Item No. 1 of 1

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ENHANCING PRODUCTIVITY AND SOILBORNE DISEASE CONTROL IN INTENSIVE ORGANIC VEGETABLE PRODUCTION WITH MIXED-SPECIES GREEN MANURES

NON-TECHNICAL SUMMARY: The use of mixed species green manures can provide added value in terms of the benefits conferred to the soil and subsequent cash crops through improved plant health. However, detailed science-based recommendations regarding their value and use in different organic agro-ecosystems have not been formulated. And, the underlying ecological basis for their disease suppressing capacities have not been characterized. The goal of the proposed work is to improve on-farm production efficiency and soilborne disease management through effective and value-driven applications of mixed-species green manures and associated microorganisms that suppress crop diseases in organic vegetable cropping systems. We will achieve this goal by conducting innovative and participatory research and extension programs that address the following questions: i) what are the effects and economic value of using mixed-species green manures in various organic vegetable cropping systems; ii) to what extent can mixed species green manures be used to predictably restructure and manage functionally-important microbial populations (i.e. pathogens and their antagonists) in the root zone of cash crops; and, iii) how can the technical and economic barriers to adoption of the most effective mixed-species green-manures for improved productivity and soilborne disease suppression be effectively over come The results of the proposed research and extension program will improve the ability of stakeholders to develop a more effective Organic System Plan.

OBJECTIVES: The goal of the proposed work is to improve on-farm production efficiency and soilborne disease management through effective and value-driven applications of mixed-species green manures in organic vegetable cropping systems. Specifically, the following objectives will be pursued: Objective 1: Evaluate the efficacy and value of mixed-species green manures in contrasting cropping systems, using a participatory approach. Objective 2: Characterize the linkages between microbial community structure and soilborne disease suppression expressed in different organic vegetable systems. Objective 3: Evaluate novel microbial inoculants to enhance the disease suppressive effects of mixed-species green manures. Objective 4: Enhance value-added green-manure adoption by organic growers using multi-criterion decision analysis (MCDA). We hypothesize that the benefits of mixed-species green manures are conferred by substrate-induced shifts in structure and activities of soil microbial communities and such shifts result in the associated soilborne disease suppression we have recently documented . We aim to test this hypothesis in coordinated field research and to assist in the practical application of results through integrated, user-driven outreach activities based on thorough socioeconomic analyses. This project will provide a thorough

synthesis of the effects and value of mixed-species green manures in organic vegetable crop production systems. The results of the proposed research and extension program will improve the ability of stakeholders to develop a more effective Organic System Plan as it relates to soil quality and soilborne disease management. Specific products of the proposed research will include: a) transformational research papers describing how green manures alter soil and rhizosphere microbial community structure and the extent to which such substrate-based changes can be used to promote natural biological control; b) innovative extension materials (articles, videoclips, fact sheets) and short courses (tailored for farmers or Extension staff and other professionals) that will provide practical advice regarding the impacts, costs, and benefits of using different green manures (with and without microbial inoculants to enhance efficacy) in various cropping systems; and, c) a comprehensive economic assessment of the aggregate benefits of using green manures and microbial inoculants for soilborne disease control in organic vegetable crops.

APPROACH: Under Objective 1, we propose to evaluate the efficacy and economics of using individual and mixed species green manures containing components previously shown to reduce soilborne disease and/or weed pressure and be of particular interest to growers in each region based on stakeholder input. Based on first year results and additional stakeholder input, the Project Directors will select a subset of treatments to be evaluated at multiple locations, each varying in cropping history, soil type and prevailing soilborne pathogen pressure. Economic analyses of the green manure treatments will include steps to assess their economic profitability to producers, relative to current practices, and to project their value at the market level to society. Under Objective 2, we propose to use a variety of molecular methods to identify and characterize the functionally important pathogen and antagonist populations that are significantly affected by the organic amendments evaluated in the field trails of Objective 1. Specifically, we hypothesize that several groups of bacteria, including those recently discovered in our laboratory, will mediate pathogen suppression in a substrate-dependent fashion. TRFLP-based community profiling and DNA macroarrays analyses will be used to quantify the relative abundance of diverse microbes, and those data will be linked to disease assessments at plant, plot, and field scale using multivariate statistical analyses of data provided by all cooperators. Under Objective 3, we propose to investigate the feasibility of developing microbes into useful inoculants to enhance green manure-induced soilborne disease suppression. Specifically, we will evaluate the use of several bacteria linked to durable soilborne pathogen suppression. Such treatments, by virtue of their novelty, are hypothesized to express new mechanisms of action, thus providing the basis for further innovation in the biopesticide industry. Based on the results of the initial screen and feedback from stakeholders, the four most effective inoculum treatments will be selected for further field testing in year 3. Under Objective 4, we will develop uniquely effective Extension and education deliverables throughthe application of a mental models approach combined with an adaptive management plan based on multi-criterion decision analysis (MCDA) to communicate, promote, and analyze stakeholder involvement in this proposed project. This approach provides a systematic framework from which effective communication of project results and benefits can be conveyed To enhance our effectiveness as a collaborative team, we will create an eOrganic research/outreach group that will allow us to communicate efficiently with each other and with the public through private and public workspaces. The public workspace will be used to communicate with other eOrganic groups and deliver extension programming and materials.

PROGRESS: 2011/09 TO 2012/08
OUTPUTS: Several preliminary reports were made that included new information on the utility and value of mixed species cover crops. Under Objective 1, data was collected on a multi-state field trial of single and mixed cover crops on station for a third year and, for the first time, on cooperator farms. In addition, data on the effects of using cover crops as a vehicle to more effectively deliver microbial biopesticides were obtained across the three locations. The microbial community profiling work describe under Objective 2 was completed and analyses of the data are still being conducted. Preliminary assessments have highlighted the occurrence of soilborne pathogens on organic tomato roots and the significant environmental variation occurring in rhizosphere microbial communities. Bacteria belonging to the genus Mitsuaria have been recovered from the research fields and were tested as biological control agents in field trials. Data for Objective 4 indicated that the net present value of cover crops tracked efficacy and varied by location. Assessments of grower knowledge and gaps related to cover crops and microbial inoculants were also conducted. Two Master's students were graduated in the past year. PARTICIPANTS: Technical training over the past year included the mentoring of one post-doctoral research, four graduate students and a visiting scholar across locations. Two Master students graduated. Collaborations with organic growers and grower

organizations (e.g. Ohio Ecological Food and Farm Association, OEFFA) have continued in all three states and were strengthened through the presentation of relevant extension materials at grower meetings. TARGET AUDIENCES: Target audiences included other researchers, extension agents and farmers interested in sustainable organic management of plant diseases. Target audiences were reached through webinars on eOrganic, publication of fact sheets on eOrganic, published abstracts of meetings, and through active engagement in the work associated with Objective 4 of the grant. PROJECT MODIFICATIONS: A one-year no cost extension was requested and approved to complete the analysis and publication of project results.

IMPACT: 2011/09 TO 2012/08
IMPACTS: Changes in knowledge included a greater appreciation of the complex linkages between rhizosphere bacteria, crop growth & health, and the relative importance of the prevailing environmental conditions in determining disease status. Still, this project demonstrated that soilborne diseases could significantly affected by the choice of cover crops in one of three growing years, on average. Differential responses by location indicate that mixed species cover crops such as rye vetch combinations can provide better outcomes for growers, but the consistency of such effects will be limited to just more than half of the site years that such combinations are used. Economic assessments showed that such site to site variability translates into significant net present values that vary by cover crop choice and location. Multivaraiate statistical analyses of community profile data revealed the importance of soil type and cover crop biomass in determining microbial population structure and abundance. Macroarray analyses revealed a high frequency of infection by several pathogenic genera across locations, even in apparently asymptomatic plants indicating the extent to which asymptomatic infections occur in the field. Information on cover crops and soilborne diseases of organic vegetables was shared with growers and researchers through two eOrganic webinars.

PUBLICATIONS (not previously reported): 2011/09 TO 2012/08
1. Baysal Gurel, F., B McSpadden Gardener, B., and Miller, S.A. 2012. Soil-borne Disease Management in Organic Vegetable Production. Online report eOrganic 7581.
2. Baysal Gurel, F., B McSpadden Gardener, B., and Miller, S.A. 2012. An expert perspective on the organic vegetable grower decision-making process related to soilborne disease management. Phytopathology 102:S4.10.
3. Baysal Gurel, F., Parajulu, K., B McSpadden Gardener, B., Norton, G., and Miller, S.A. 2012. Assessing organic vegetable grower beliefs regarding soilborne disease management. Phytopathology 102:S4.11.
4. Meyer, S. L. F., K. L. Everts, and B. B. McSpadden Gardener. 2012. Mixed species cover crop green manures for management of soilborne pathogens on tomato. Society of Nematologists 51st Annual Meeting Program Book, August 12-15, Savannah Georgia, page 81.
5. Meyer, S. l. F., K. L. Everts, and B. B. McSpadden Gardener. 2011. Effects of green manures on nematode population densities in an organic tomato field. Phytopathology 101:S120.
6. Parajuli, K.J. 2011. Economic Impact Analysis of Mixed-Species Green Manure on Organic Tomato: Evidence from the Northeastern United States. Masters Thesis. Virginia Polytechnic Institute, Blacksburg, VA.
7. Summers, C.F., C. D. Smart, B. B. McSpadden Gardener, K. L. Everts, A. R. Dunn, S. Park. 2012. The impact of mixed-species cover crops on rhizosphere pathogens of organically managed tomato crops in New York, Ohio, and Maryland. Phytopathology 102:S4.115

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