Linking Cover Crops, Plant Pathogens and Disease Control in Organic Tomatoes

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THE OHIO STATE UNIVERSITY OARDC

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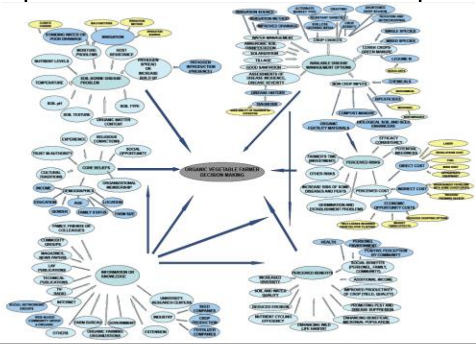
Mixed Cover Crops for Soilborne Disease Suppression

- Goal 1: Assess grower knowledge and fill gaps with essential information on cover crops, inoculants, and tomato disease suppression
- Goal2 :Evaluate and enhance the effects of mixed species green manures on productivity and plant disease suppression in tomato

Extension/Outreach Goals

- Assess the needs and knowledge gaps of growers related to cover crop use, soilborne disease management, and microbial biopesticides
- Develop useful materials that enhance organic growers' capacities to better control soilborne diseases through the use of cover crops and microbial inoculants in vegetable cropping systems

Defining Knowledge Gaps: Expert and Grower Model Development

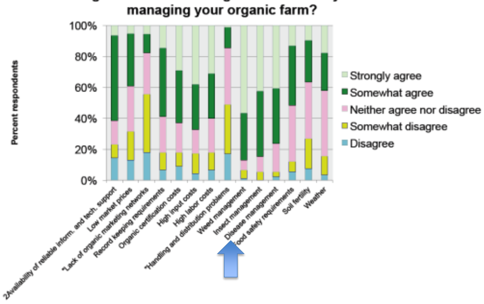


Assessing Knowledge Gaps: 2011 Grower Survey

- Survey designed to quantify knowledge base and identify gaps in grower knowledge
  - Topical focus: Cover crops, disease management, inoculant/biopesticide use
  - 40 Multiple choice and 10 open-ended questions
  - 93 respondents (29% response rate) from throughout North Central and Northeastern Region
  - 71% vegetable farmers, with ~45% listing tomato as top crop in acreage and/or value, and 57% listed tomato as the crop with biggest disease problems

Survey Results: The Challenge of Plant Diseases

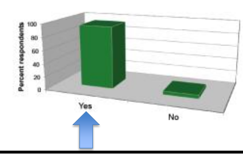
Fig. 2. To what extent do you agree or disagree that the following factors are challenges or obstacles you face in managing your organic farm?



Grower Knowledge Gap: Organic Soilborne Disease Management

Fig. 3. How familiar are you with soil-borne disease management practices?

Fig. 5. Do you need more information about soil-borne disease management in organic vegetable production?



Survey Results: Cover Crops

- Majority of growers (68%) surveyed use cover crops
  - <u>Mixed species cover crops were most commonly used</u>
  - Perceived benefits varied by grower & CC choice
  - Significant limitations to effective use noted by growers
    - Seed and equipment cost, yield loss due to delayed planting and shortened growing season were most significant (>40% strongly agreed)
    - Fuel costs, limited growing options, and germination/establishment were also important (>25% strongly agreed)

Survey Results: Microbial Inoculants

- Nearly half of organic growers use microorganisms and/or biopesticides
  - 43% used inoculants and 49% used biopesticides
    - Inoculants for legume crops, but rarely cover crops
    - Biopesticides used mainly for foliar diseases and pests
    - 51% thought cost justified use, but 74% waited until after symptom appearance to make application

Bridging the Gap through Extension

- Published 6 New Online Fact Sheets
- Presented Multiple Workshops to Organic Growers
  - In cooperation with OEFFA (2011, 2012)
  - As part of annual Extension programming in MD, NY, and OH
- Presented 2 Webinars through eOrganic

Mixed Cover Crops for Soilborne Disease Suppression

- Goal 1: Assess grower knowledge and fill gaps with essential information on cover crops, inoculants, and tomato disease suppression

- Goal2 :Evaluate and enhance the effects of mixed species green manures on productivity and plant disease suppression in tomato

Field Research Goals

- Evaluate the efficacy and value of mixed-species green manures in organic vegetable production

- Characterize the linkages between microbial community structure and soilborne disease suppression

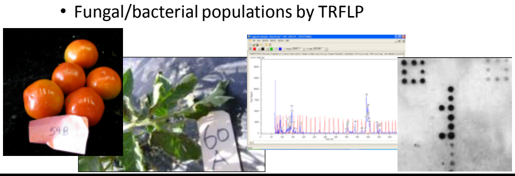
- Evaluate mixed-species cover crops as vehicles for delivering enhanced suppression by microbial biopesticides

Field Studies of Cover Crops and Disease Suppression

- Main treatments
  - No, single and mixed cover crops followed by fresh market tomato cash crop
  - Rye, vetch, clover, tillage radish alone and in combination
  - 12 site years of data; 2 years x 6 fields (3 OH, 2 NY, 1 MD) analyzed to date

Field Studies of Cover Crops and Disease Suppression

- Responses measured
  - Soil fertility and organic matter
  - Crop growth, yield, and disease
  - Rhizosphere microbial population structure
    - Pathogens by macroarray
    - Fungal/bacterial populations by TRFLP



Complication:

Cover Crop Establishment Varied by Site and By Year

a. Mixed species hay established in fall and spring

b. Tillage radish in late fall and the following spring

Productivity Varied More by Site & Year than Cover Crop Treatment

New York

Year	Treatments / Field	No cover	Rye	Turnip & Rye	Rye & Vetch	Clover & Rye
2010	West	17.62±0.29a[2]	17.21±1.67a	14.08±0.50b	13.5±0.52b	13.18±0.36b
	East	22.97±0.96	22.72±0.59	29.92±1.77	26.37±0.91	27.4±1.74
2011	West	28.91±0.435a	29.445±1.0ab	23.76±0.13b	30.28±1.48a	25.04±0.71b
	East	36.31±1.87	35.21±0.89	36.02±1.19	39.4±1.27	37.54±0.90

Ohio

Year	Treatments / Field	Natural Hay	Rye	Radish fallow	Rye & Vetch	Vetch
2010	Fry	6.32±0.7	7.06±0.23	6.04±0.49	7.01±0.22	8.04±0.26
	FryA	1.77±0.4	3.36±0.38	2.36±0.47	4.06±0.32	3.3±0.36
	EB	4.76±0.21	3.49±0.26	3.89±0.32	4.66±0.22	4.62±0.31
2011	Fry	14.8±0.5	15.88±0.6	15.77±0.63	13.4±0.51	15.31±0.71
	FryA	12.3±0.34	11.09±0.21	12.14±0.22	11.75±0.14	10.99±0.28
	EB	6.68±0.32	5.534±0.31	5.72±0.43	5.645±0.28	6.34±0.13

Maryland

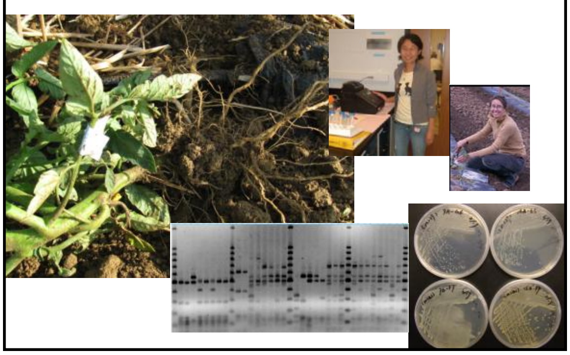
Year	Treatments	No cover	Mixed Hay	Radish & Vetch	Rye & Vetch	Vetch
2010		31.25±1.35b	33.98±1.15b	23.52±3.42a	20.68±2.97a	39.0±1.57b
2011		97.62±2.44bc	93.25±1.89c	106.28±2.8ab	101.38±1.32abc	112.08±1.6a

2 year Results Summary

<u>Field</u> was reliable predictor of CC performance in 5 of 6 instances

	Total S[1]/ Total[2]	Total B[3]/ Total
Productivity Measurements[4]		
Marketable Yield (weight)	0/12	4/12
Total Yield (weight)	0/12	4/12
Shoot biomass 1	2/12	3/12
Shoot biomass 2	0/12	4/12
Soil pH	1/12	5/12
Soil organic matter (%)	3/12	7/12
Disease Ratings[5]		
Early blight	4/12	5/12
Septoria blight	3/12	4/12
Phytopthora blight	1/4	2/4
Leaf mold	0/2	1/2
Late blight	0/2	0/2
Southern blight	0/2	1/2
Bacterial Spot	0/3	0/3
Inoculated Bacterial Spot[6]	0/3	0/3
Inoculated Bacterial Spot	0/3	0/3
Inoculated Bacterial Spot	0/3	0/3
Inoculated Bacterial Spot	0/3	0/3
Plant Pathogenic Nematode Counts[7]		
Tylenchus spp. Time 1	0/2	1/2
Aphelenchus spp. Time 1	1/2	1/2
Total plant parasitic nem. T1	1/2	2/2

Rhizosphere Sampling And Analyses



Percent of Roots Harboring Soilborne Pathogens of Tomato

	Pathogen	NY2010	OH2010	MD 2010	NY 2011	OH 2011	MD 2011
Fusarium oxysporum	Fo	38	41	15	35	60	25
Alternaria alternata	Aa	14	35	7	21	54	29
Fusarium solani	Fs	7	4	1	6	27	18
Phoma destructive	Pd	10	19	3	13	36	22
Septoria sp.0599	S	8	11	5	2	27	7
Phytophthora capsici	Pc	1	–	–	–	–	–
Colletotrichum spp.	C	–	11	–	–	18	–
Pythium aphanidermatum	Pa	–	4	–	–	–	–
Pyrenochaeta lycopersici	Pl	–	3	–	–	7	–
Pythium ultimum	Pu	–	9	10	–	–	–
Pythium crytoirregulare	Py	–	–	1	–	–	–
Rhizoctonia solani	Rs	–	2	–	–	15	7
Pythium irregulare	Pr	–	–	3	–	–	–
Verticillium albo-atrum	Va	–	–	2	–	–	–
Phytophthora nicotianae	Pn	–	–	–	–	1	–

Variation in Tomato Rhizosphere Populations and Induced Resistance by Cover Crop

State	New York				Ohio						Maryland			
Year	2010		2011		2010			2011			2010	2011		
Field	East	West	East	West	Fry	FryA	EB nobio	Fry	FryA	EB	A	A		Total B+S[3]/
T-RFLP Band													Total S/Total	Total
Total 16S 1	NS	NS	NS	NS	NS	B	NS	NS	NS	NS	NS	NS	0/12	1/12
Total 16S 2	NS	NS	B	NS	NS	NS	NS	NS	NS	S	NS	NS	1/12	2/12
Total ITS 1	NS	NS	NS	NS	NS	NS	NS	NS	NS	S	NS	NS	1/12	1/12
Total ITS 2	S	NS	B	NS	S	S	NS	S	B	S	NS	NS	5/12	7/12
X97.1												S		
X125				S			S							
X125.1	S											S		
X127	S													
X132.1												S		
X133														
X133.1														
X134.1												B		
X135.1												B		
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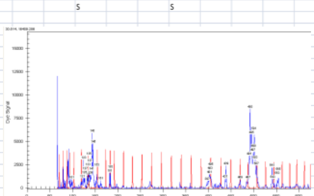

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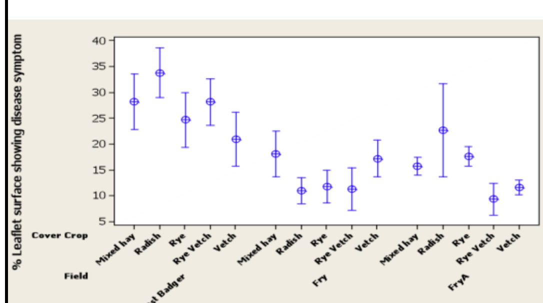

Microbial Inculation of CC

- Goal: Determine if CC can serve as a vehicle for delivering microbial inoculants, boosting their populations and beneficial activities

Field Research Summary

- Considerable year to year variation in field performance of CC at each location
  - No simple recommendation for mixed vs. single vs. no CC based on 12 site years of data
  - Response of organic tomato crop to CC additions dependent on timing of planting, incorporation and transplanting as well as site characteristics

Overall Summary

- Yield and Disease Responses have site-specific tendencies
  - Microbial properties also have some site-specific quality, but consistency of relationships to productivity and suppression within a site remains to be determined
  - Changes in crop health and disease suppression tend to be of small magnitude and limited predictability
  - Value of added microbial inoculation still under investigation

Find all upcoming webinars and archived eOrganic webinars at http://www.extension.org/pages/25242

Find the slides as a pdf handout and the recording at http://www.extension.org/pages/66826

Additional questions about organic farming? https://ask.extension.org/groups/1668

We need your feedback! Please fill out our follow-up email survey!

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