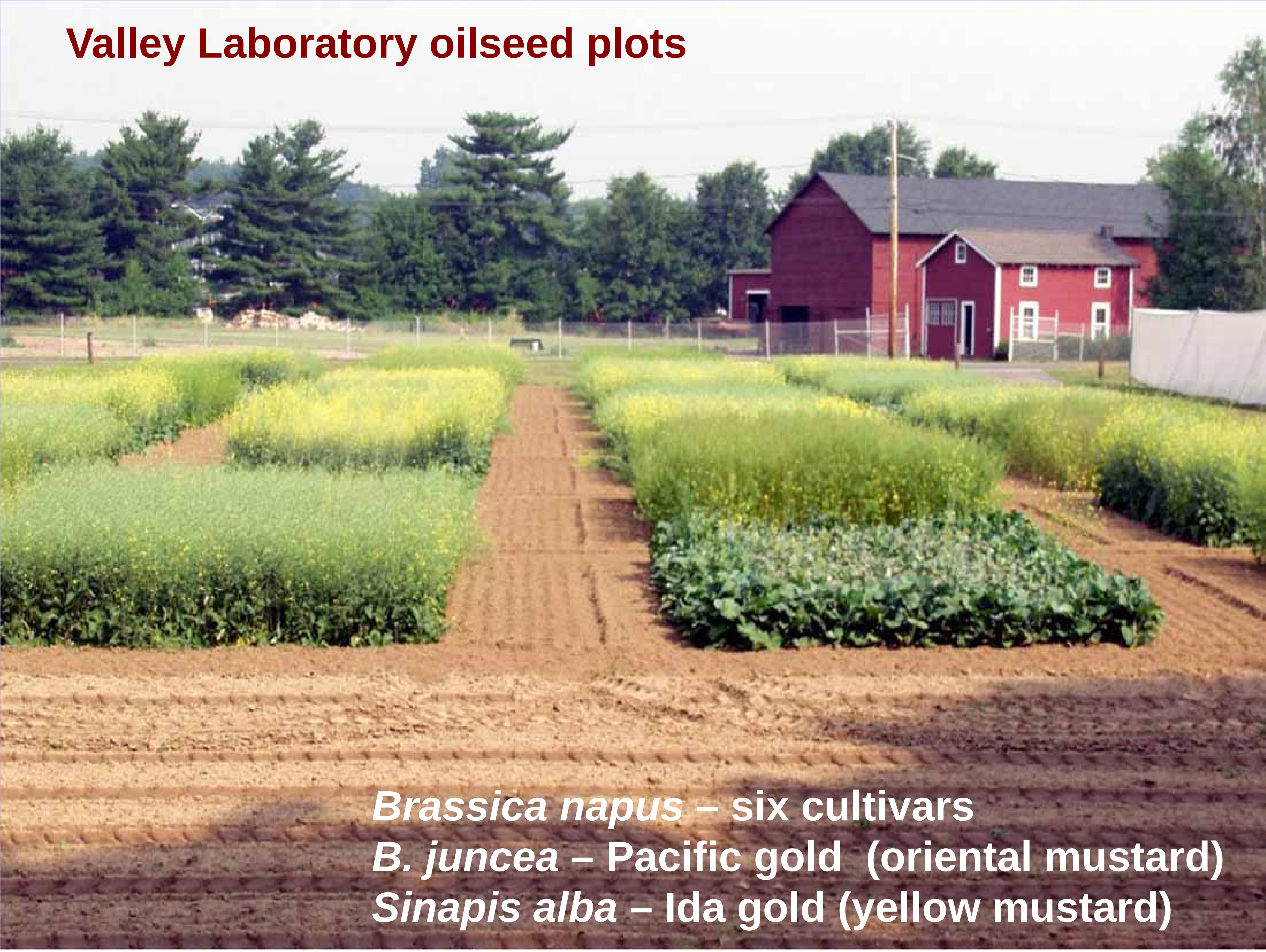
Detrimental Allelopathy = Biofumigation

Naturally occurring nematicidal/ fungicidal compounds in plants like brassicas, Rudbeckia, velvetbean, sesame, sorgho-sudangrass.

Biofumigants for pathogen management:

- ✓ Applied as green manure or seed meal amendments
- ✓ Host status and cultivar effects
- ✓ Efficacy in microplots and small field plots

Valley Laboratory oilseed plots



Biofumigation for disease management

Biofumigant oilseed crops

- ✓ 120 glucosinolates (30 - 40 in *Brassica* spp.)
- ✓ Develop profiles for cultivars (plants vs seed meals)
- ✓ Activity/efficacy against various pathogens, nematodes and weeds
- ✓ Compare to discover type and amount of glucosinolate(s) associated with efficacy
- ✓ Necessary for breeding and bioengineering

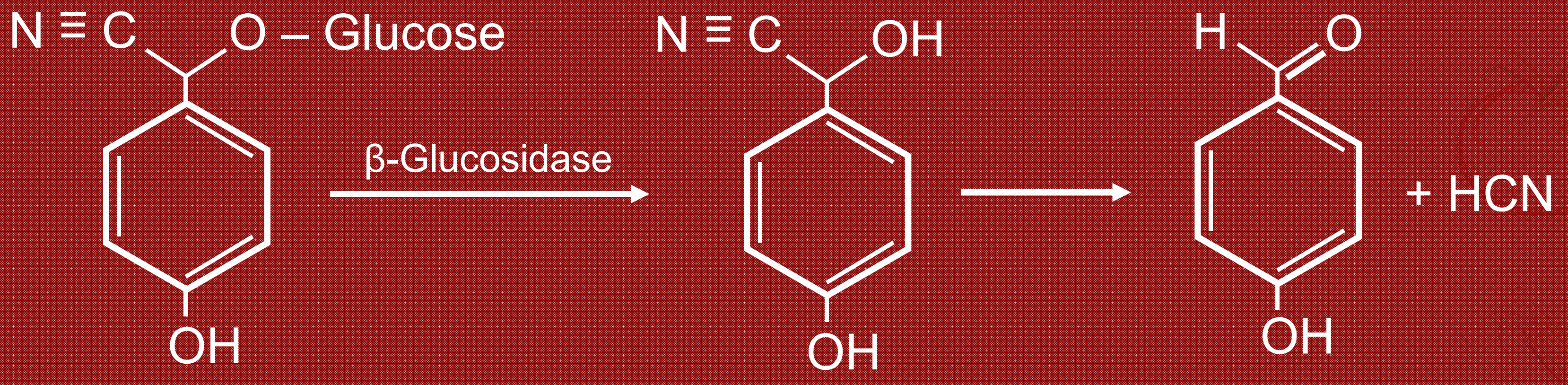
Crop rotation and cropping sequences

Chemistry

Decomposition of glucosinolates e.g. brassica crops

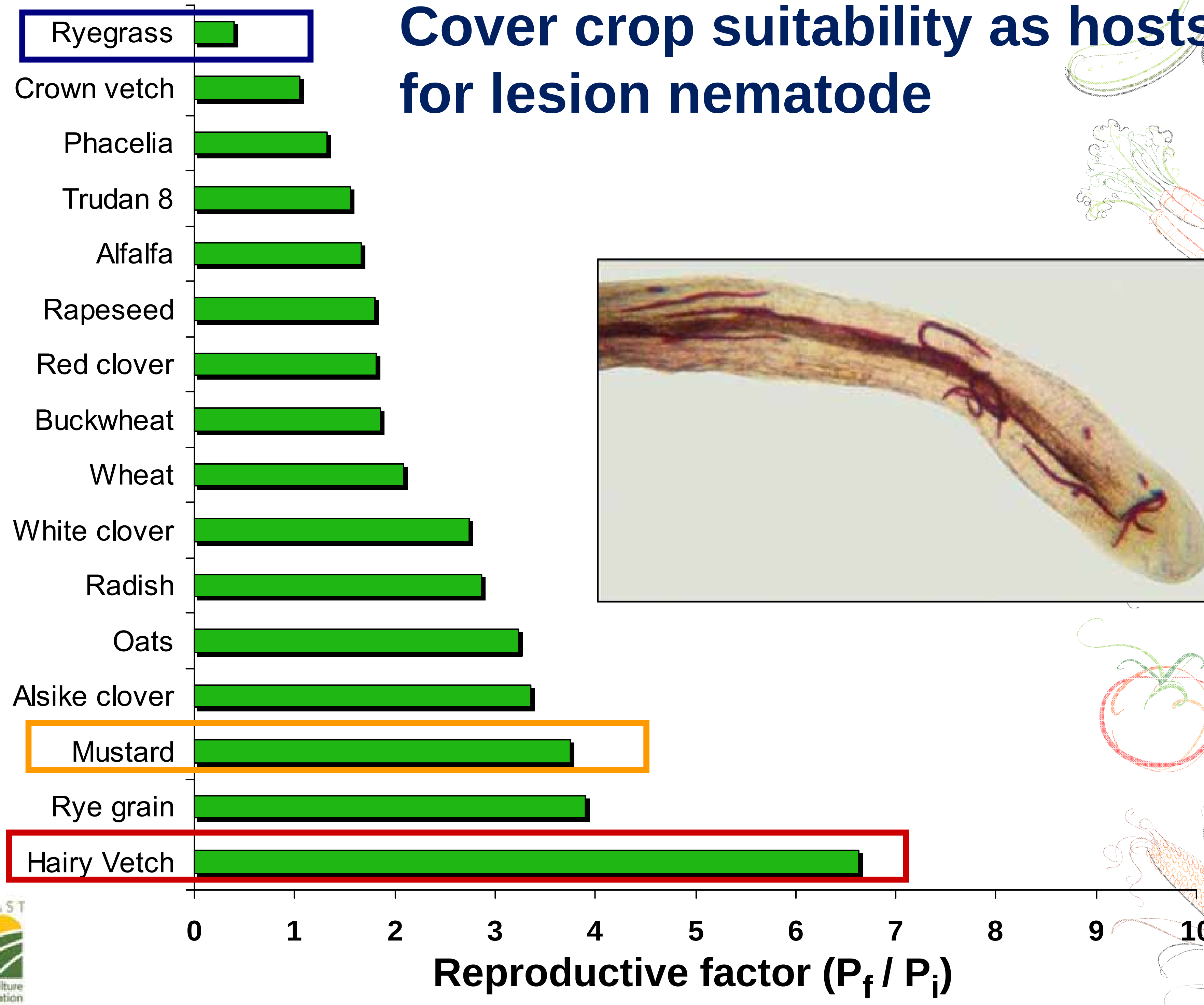
Glucosinolates —myrosinase→ Isothiocyanates

Decomposition of cyanogenic glucosides e.g. sudangrass

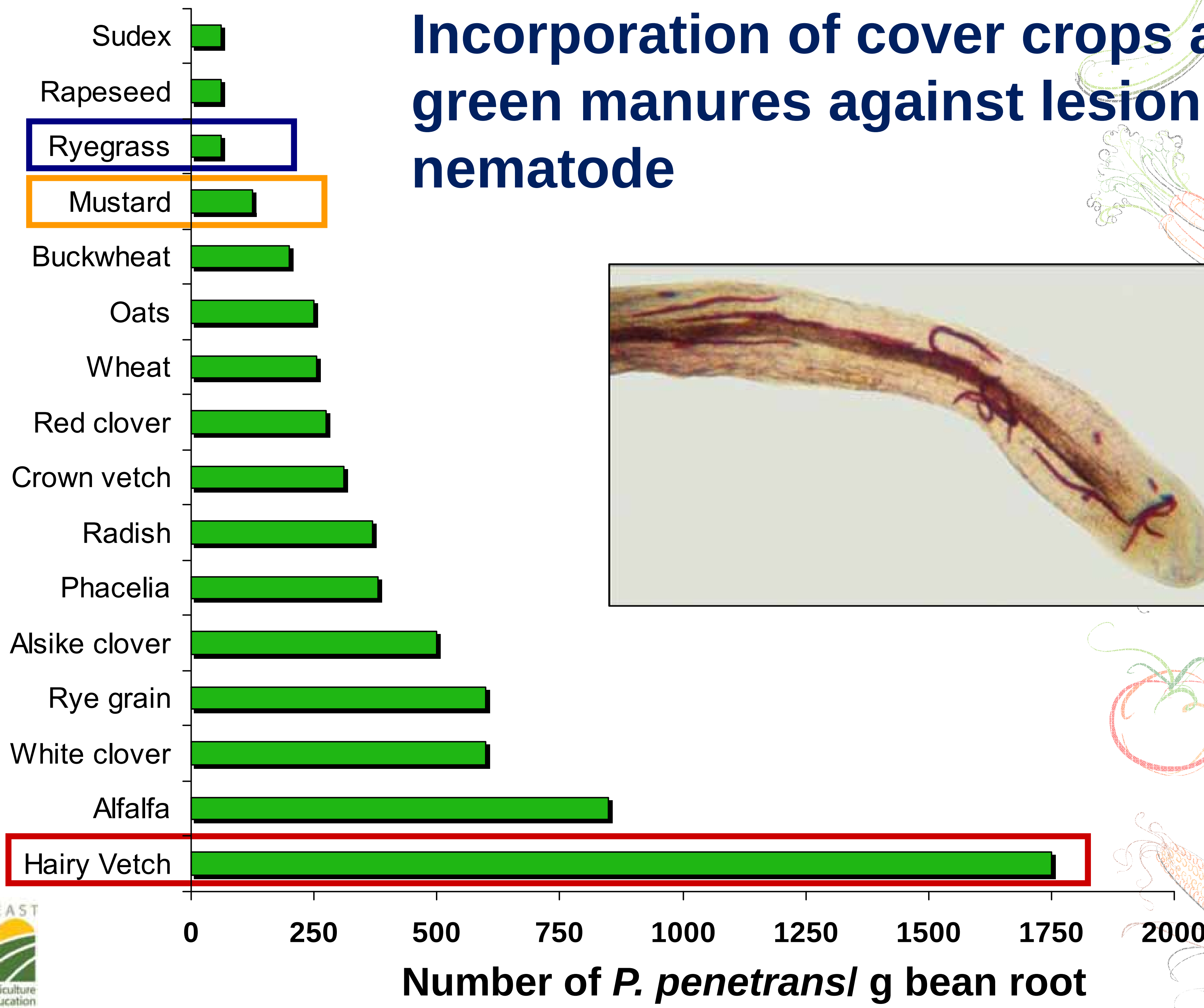


Dhurrin   p-Hydroxymandelonitrile   p-Hydroxybenzaldehyde

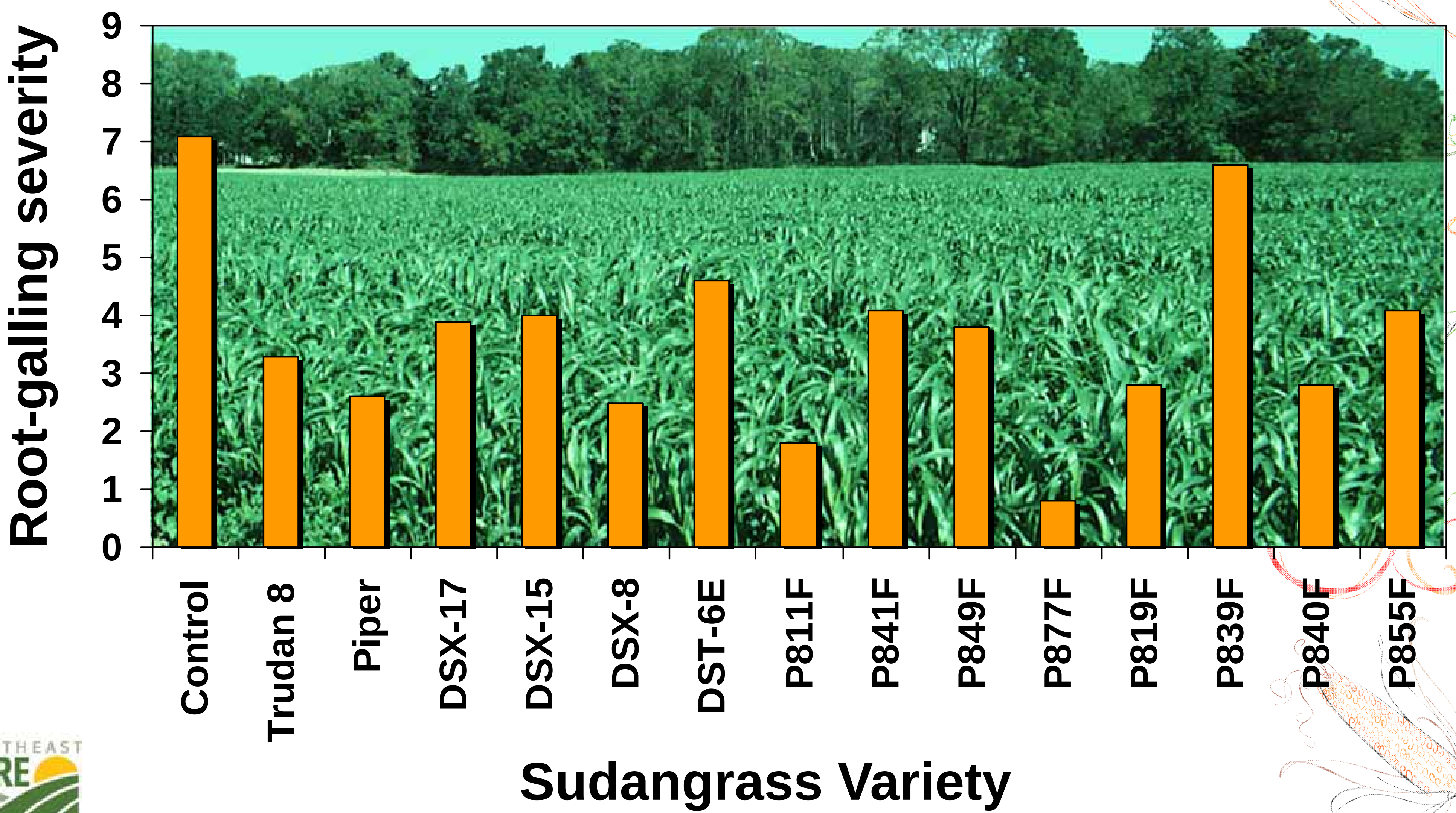
Cover crop suitability as hosts for lesion nematode



Incorporation of cover crops as green manures against lesion nematode



Suppressive effect of sudangrass varieties on root-galling severity of lettuce



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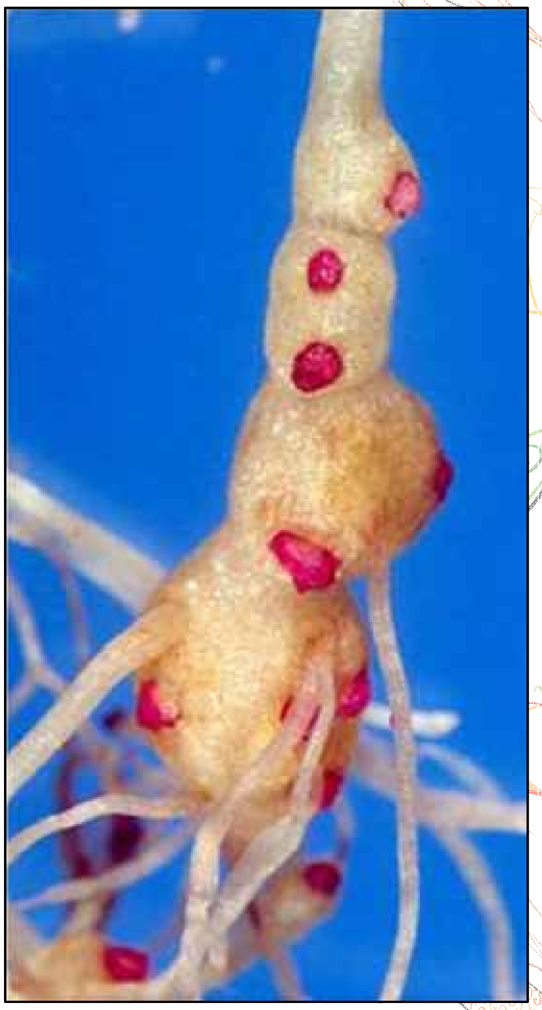
Biofumigation for disease management

Seed Meal Bioassay: Rates vs Root-knot nematode

Seed Meal Rate cv. Dwarf Essex	Percent Nematode Control
None	----
1 mg/cm^3	22
2 mg/cm^3	54
4 mg/cm^3	81



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Biofumigation for disease management

Seed Meal Bioassay: Type vs Root-knot nematode

Seed Meal Type	Percent Nematode Control
Pacific Gold	93
Dwarf Essex	84
Sterling	67
Ida Gold	39
Sunrise Spring	17
Hyola 410	6

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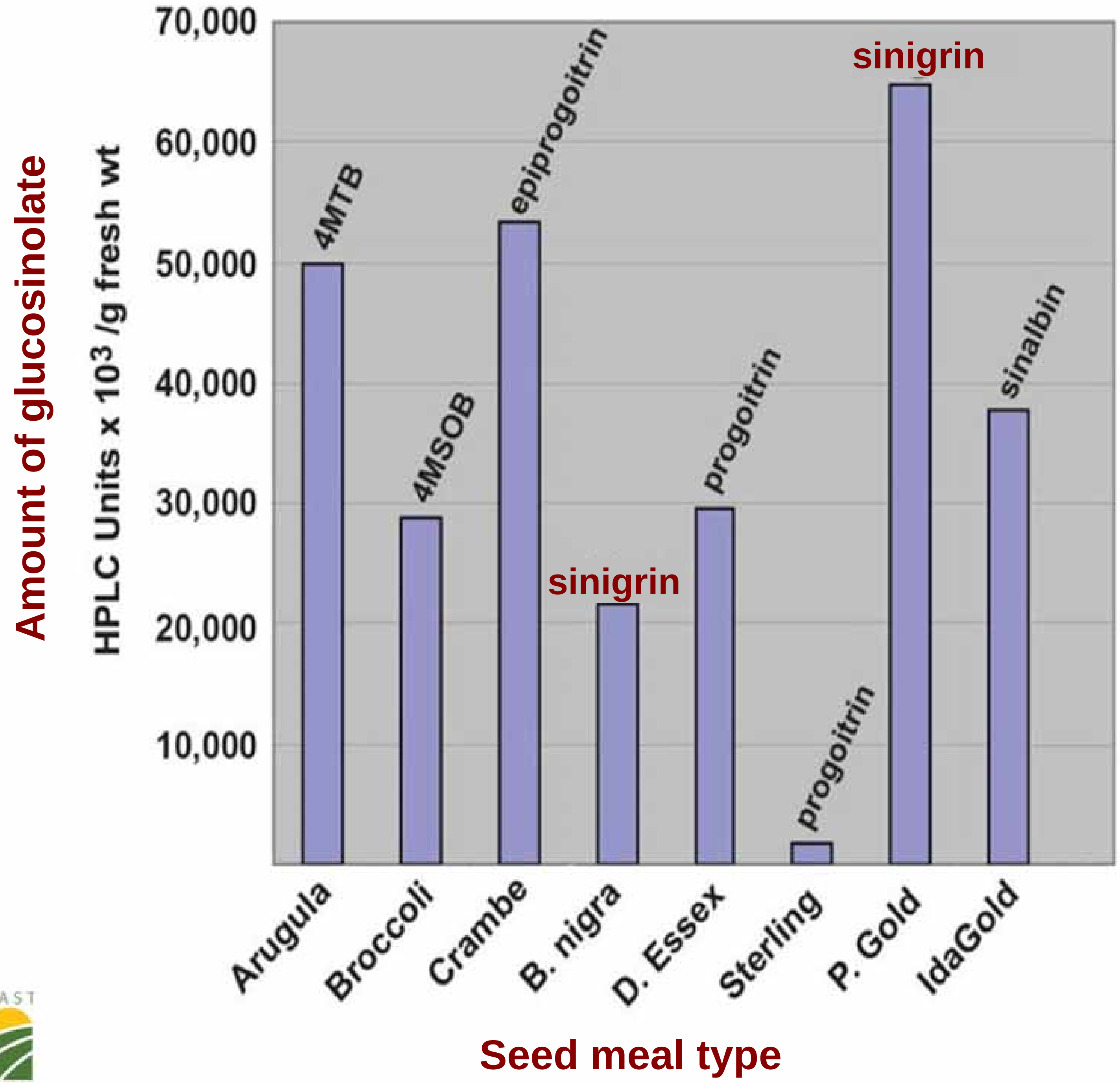

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Biofumigation for disease management

Biofumigation

- ✓ Highest toxicity levels – *B. nigra* and *B. juncea* Pacific Gold contains sinigrin
- ✓ Sinigrin levels 3x higher in Pacific Gold, 100% versus 70% mortality at 1.3 g seed/L
- ✓ Biofumigation with brassicas has also been shown to reduce *R. solani* and *V. dahliae* in soils
- ✓ Microplot research has shown that brassica green manure was more effective against *F. oxysporum* than fallow or host resistance

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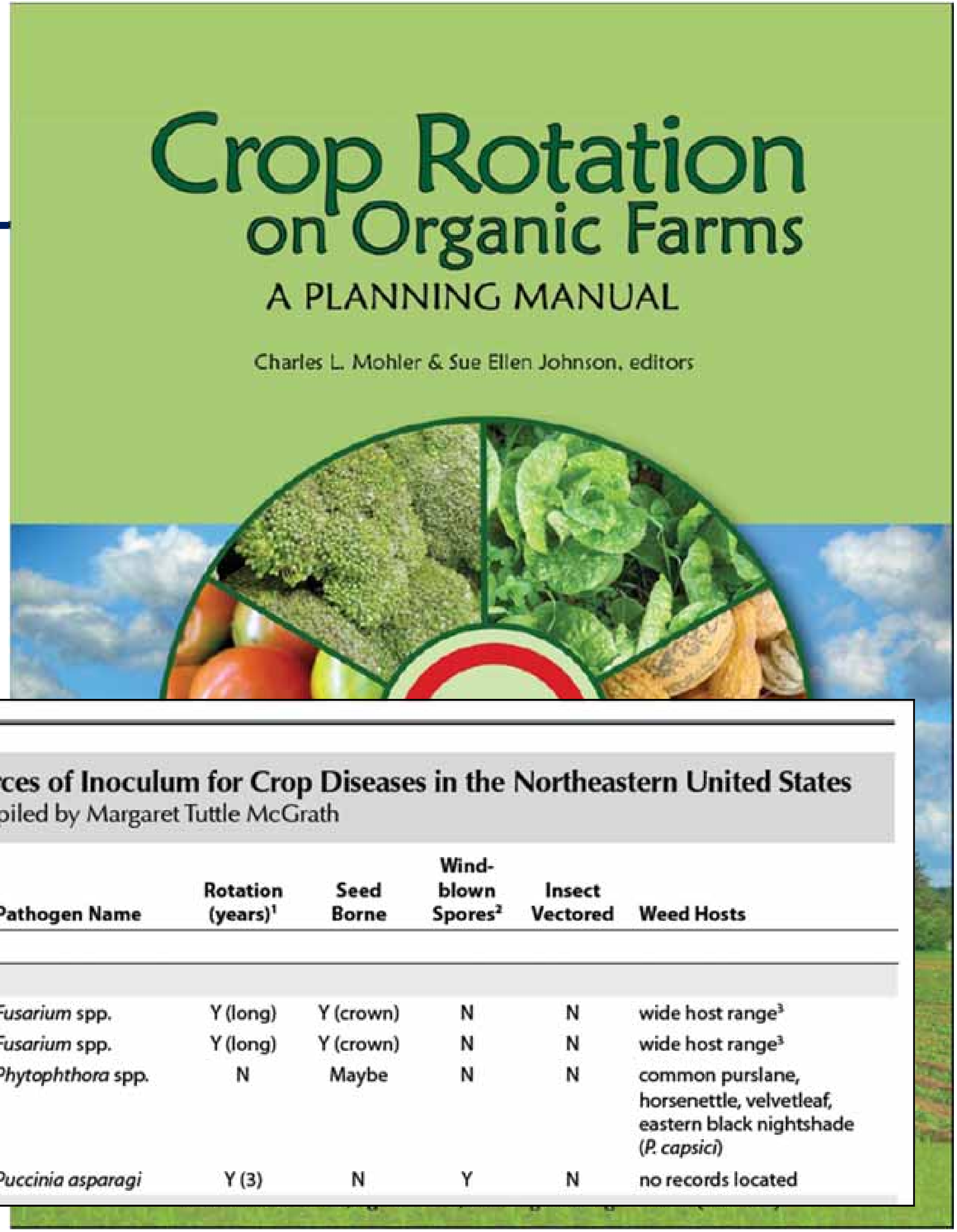
Additional resources

http://www.sare.org/Learning-Center/Books/Crop-Rotation-on-Organic-Farms

Hardcopy $24 or download pdf file



APPENDIX 3 Sources of Inoculum for Crop Diseases in the Northeastern United States
Compiled by Margaret Tuttle McGrath

Disease	Pathogen Name	Rotation (years)[1]	Seed Borne	Wind-blown Spores[2]	Insect Vectored	Weed Hosts
VEGETABLE CROPS						
Asparagus						
Fusarium crown rot	*Fusarium* spp.	Y (long)	Y (crown)	N	N	wide host range[3]
Fusarium root rot	*Fusarium* spp.	Y (long)	Y (crown)	N	N	wide host range[3]
Phytophthora spear rot	*Phytophthora* spp.	N	Maybe	N	N	common purslane, horsenettle, velvetleaf, eastern black nightshade (*P. capsici*)
Rust	*Puccinia asparagi*	Y (3)	N	Y	N	no records located

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Management emphasizes…

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Sanitation

- Pathogen-free, certified seed (when possible) esp. potatoes
- Reduce pathogen inoculum removing culls and incorporating crop residue
- Reduce spread by limiting movement of soil and crop debris on equipment, tools, people

Management emphasizes…

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Environmental modification

➡ **Cultural practices…create an unfavorable environment for the pathogen**

- ✓ Maximize air movement around plants
- ✓ Manage weeds and volunteers
- ✓ Minimize leaf wetness – drip irrigation
- ✓ Optimize/balance fertility
- ✓ Adequate soil drainage
- ✓ Good soil tilth
- ✓ Mulches
- ✓ Etc.

Environmental modification

Soil moisture and temperature

Many diseases are more severe with high soil moistures

Anaerobic conditions damage/weaken roots more susceptible to seed rots, damping-off and root rots

Ridge Tillage

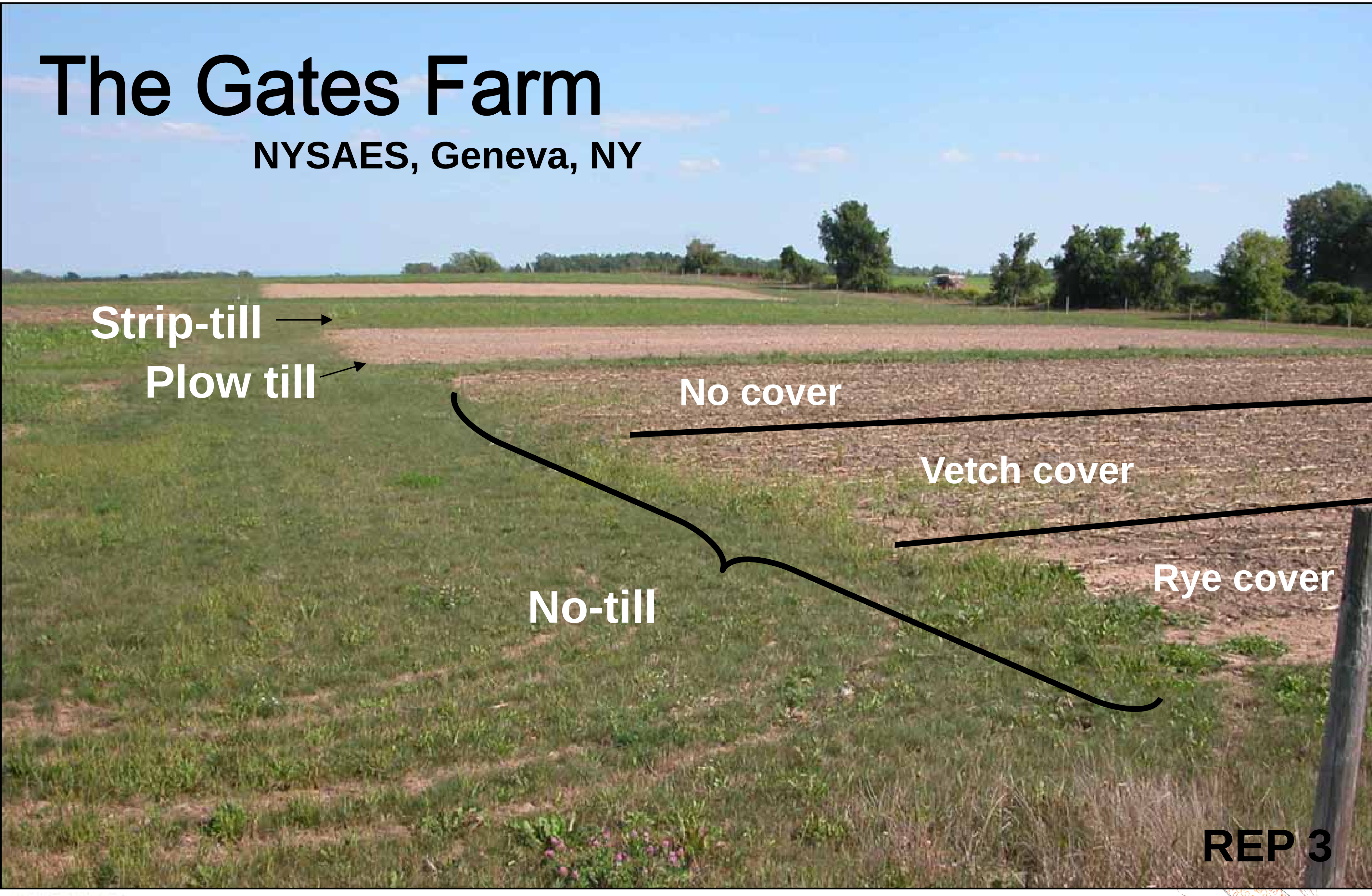
Ridge Tillage

Ridge Tillage

Strip Tillage

The Gates Farm

NYSAES, Geneva, NY



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Effect of tillage systems on snap bean – NYSAES, Gates Farm, 2011

Rotation 1 – Continuous vegetable rotation

Tillage	#Plant/ 10ft	RRS (1-9)	Pod Wt (lb/100ft)
Ridge	46.8	4.2	53.5
Zone-Till	47.5	4.5	45.1
Plow	46.9	5.3	29.8
LSD (P=0.05)	*3.85*	*0.55*	*10.21*

Rotation 2 – Vegetable rotation w/ soil-building crops

Tillage	#Plant/ 10ft	RRS (1-9)	Pod Wt (lb/100ft)
No-Till	41.2	4.3	44.5
Zone-Till	46.6	4.4	55.2
Plow	44.5	4.0	34.1
LSD (P=0.05)	*4.2*	*0.45*	*11.0*

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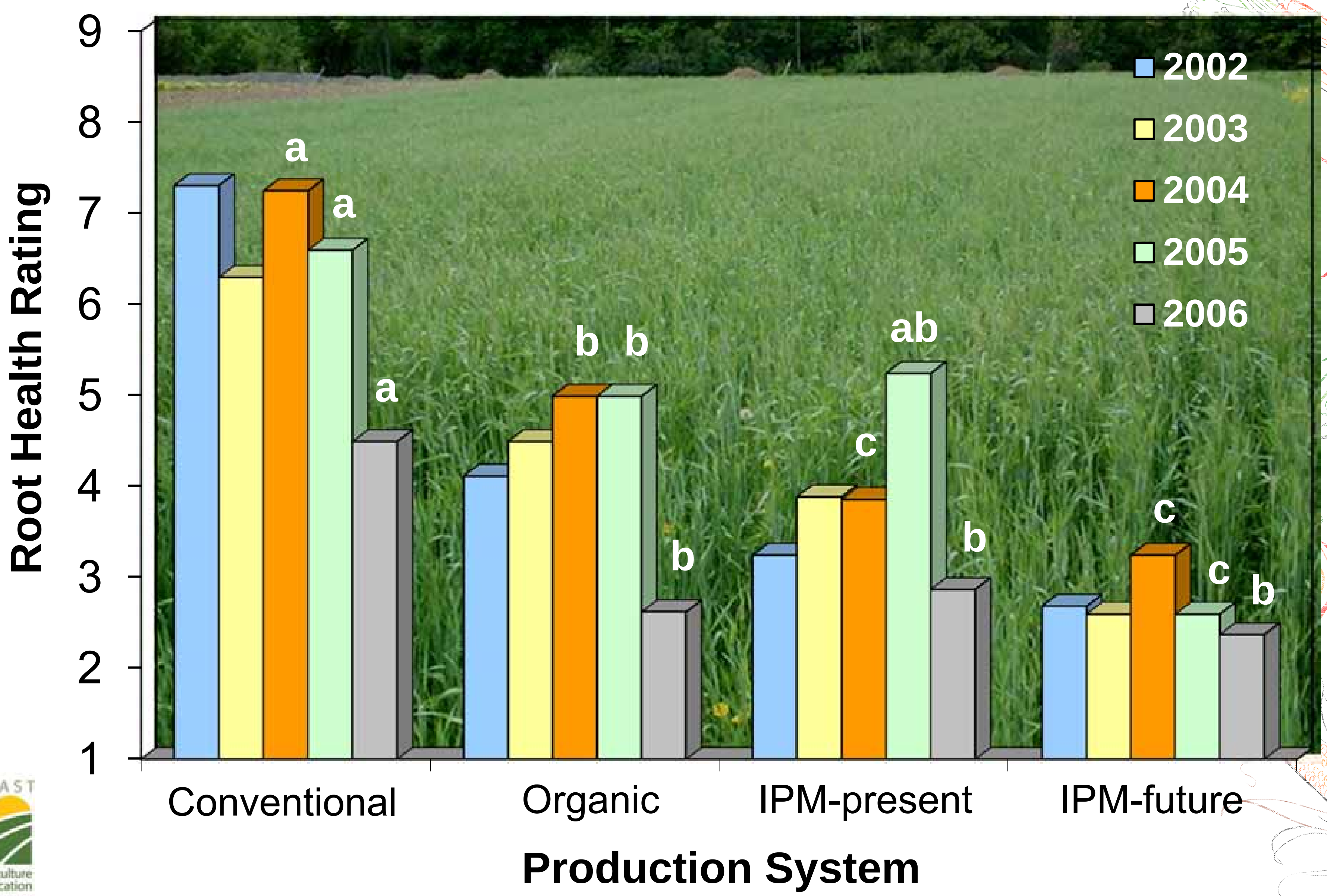
IPM Systems Comparison Site

NYSAES, Geneva, NY (C. Petzoldt et al.)



Differences in snap bean root rot and yields at IPM systems fields, NYSAES 2008

Production System	Root Health Rating*		Sample wt (g/ 20 plants) **	Yield (T/A)
	Bioassay	Field		
IPM present	6.3	4.2	862	3.35
IPM future	5.4	4.5	1298	3.89
Organic	7.0	5.0	743	3.17
Conventional	7.0	4.9	834	2.43
lsd (p=0.05)	*0.60*	*0.54*	*358.5*	*0.517*

*Rated on a 1-9 scale (1 = healthy to 9 = severely symptomatic, decayed

**IPM future was most mature, IPM present and conventional systems were least mature at harvest.

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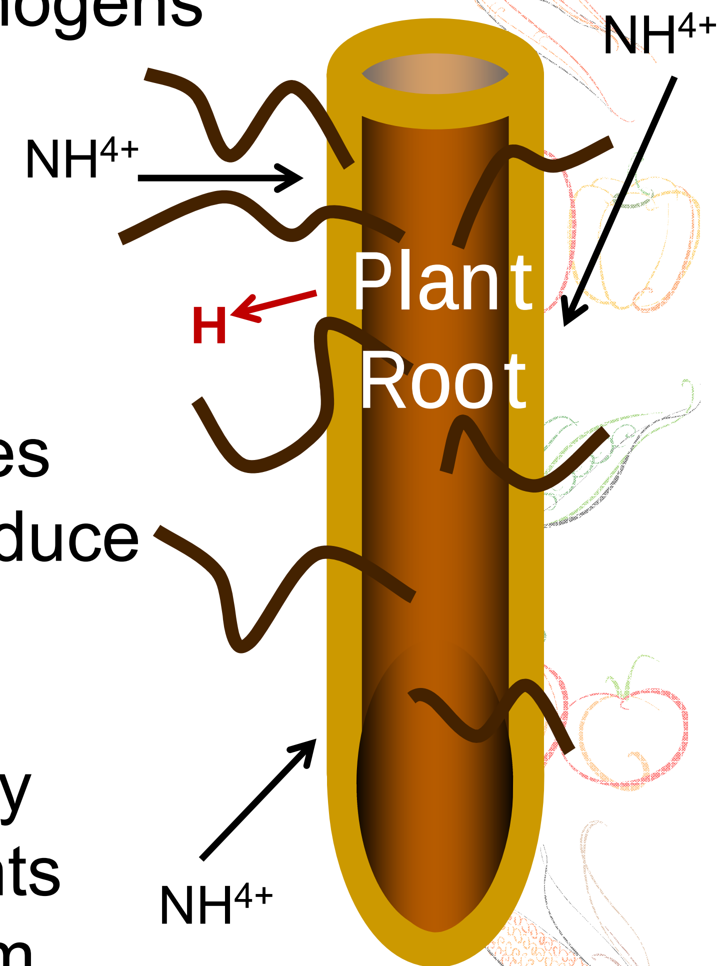
Management emphasizes…

Optimizing plant nutrition

Effects of soil nutrients and plant nutrition

- ✓ Nutrients affect both plants and pathogens as well as all other soil microbes
- ✓ Macro and micronutrients, pH and organic matter
- ✓ In general, optimal nutrition promotes plant growth and as a result may reduce the severity of certain diseases.
- ✓ Certain diseases may be reduced by targeting the form of specific nutrients like nitrogen, phosphorus, potassium, calcium, etc.



H ions released lowering pH around root zone

Effects of soil nutrients and plant nutrition…

Nitrogen

Essential for plant growth

↑ **NO_3** reduces *F. oxysporum*, *R. solani* and *Pythium* spp.

↑ **NH_4** reduces *Thielaviopsis basicola*

Phosphorus and Potassium

Essential for plant growth and general disease resistance

Low **P** may ↑ problems with *Pythium* & other root rot diseases

Low **K** typically increases diseases caused by *Rhizoctonia solani*

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Effects of soil nutrients and plant nutrition…

Calcium

Strengthens cell walls

Optimizing **Ca** fertility ↑ resistance to Pythium root rot as well as Fusarium wlts and Sclerotinia diseases

Manganese

Controls liginin and suberin biosynthesis

Increased **Mn** fertility ↓ potato scab as well as Fusarium and Sclerotinia diseases

Effects of soil nutrients and plant nutrition…

Boron

Promotes cell wall rigidity and membrane integrity

Increased **B** fertility ⬇ clubroot of crucifers, *Fusarium solani* root rot of beans and Verticillium wilt in tomato

pH

Levels influence nutrient availability

Higher pH reduces *F. oxysporum*

Lower pH reduces potato scab and black root rot

Effects of soil nutrients and plant nutrition…

Soil pH

Common scab of potato
(*Streptomyces* spp.)

dry soils pH 6.0 to 7.0
favor disease so lower pH
to reduce disease

Clubroot of crucifers
(*Plasmodiophora brassicae*)

pH 5.7 or lower

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Management emphasizes…

Host resistance

- **Two types of resistance**

Horizontal resistance – partial resistance to multiple strains of a pathogen using many genes (stable)

Vertical resistance – complete resistance to a single strain of a pathogen using a single gene (unstable)

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Host resistance

Select the appropriate cultivars

- ✓ Adapted to your region
- ✓ Host resistance is one of the most effective ways to manage diseases

Susceptible	Tolerant	Resistant
Severely diseased	Diseased but not minimal effect on yield	Diseased later during the season or only if environment is very favorable for the pathogen

Host resistance

- Often resistant varieties are not available

Celebrity VFFNTA Hybrid

BHN 640 VFFF Hybrid

Host resistance – screening trials

- **Dry bean variety trial, NYSAES, 2009**

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67-3
CLRK

Pea variety trial, Genesee Co. NY, 2008

Host resistance – Pea root rot trial, 2010

Boogie
Tonic
ES 414

Host resistance – greenhouse screening

Root rot severity scale

1 no visible symptoms

3 light discoloration, 10% of root & hypocotyl tissues w/ lesions

5 ~ 25% of hypocotyl & root tissues w/ lesions, tissues firm

7 ~ 50% of hypocotyl & root tissues w/ lesions, some softening, rotting & reduction in roots

9 > 75% of hyptocotyl & root tissues w/ lesions, severe rotting & reduction in roots

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Root rot rating scale - soil bioassay w/ bean

Good	Moderate	Poor

Host resistance – grafting

- **Grafting** = fusing a scion (young shoot) onto a resistant rootstock
  - Can protect against several soilborne fungal, bacterial, viral and nematode pathogens

Figure 2. Details of the Grafting Process. Photo courtesy C. Rivard

Host resistance – grafting

- **Selecting rootstocks** - need to have an accurate diagnosis!

Table 1. Rootstock and Disease Resistance

Rootstocks	TMV	Corky Root	Fusarium Wilt		Verticillium Wilt	Root-knot Nematode	Bacterial Wilt	Southern Blight
			Race 1	Race 2				
Beaufort*	R	R	R	R	R	MR	S	HR
Maxifort*	R	R	R	R	R	MR	S	HR
TMZQ702**	R	S	R	R	R	R	MR	?
Dai Honmei***	R	R	R	S	R	R	HR	?
RST-04-105****	R	R	R	R	R	R	HR	MR
Big Power*****	R	R	R	R	R	R	S	HR
Robusta******	R	R	S	R	R	S	S	?

HR=Highly Resistant **R**=Resistant **MR**=Moderately Resistant **S**=Susceptible

* = De 'Ruiter Seed Co. ** = Sakata Seed Co. *** = Asahi Seed Co. **** = D Palmer Seed Co. ***** = Rijk Zwaan ****** = Bruinsma Seed Co.

ADAPTED FROM: RIVARD, C.L., 2010. GRAFTING FOR OPEN FIELD AND HIGH TUNNEL TOMATO PRODUCTION. PHD DISSERTATION. PG 171.

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Management emphasizes…

Seed treatments

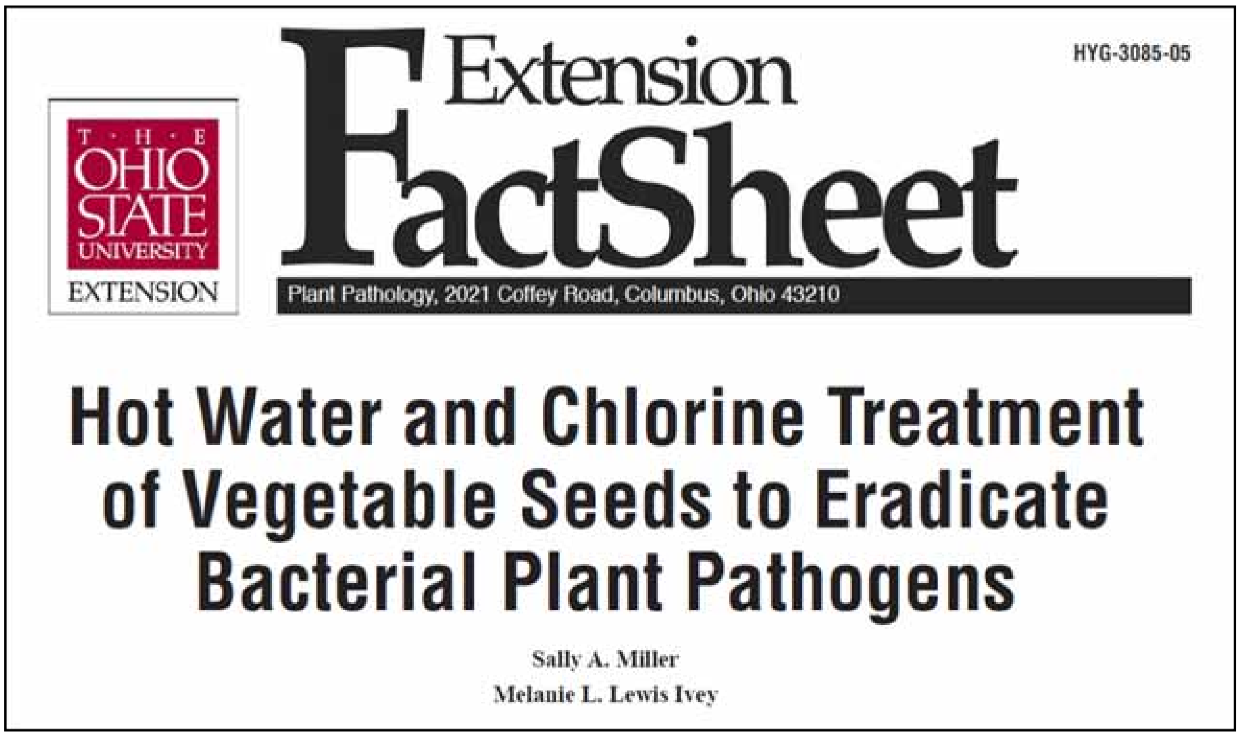
Purpose of seed treatments is…

- ✓ Eradicate seedborne pathogens or protect from seedborne pathogens
- ✓ Improve germination rates
- ✓ Easy handling and accuracy of planting (pelleting)

Seed treatments

Physical seed treatments

- ✓ **Hot-water** seed treatment
- ✓ **Bleach** seed treatment (disinfest only)



THE OHIO STATE UNIVERSITY EXTENSION

Extension FactSheet

HYG-3085-05

Plant Pathology, 2021 Coffey Road, Columbus, Ohio 43210

Hot Water and Chlorine Treatment of Vegetable Seeds to Eradicate Bacterial Plant Pathogens

Sally A. Miller
Melanie L. Lewis Ivey

http://ohioline.osu.edu/hyg-fact/3000/pdf/3085.pdf

Seed treatments

- **Physical seed treatments**
  - ✓ **Biological seed treatments**

Kodiak (*Bacillus subtilis*; Bayer CropSciences)

Mycostop (*Streptomyces grieseoviridis,* Verdera)

SoilGard (*Gliocladium virens,* Certis)

Rootshield (*Trichoderma harzianum,* BioWorks)

Actinovate (*Streptomyces lydicus,* Natural Industries)

In general, research studies have yielded inconsistent results with use of these products.

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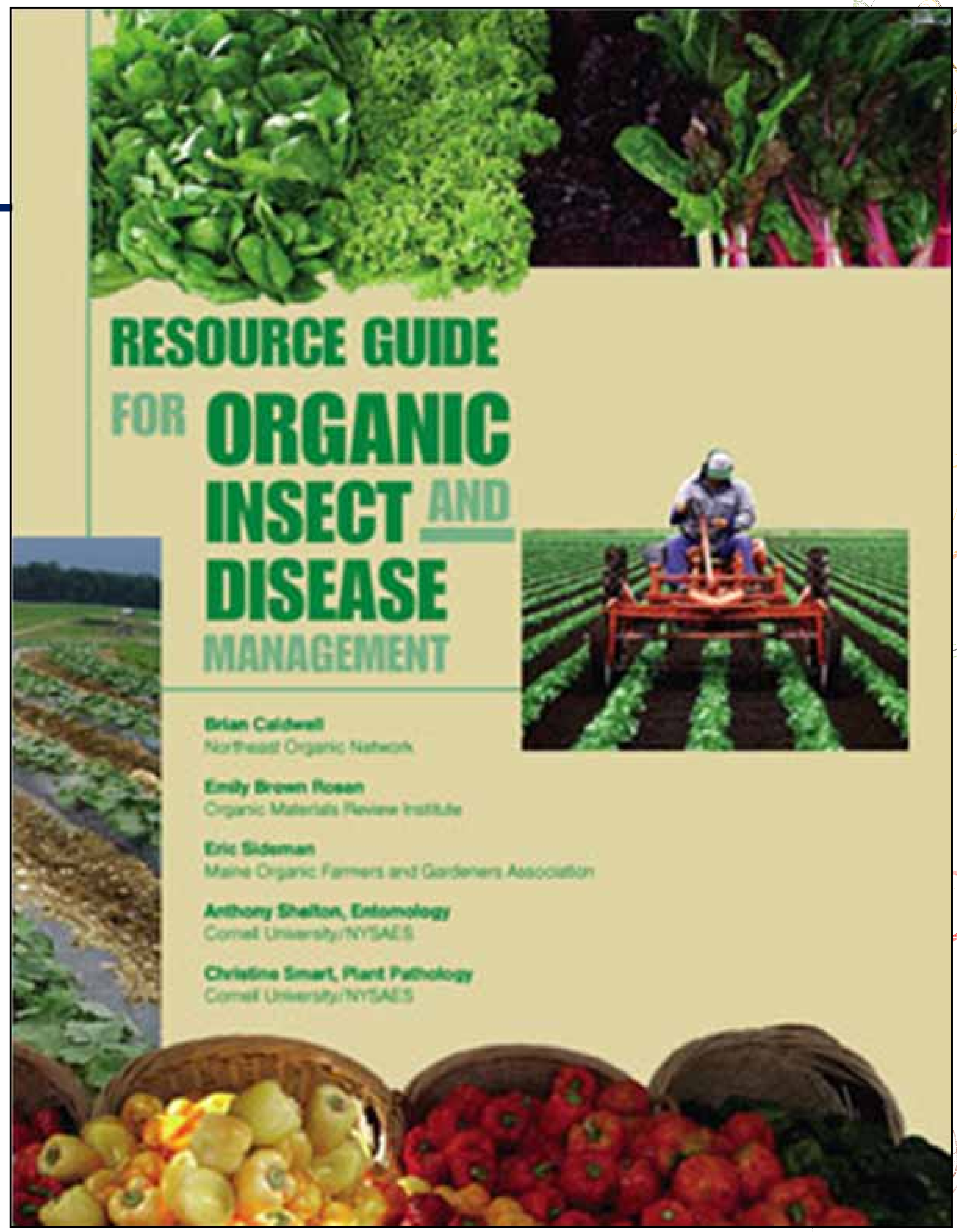
Additional resources

http://web.pppmb.cals.cornell.edu/resourceguide/



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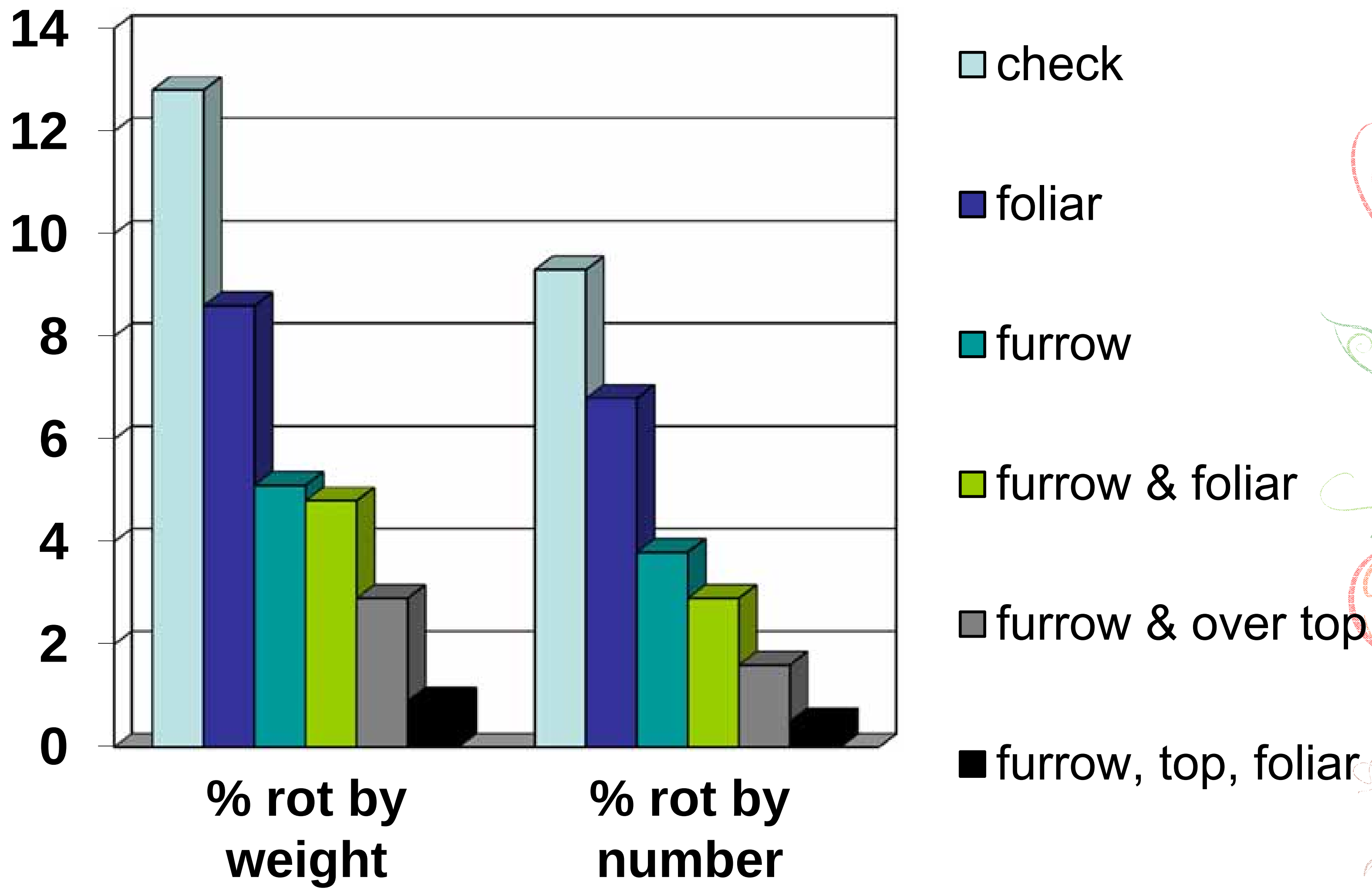
Chemical seed treatments

Crop	Active Ingredient								
	Thiram	Metalaxyl	Mefenoxam	Captan	Azoxystrobin	*Bacillus subtillis*	Fludioxonil	Trifloxystrobin + metalaxyl	*Bacillus pumilus*
Bean, snap	x	x	x	x	x	x	x	x	x
Beets	x	x	x	x			x	x	x
Carrots	x	x	x				x		
Cole crops	x		x	x			x		
Eggplant	x		x				x		
Peas	x	x	x	x		x	x	x	x
Pumpkins	x		x	x			x		
Tomato	x		x				x		

2011 PA Veg Production Guide

Control of pocket rot on beets with different methods of Quadris application.

NYSAES Research Farm, 2008.



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Organic in-furrow and soil treatments

ActinoGrow (*Streptomyces lydicus*; SipcamAdvan)

Actinovate (*Streptomyces lydicus,* Natural Industries)

Evidence of efficacy as a seed trt for damping-off caused by *Pythium* and *Rhizoctonia* spp. on tomato, pepper and lettuce.

Companion (*Bacillus subtilis GB03,* Growth Products, Ltd)

Contans (*Coniothyrium minitans,* SipcamAdvan)

Evidence of efficacy against *Sclerotinia sclerotiorum*.

MeloCon (*Paecilomyces lilacinus,* Certis)

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Organic in-furrow and soil treatments

Mycostop (*Streptomyces grieseoviridis,* Verdera)

Procidic (Citric acid, Greenspire Global, Inc.)

Promax (Thyme oil, Bio Huma Netics, Inc.)

Evidence of efficacy as a seed trt for damping-off caused by *Pythium* spp. and *Fusarium* spp. on cucurbits and tomato.

Rootshield (*Trichoderma harzianum,* BioWorks)

SafeStrike (Blend natural oils and surfactants; Greenspire Global, Inc.)

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Organic in-furrow and soil treatments

Serenade Soil (*Bacillus subtilis QST713,* AgraQuest)

SoilGard (*Trichoderma virens,* Certis)

Evidence of efficacy as a drench for damping-off caused by *Pythium* spp. on lettuce also Phytophthora blight on summer squash

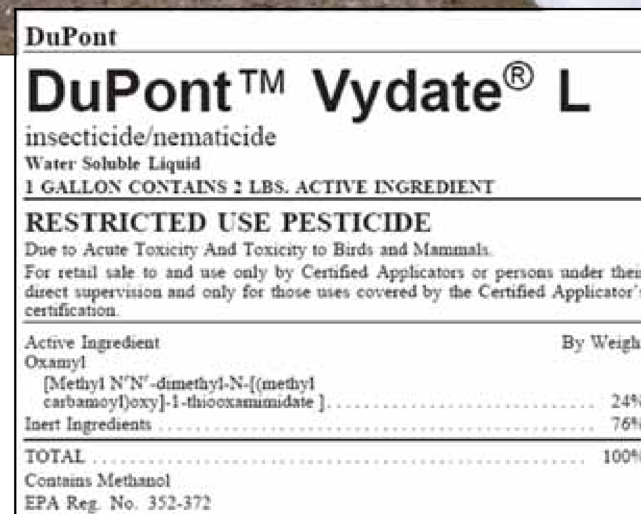
Subtilis Biological Fungicide (*Bacillus subtilis* MBI600, Becker Underwood)

Tenet (Two *Trichoderma* spp., SipcamAdvan)

TerraClean (Hydrogen dioxide + Peracetic acid, BioSafe Systems) formerly ZeroTol

Chemical soil treatment

- **Fumigants** - general biocides that are injected and diffuse upward and laterally and usually require tarping or soil sealing
  - ✓ Efficacy is affected by temperature, rainfall, soil texture, etc.



- **Non-fumigant nematicides** – more narrow spectrum of activity and move by percolation in water, active at lower doses and can be applied at planting

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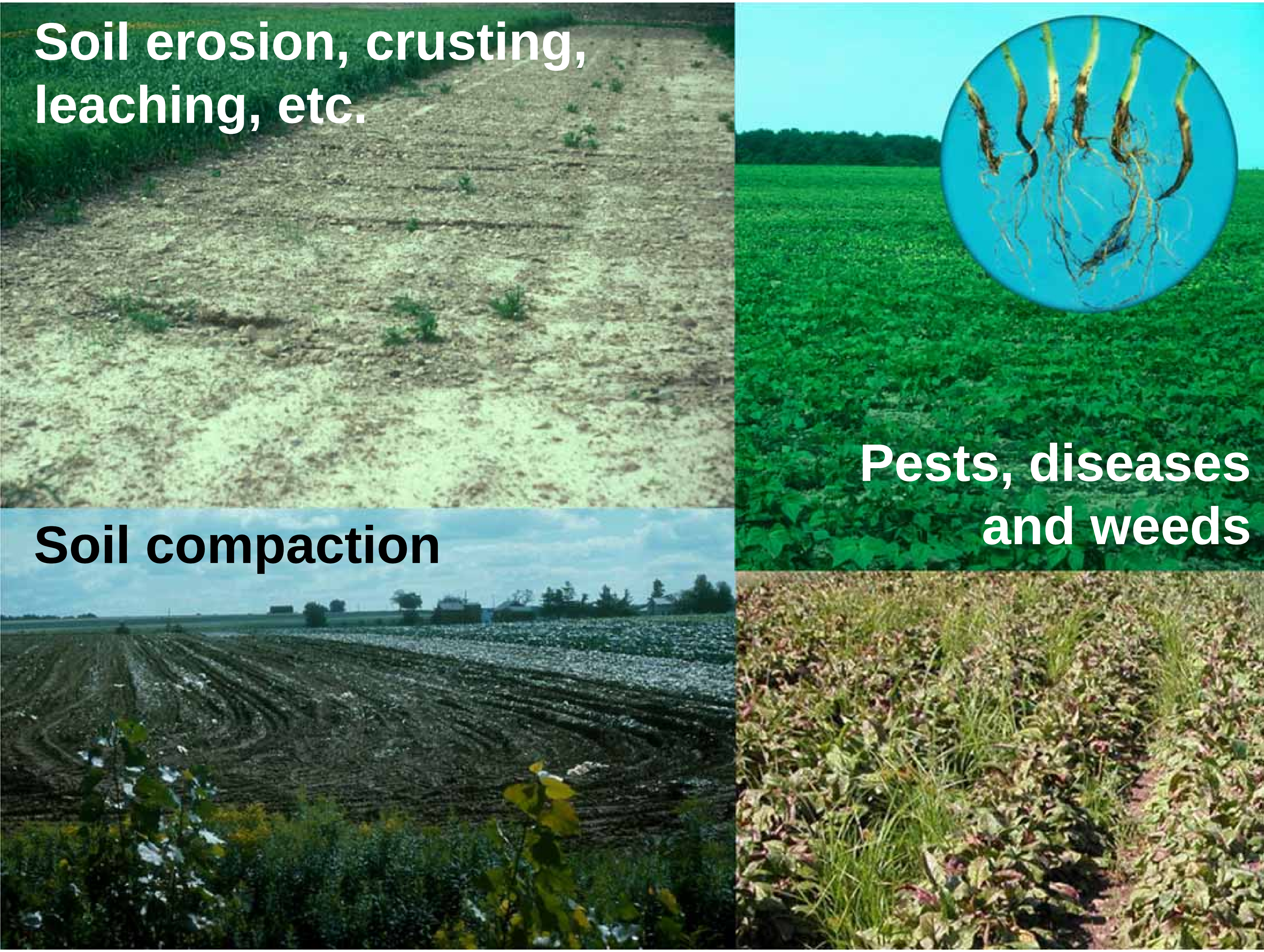
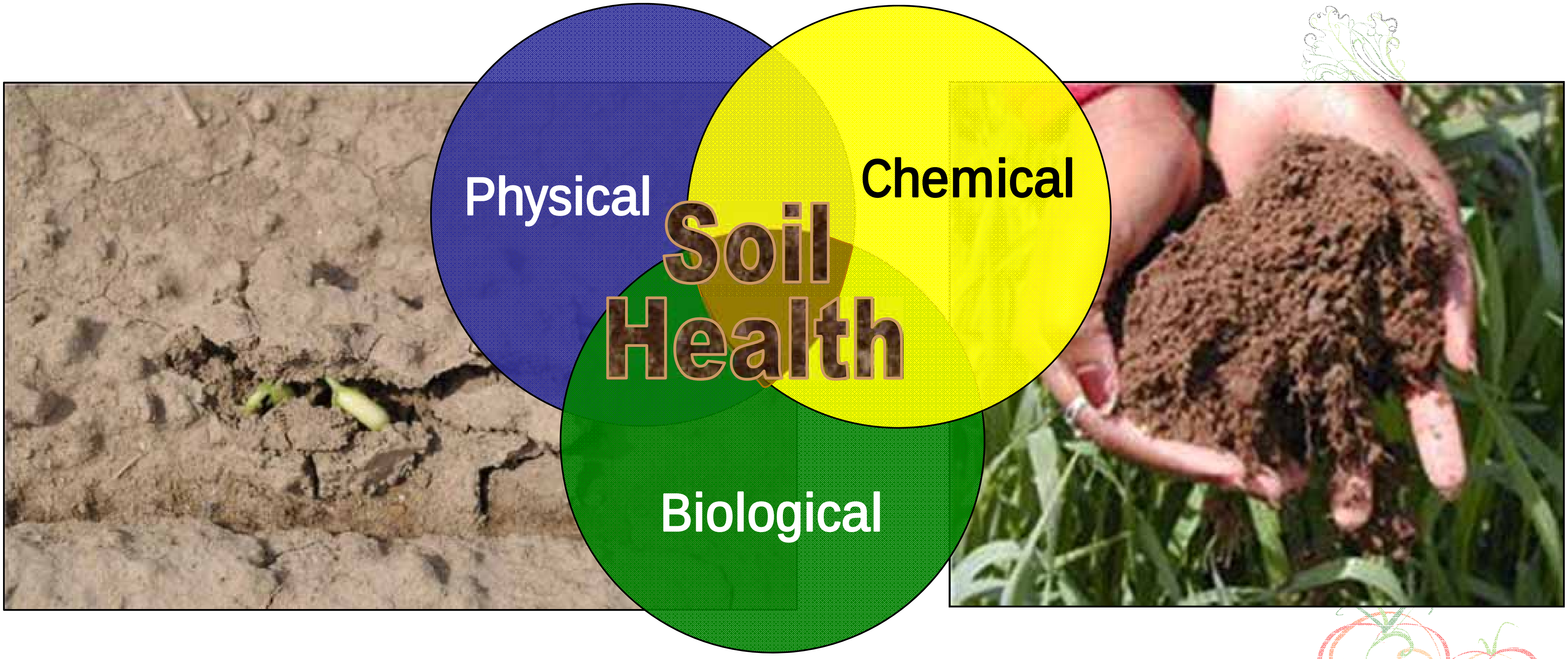
General management strategies

- **Long-term practices** should focus on alleviating soil constraints or barriers to crop production such as:
  - Poor aggregation and soil crusting
  - Soil compaction and poor drainage

Ray Weil, Univ. MD


Soil erosion, crusting, leaching, etc.
Pests, diseases and weeds
Soil compaction

Soil health concept



Emphasizes integrating and optimizing the biological, chemical and physical properties of soil as they affect farm profitability and environmental sustainability

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A healthy soil has....

- ✓ Good soil tilth
- ✓ Sufficient depth
- ✓ Sufficient but not excess supply of nutrients
- ✓ Good soil drainage
- ✓ Small population of plant pathogens and other pests
- ✓ Low weed pressure
- ✓ Large populations of non-pathogenic organisms
- ✓ Free of chemicals and toxins that may harm plants
- ✓ Resistant to degradation
- ✓ Resilient when unfavorable conditions occur

Fred Magdoff Univ. of VT (personal communication)

Aspects of soil health

Inherent soil quality

Results from natural soil forming processes and factors

interaction

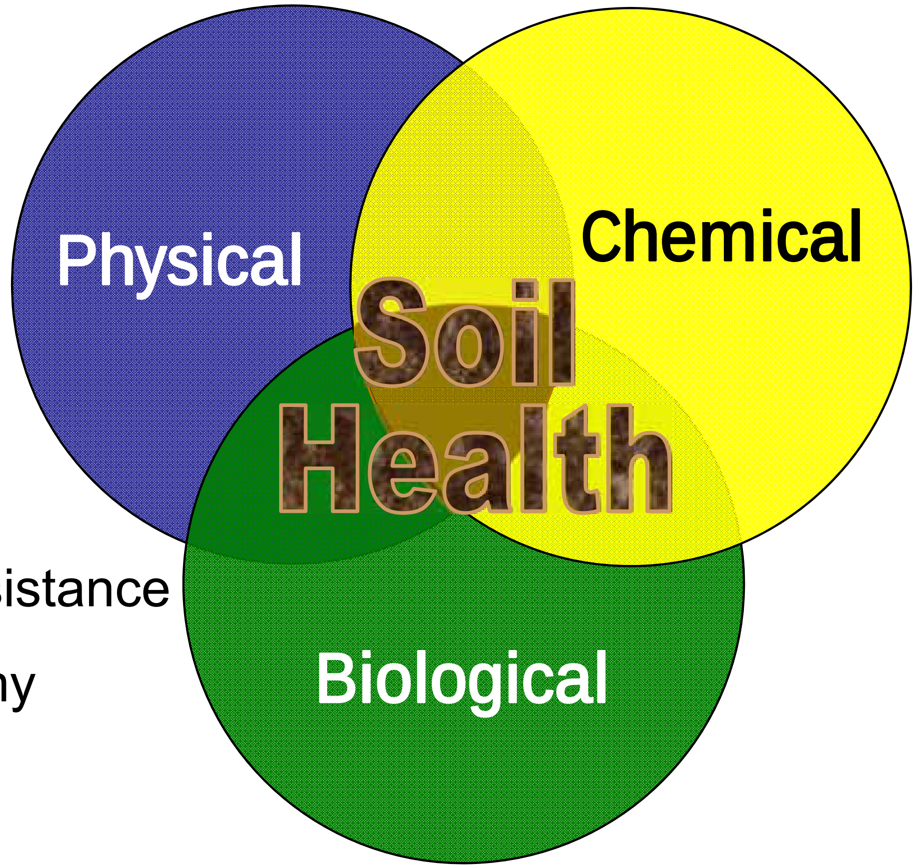
Dynamic soil quality

Changes due to human use and management

(Pierce and Larson, 1993)

How do we measure soil health?

- ✓ Aggregate stability
- ✓ Water infiltration rate
- ✓ H_2O holding capacity
- ✓ Pore size distribution
- ✓ Soil penetrometer resistance
- ✓ Soil texture / taxonomy
- ✓ Etc.



- ✓ pH
- ✓ % organic matter
- ✓ Cation exchange capacity
- ✓ Total carbon & nitogen
- ✓ Macronutrients
- ✓ Micronutrients
- ✓ Heavy metals, toxins
- ✓ Etc.

- ✓ Disease suppressive capacity of the soil
- ✓ Specific pathogens (eg. pathogenic nematodes)
- ✓ Specific beneficials (eg. earthworms, mycorrhizal fungi, free-living nematodes)
- ✓ Rate of microbial N cycling
- ✓ Decomposition rate
- ✓ Etc.
- ✓ Active carbon
- ✓ Respiration
- ✓ DNA profiles

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2011 Cornell Soil Health Test Indicators

Soil Indicator	Soil Process (function)
Soil texture and stone content	all
Aggregate stability	aeration, infiltration, shallow rooting, crusting
Available water capacity	plant-available water retention
Soil strength (penetration)	rooting
Organic matter content	energy C storage, water & nutrient retention
Active carbon content	organic material to support biological function
Potentially mineralizable nitrogen	ability to supply N
Root health rating	soil-borne pathogen pressure
pH	toxicity, nutrient availability
Extractable P	P availability, environmental loss potential
Extractable K	K availability
Minor element content	micronutrient availability, elemental imbalances, toxicity

Cornell Soil Health Test Report

- Establish a baseline assessment
- Compare field(s) to benchmark
- Monitor impact of soil management practices
- Conduct on-farm side-by-side comparisons

CORNELL SOIL HEALTH TEST REPORT (COMPREHENSIVE)

Name of Farmer: Chazy Plots	Sample ID: E147
Location:	Agent: Bob Schindelbeck, Cornell University
Field/Treatment: CH 14	Agent's Email: 0
Tillage: 7-9 INCHES	Given Soil Texture: SILTY
Crops Grown: COG/COG/COG	Date Sampled: 4/25/2007

	Indicators	Value	Rating	Constraint
PHYSICAL	Aggregate Stability (%)	22	25	aeration, infiltration, rooting
PHYSICAL	Available Water Capacity (m/m)	0.18	63	
PHYSICAL	Surface Hardness (psi)	107	78	
PHYSICAL	Subsurface Hardness (psi)	400	13	Subsurface Pan/Deep Compaction
BIOLOGICAL	Organic Matter (%)	2.1	14	energy storage, C sequestration, water retention
BIOLOGICAL	Active Carbon (ppm) [Permanganate Oxidizable]	462	21	Soil Biological Activity
BIOLOGICAL	Potentially Mineralizable Nitrogen (µgN/ gdwsoil/week)	2.0	0	N Supply Capacity
BIOLOGICAL	Root Health Rating (1-9)	2.3	88	
CHEMICAL	*pH	8.3	0	Toxicity, Nutrient Availability (for crop specific guide, see CNAL report)
CHEMICAL	*Extractable Phosphorus (ppm) [Value <3.5 or >21.5 are downscored]	9.5	100	
CHEMICAL	*Extractable Potassium (ppm)	20	11	Plant K Availability
CHEMICAL	*Minor Elements		56	
	OVERALL QUALITY SCORE (OUT OF 100):		39.1	Very Low

Measured Soil Textural Class:==> silt loam

SAND (%): 17.0 *SILT (%): 77.0* *CLAY (%): 6.0*

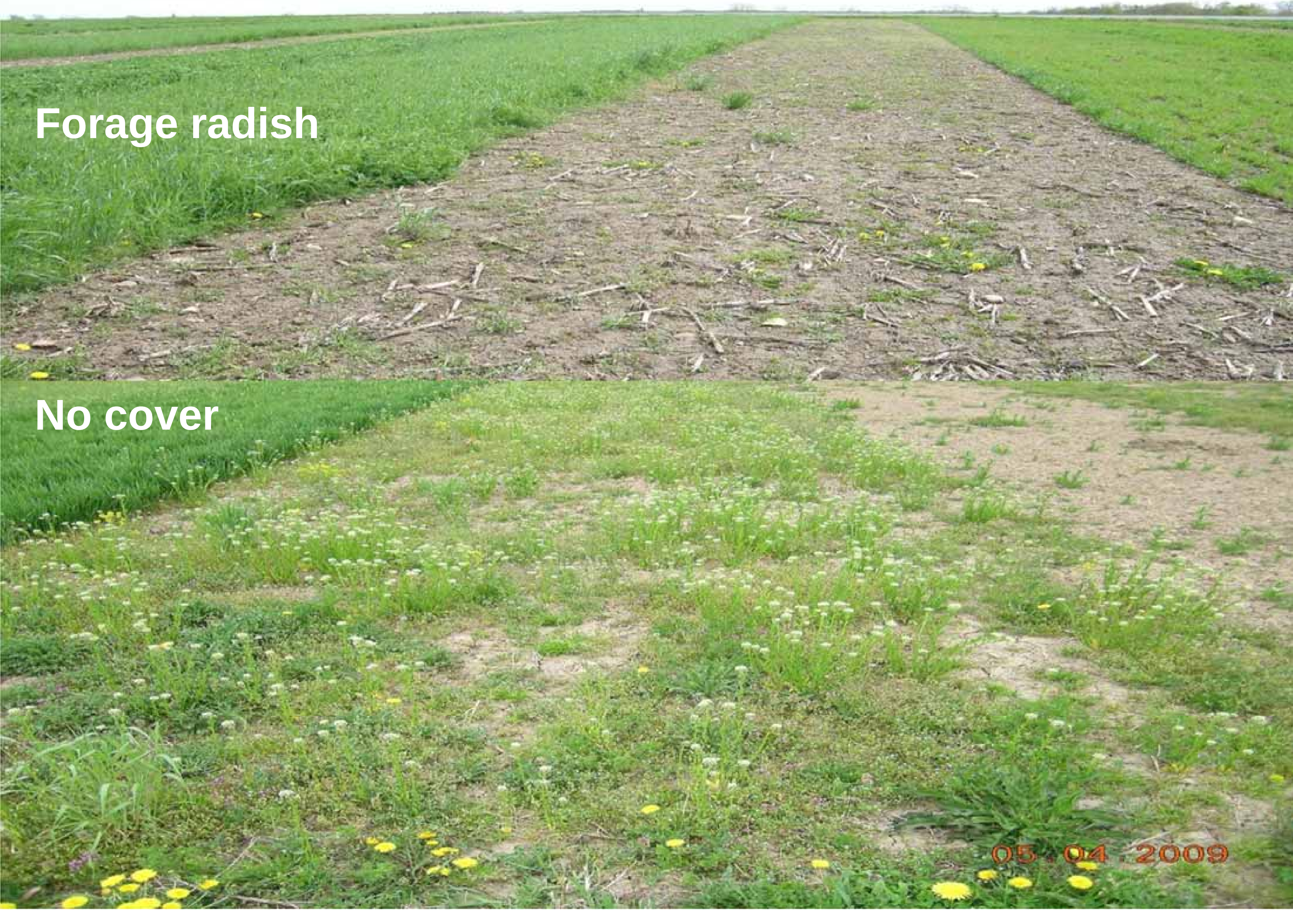
Location (GPS): Latitude=> 0 Longitude=> 0

* See Cornell Nutrient Analysis Laboratory report for recommendations

Linking indicators to management

- **LOW AGGREGATE STABILITY:** reduce tillage, shallow-rooted cover/sod crops, manure, compost
- **LOW AVAILABLE WATER CAPACITY:** add stable OM (compost); reduce tillage
- **HIGH PENETROMETER READINGS:** deep tillage/zone building, deep-rooted cover crops
- **LOW ACTIVE CARBON:** cover crops, sod rotation crops, manure, compost
- **LOW POTENTIALLY MINERALIZABLE NITROGEN:** add OM, leguminous cover/rotation crops
- **HIGH BULK DENSITY:** add OM through cover crops, perennial sod crops, manure, compost; limited soil loosening
- **HIGH ROOT ROT RATING:** proper rotation, cover crops

Effects of Cover Crops on Early Season Weed Suppression



Effects on Physical Properties

Website

http://soilhealth.cals.cornell.edu

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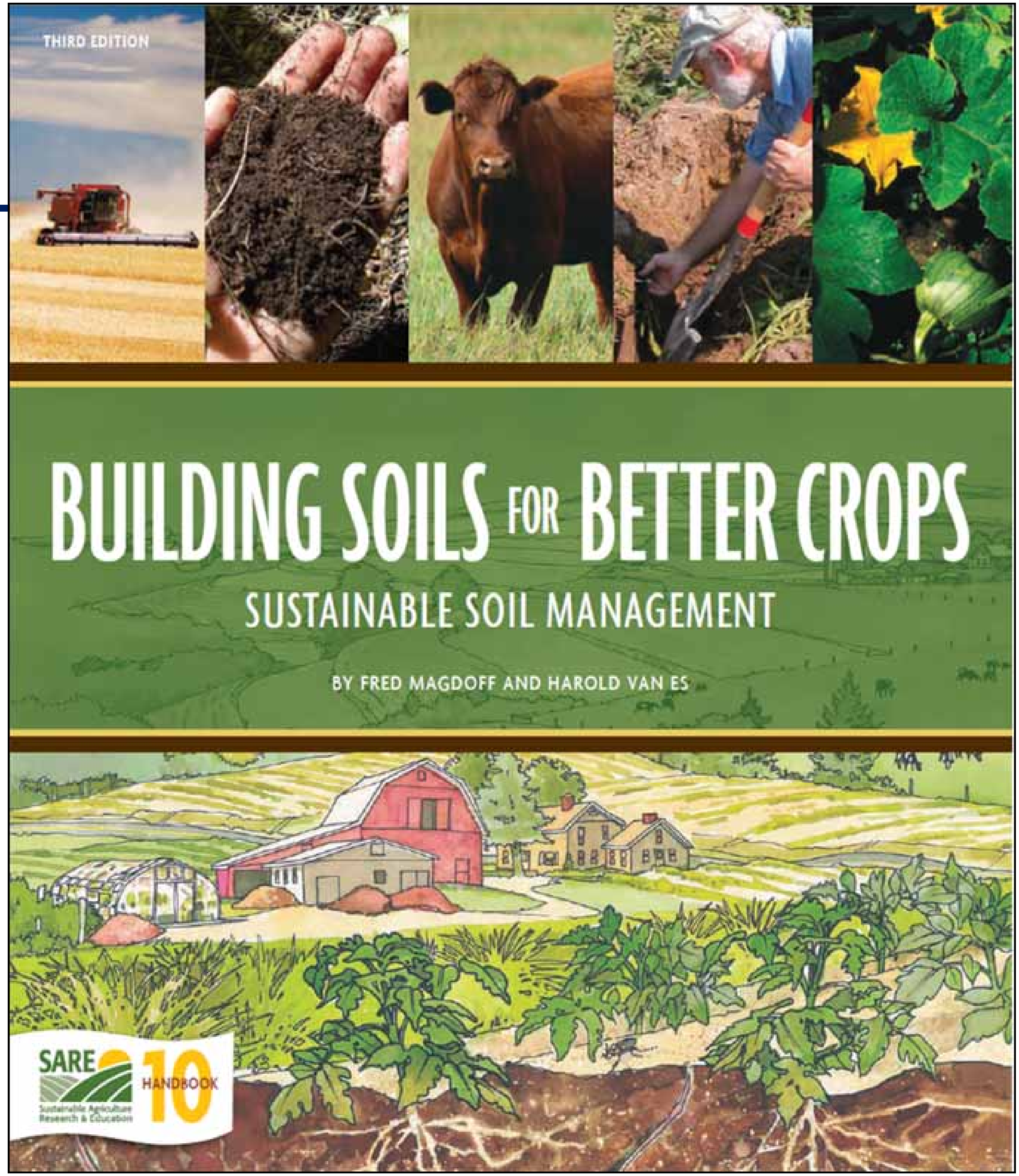
Additional resources

http://www.sare.org/Learning-Center/Books



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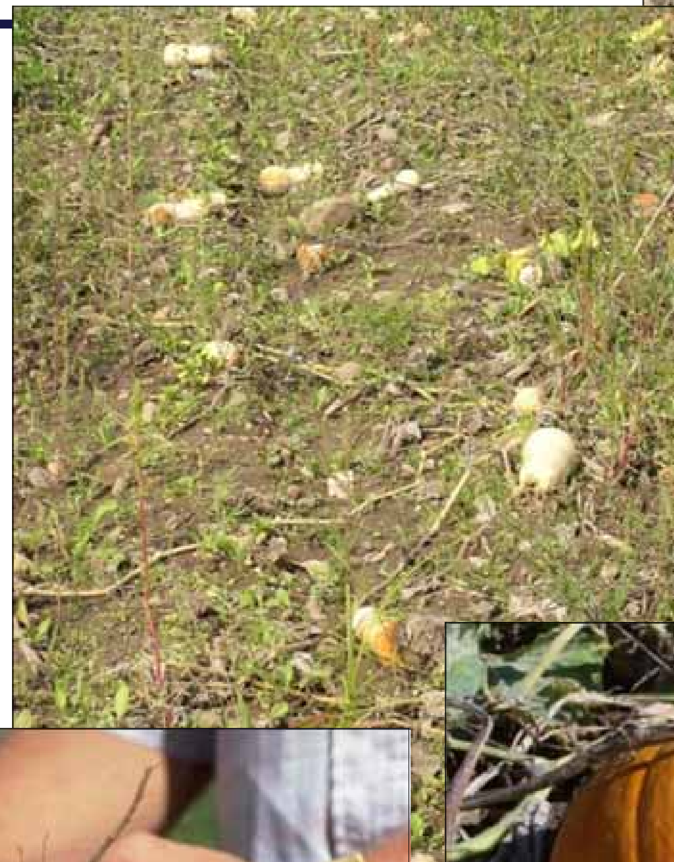
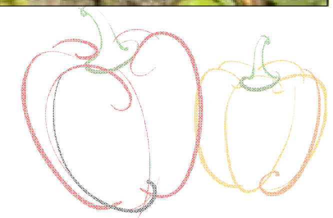
Phytophthora Blight





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Phytophthora blight management

- First line of defense =
  Keep Phytophthora out!

- ✓ Don't dispose of **culled plants** or fruit in a vegetable field.

- ✓ **Clean equipment**, tools and boots between fields.

- ✓ Know where your **irrigation water** comes from – surface water vs wells.

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Phytophthora blight management

➡ If you already have Phytophthora….

- ✓ **Avoid** planting severely **infested field** or low areas of the field.

- ✓ **Improve soil drainage** – deep ripping of subsoil, raised beds (not vining crops), avoid water pooling at base of plant, monitor irrigation, plant drives.

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Phytophthora blight management

- **If you already have Phytophthora….**
  - ✓ **Moldboard plow???**

Phytophthora blight and mustards

Caliente 199 mustard on Long Island, NY

- ✓ Drill or broadcast early spring or fall (10lb/A)
- ✓ 50 to 100lb N to increase mustard biomass
- ✓ Incorporate 5 to 6 weeks following flowering – flail chop then incorporate (cultipack) and seal soil
- ✓ Plant 2 weeks later

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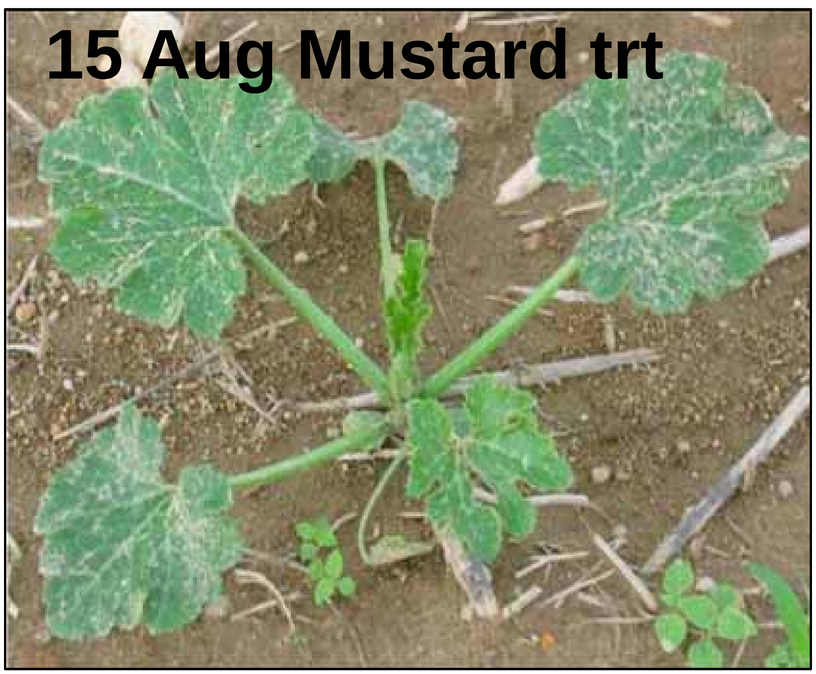
Phytophthora blight and mustards

➡ 2008 Trial on Long Island, NY by Meg McGrath

- ✓ 6 May – Drilled mustard
- ✓ 7 July – Chopped, rototilled, cultipacked, irrigated
- ✓ 23 July – Seeded zucchini



Phytophthora blight management

➡ **If you already have Phytophthora….**

✓ **Plant tolerant varieties**

Variety	Tolerance		
Sweet Peppers	**High**	**Moderate**	**None**
Intruder	x		
Paladin	x		
Aristotle		x	
Declaration		x	
Revolution		x	
Vanguard		x	
Karisma			x
Red Knight			x

Harder rinded pumpkins have a little tolerance.

Phytophthora blight management

➡ If you already have Phytophthora….

- ✓ **Crop rotation** every year out of a susceptible host reduces the number of viable oospores
- ✓ **Manage weed hosts** such as American black nightshade, common purslane, Carolina geranium

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Phytophthora blight management

➡ If you already have Phytophthora….

- ✓ **Rogue out** infected plants when possible – the sooner the better!

  Infected plants in the field serve as an inoculum source for later in the season.

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Phytophthora blight management

If you already have Phytophthora….

- ✓ **Chemical fungicide options**

Keep in mind *P. capsici* is a **highly variable**/ changeable pathogen (similar to *P. infestans*)

In NY, most fields had both mating types = oospores = genetic diversity

Fungicide resistance can develop quickly

- ✓ Resistance to mefenoxam is very common in US.

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Phytophthora blight management

➡ **If you already have Phytophthora….**

✓ **Chemical fungicide options**

For **crown and stem rot phase**:

✓ Ridomil Gold SL (mefenoxam, FRAC 4)

✓ MetaStar AG (metalaxyl, FRAC 4)

✓ Ultra Flourish 2E (mefenoxam, FRAC 4)

- 3 applications (at transplanting & 30-day intervals)
- Applied through drip or banded
- Don’t use if mefenoxam resistance

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Phytophthora blight management

➡ If you already have Phytophthora….

✓ Chemical fungicide options

For **aerial phase** **SUPPRESSION** only:

- ✓ Presidio(fluopicolide, FRAC 43)
- ✓ Revus (mandipropamid, FRAC 40)
- ✓ Forum (dimethomorph, FRAC 40)
- ✓ Ranman (cyazofamid, FRAC 21)
- ✓ Ridomil Gold Copper (mefenoxam + copper, FRAC 4+M1)
- ✓ Fixed copper (FRAC M1)

White mold (*Sclerotinia sclerotiorum*)

- Soilborne pathogen with a wide host range (400+)
- Severity is highly dependent on favorable weather conditions for the pathogen….wet and 68-77°F

Snap bean, tomato, cabbage, carrot, cucurbits, soybean, sunflower, alliums…most vegetables

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White mold (*Sclerotinia* spp.)

- Select fields with **good air drainage** – avoid hedge rows, tree lines
- **Avoid** planting **contaminated seed**
- **Avoid** planting in **heavily infested fields** – extend rotations with non-host grain and corn crops
- If possible, select varieties that bloom evenly and have a short blossom period
- **Maximize row spacing** to facilitate good air flow and drying of foliage

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White mold (*Sclerotinia* spp.)

- **Optimize plant fertility** – over fertilization = lush dense canopy
- **Manage weeds** – potential hosts and creates more favorable microclimate
- **Minimize** any **injury** to the crop
- **Incorporate crop debris** immediately following harvest – facilitates breakdown of sclerotia by microbes
- Apply **well timed fungicide sprays** at flowering and ensure good blossom coverage

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Spray timing for white mold management

- **Two sprays are still recommended…**
  - **1st spray at 10 to 40% bloom**
  - **2nd spray 7 to 10 days later**

- **How to determine % bloom?**
  - Count the number of plants with 1^+ open blossoms on 10 consecutive plants in 10 locations in the field and average the result.

2008 Snap Bean Fungicide Trial

H. Dillard & A. Cobb, Cornell

Treatment, rate/A, Application timing ( )	Gray mold (%)		White mold (%)	
Untreated control	3.9	a	24.3	a
Endura 70WDG, 8oz (A,B)	1.4	cd	5.6	cd
Endura 5 oz + Topsin M 4.5F, 20 fl oz (A,B)	1.6	cd	1.2	d
Rovral 4F, 2 pt (A,B)	1.9	cd	3.3	d
Rovral 1.5 pt + Bravo WS 3 pt (A,B)	1.7	cd	11.9	b
Rovral + Topsin M 14 fl oz (A,B)	1.3	cd	5.1	d
Topsin M 4.5F, 20 fl oz (A,B)	3.3	a	1.5	d
Bravo WS 3 pt + Topsin M 14 fl oz (A,B)	2.1	bc	4.6	d
Switch 62.5WG 12 fl oz (A,B)	1.9	bcd	12.1	b
Champion 3 lb + Endura 5oz (A,B)	1.1	cd	6.6	bcd
Quadris 6.2 fl oz + Topsin M 20 fl oz (A,B)	2.1	bc	2.8	d
Rovral + Headline 8 fl oz (A,B)	3.1	ab	11.4	bc

A = 32% bloom, 7 July
B = 100% bloom + pins, 14 July

3 to 6% rejection threshold for pods with mold.

Coniothyrium minitans

- Mycoparasite of Sclerotinia spp.
- Commercially formulated and available as **Contans WG** (distributed by Advan LLC)
- Sold as conidia (spores) that are dried and mixed with glucose
- Product is mixed with water and sprayed on the soil

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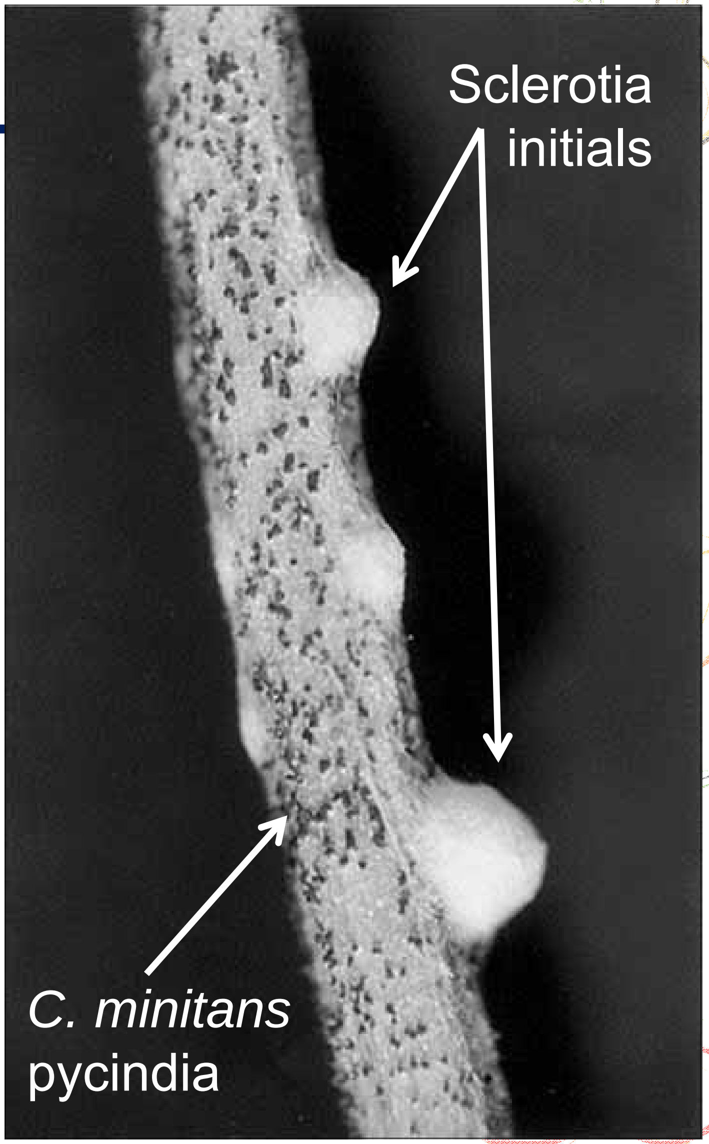
Coniothyrium minitans

- Applied in fall just after harvest (1 lb/A) or in spring (2 lb/A) 2 to 3 months before snap bean flowering (excellent coverage required).
- Product is incorporated into the top 1 or 2 inches of the soil….care must be taken to not disturb the soil and expose buried sclerotia.
- Does not readily persist in the soil in the absence of sclerotia.



Sclerotia initials on bean stem colonized by *C. minitans*.
(Gerlah et al. Phytopath. 1999)

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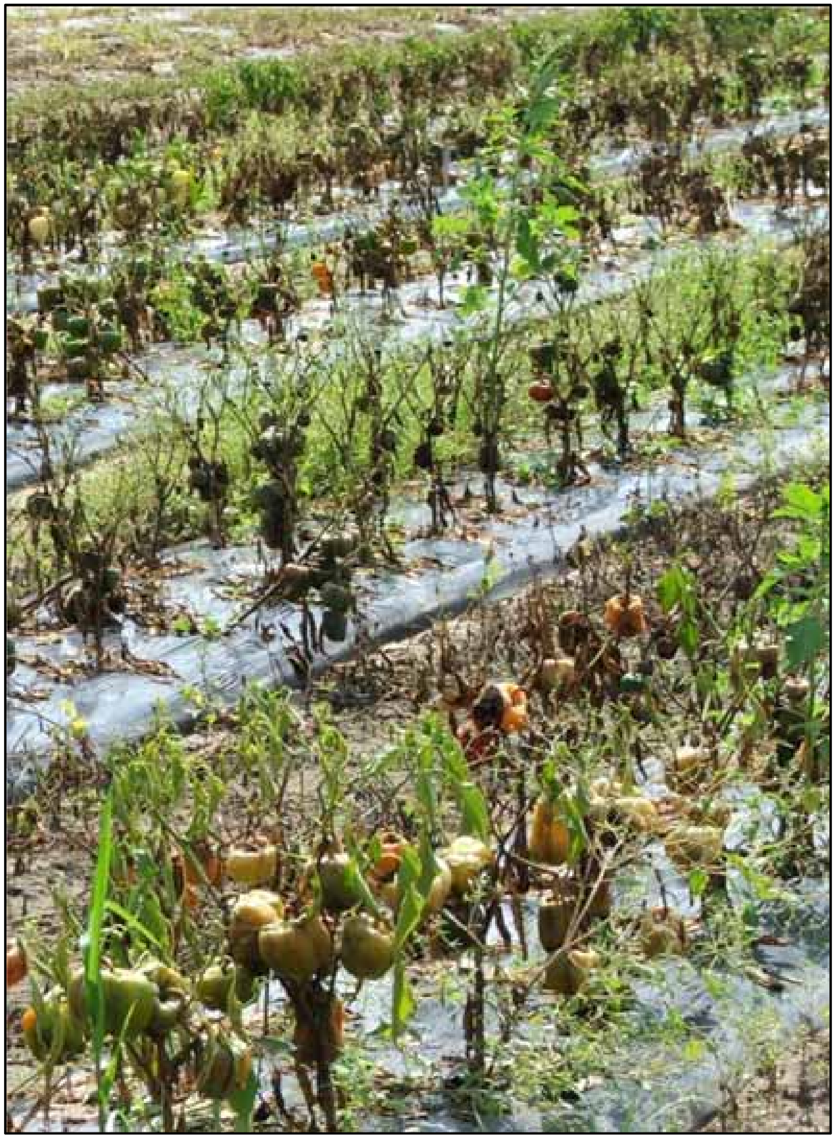
Identification, Assessment and Management of Soilborne Plant Pathogens in Vegetable Production Systems



Questions on the management of soilborne pathogens and diseases?

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