OREI Project Details

Award Year 2008

5 Research Projects

PROJECT INDEX

Best Management Practices for Organic Orchard Nutrition

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Performing Institution	HORTICULTURE, UNIVERSITY OF ARKANSAS, FAYETTEVILLE, ARKANSAS 72703

NON-TECHNICAL SUMMARY

Organic fruit production in the South is limited. Previous work has determined that there is an opportunity for local and regional markets for organically produced fruit. However, production is limited due to lack of region and locally specific tested and demonstrated research-based information. Preliminary survey work indicated that two significant horticultural problems facing organic producers are ground cover and weed management, and management of nutrient status of the tree with fertiliers or nutrient sources, and soil and foliar testing protocols. Because sustainable organic production has as a cornerstone principal, the development and management of soil quality and health, and because both nutrient management and ground cover management interact to affect soil quality and health, and thereby tree growth and productivity, a study was initiated. The goal of the study is to develop and demonstrate science based, regionally appropriate organic production systems for apples in the southern region. The specific focus of the study is to develop, demonstrate and communicate the best practices for organic orchard nutrition by studying the interaction of ground cover management and nutrient source on organic orchard growth and productivity. An organic orchard was planted using standard techniques in 2006 and treatments initiated at that time. The effects on tree establishment have been reported. For the study the interaction of ground cover management system and nutrient source were studied with the interaction of treatments as follows. Ground cover management treatments were: 1) municipal green compost (GC), 2) mow-and-blow where the undertree and between row vegetation (primarily planted K31 tall fescue) is periodically mowed and blown under the trees (MB), 3) refuse wood chips (WC), and 4) shredded business paper (SP). The nutrient source treatments were: A) the ground cover provides all nutritional needs (NF), B) composted poultry litter (PL), and C) a certified organic pelletized poultry based fertilizer (CF). The PL and CF nutrient source treatments are applied each spring prior to budbreak based standard foliar \N\ as sampled the previous season to be in the range of 1.9 - 2.4% N. After nutrition is applied, ground cover treatments are applied with mulches applied to a depth of 3-6cm. Beginning in the current season of this study, trees will begin to flower and produce a crop. Treatment effects on growth, cropping and economic performance of the orchard systems and make empirical observations of the basis for those outcomes. The incidence of pests and diseases in the organic system will be measured and observed. Soil quality and health will be assessed annually including measurements of soil biodiversity, soil physical properties, and soil chemical properties. From the findings of the

study, information will be conveyed in traditional scientific formats (presentations and publications) as well as provided to constituencies through grower group meetings, annual conferences and workshops. Additionally, the orchard will serve as a vehicle for direct education through university classroom experiences and grower field days.

OBJECTIVES

Long-term goals and Objectives The long-term goal of this project is to test and develop effective organic fruit tree best management practices for the South with focused emphasis on ground cover and nutrient management. The specific objectives of this project are: 1. Conduct a controlled, replicated study to evaluate the effects of ground cover and nutrient management practices on soil chemical, physical and biological characteristics, plant health, growth and productivity, insect, disease and weed management, and orchard economic plans in order to develop locally-appropriate recommendations for organic fruit tree growers in the South 2. Conduct on-farm grower research in cooperation with UA trial 3. To develop an apprenticeship program to train the farm managers in organic production techniques utilizing developed commercial orchards and seasoned management expertise 4. Develop economic production and marketing budgets to determine feasible production methods 5. Develop an organic apple teaching module from research-generated results to incorporate into existing Extension Agent trainings and other agricultural advisors, and a multi-dimensional Extension program for growers, consultants, and other agriculture professionals.

APPROACH

The outcomes of this project will be: 1. Scientific evidence of the long-term effects of ground cover and nutrient management on soil chemistry, physical properties, and biology, and tree growth, yield and physiology 2. Recommendations for best management practices of organic orchard nutrition based upon scientific evidence, validated by practical grower experience. 3. Recommendations for ground cover management in organic orchards in the south 4. Development of economic operating and marketing budgets for organic orchards in the south 5. Trained organic orchard managers through on-farm trials and apprenticeships 6. Informed growers and Extension personnel on successful production practices of organic orchard management. An orchard was established in 2006 using Enterprise/M26 apples planted at 2m x 4m spacing (\~600 trees/acre) and trained to a 2-wire minimal trellis system in a modified vertical axis, conical shaped tree to be 4m tall and 1.5m wide at the base. The orchard is managed organically and will be certified in 2008. The interaction of ground cover management system and nutrient source were studied. Ground cover management treatments were: 1) municipal green compost (GC), 2) mow-and-blow where the undertree and between row vegetation (primarily planted K31 tall fescue) is periodically mowed and blown under the trees (MB), 3) refuse wood chips (WC), and 4) shredded business paper (SP). The nutrient source treatments were: A) the ground cover provides all nutritional needs (NF), B) composted poultry litter (PL), and C) a certified organic pelletized poultry based fertilizer (CF). The PL and CF nutrient source treatments are applied each spring prior to budbreak based standard foliar \N\ as sampled the previous season to be in the range of 1.9 - 2.4% N. After nutrition is applied, ground cover treatments are applied with mulches applied to a depth of 3-6cm. Tree growth, fruit yield, fruit quality will be measured. Economic inputs and crop value will be recorded and estimated, respectively. The nutrient status of the trees and soil within treatment zones will be monitored periodically during the season. The impact of treatments on the incidence of pests and diseases in the organic system will be measured and observed. Soil quality and health will be assessed annually including measurements of soil biodiversity, soil physical properties, and soil chemical properties. Outreach from the program will be conducted through formal classroom activities, growers workshops and field tours and development of organic production handbook. Project collaborators will attend and present this project at various other producer and scientific meetings and conferences. Information about the project will also be disseminated through the Fruit and Nut Extension newsletter and be made available through the UA Ecological Agriculture website (www.uark.edu/ua/uaecoag/).

PROGRESS

2008/09 TO 2013/08 Target Audience: The target audience was multi-dimensional including organic fruit producers, conventional fruit producers, commercial fruit grower trade associations, hobbyists, extension workers, consultants, other scientists, students, garden and food writers, and consumers. The project was not targeted towards a specific racial or ethnic population, or any specific disadvantaged population. The project was focused on developing science-based information that would serve to provide sustainable fruit production systems that could also be certified organic through the USDA National Organic Program. Efforts to reach the

audiences included presenting information at grower and trade groups, at regional, national, and international science meetings attended by consultants, extension workers and scientists, and teaching in university classrooms. Field days and tours were used for individual growers, consultants and extension workers, as well as for groups. The research planting was used extensively by university classes on horticulture, soil and environmental science, fruit production, and organic and sustainable production systems. The project utilized an apprentice who worked part-time on a cooperating grower farm and part time within the research project. The apprentice and apprentice program maintained a pest scouting website and farm-work journal. Results of the project have been published in grower trade group proceedings, as presentation abstracts, and as journal papers. Changes/Problems: Nothing Reported What opportunities for training and professional development has the project provided? Trained apprentices, incorporated orchard into classroom educational activities for students, 3 PhD students , 2 MS students, 2 visiting scientists (China, Italy), 9 undergraduate employees. The orchard was used for several classes as served as a learning laboratory for students in horticulture and environmental, soil and water sciences. How have the results been disseminated to communities of interest? Project information and results were widely extended to various stakeholders and clientele groups through farm tours, workshops and conferences (regional, national, international). Two, day-long in-depth organic apple schools were held in conjunctions with the AR-OK Horticulture Industry Show in Fort Smith AR, January 2011 and January 2013. Additionally, presentations on the organic orchard project were delivered to growers at the Missouri Organic Conference (2013, 2014), Southern Sustainable Agriculture Working Group (2011, 2013). Scientific presentations have been delivered at annual conferences for the American Society of Horticulture Sciences, Soil Science Society of America, Entomological Society of America. Finally, a case study is being developed on the organic orchard for SSARE to share lessons learned and best practices with growers, extension agents and scientist. What do you plan to do during the next reporting period to accomplish the goals? Nothing Reported

2011/09/01 TO 2012/08/31 Target Audience: The target audience for this reporting period were diversified specialty crop producers and apple producers in the mid-South region. Additionally, scientists in the fields of horticulture, soil biology, entomology and agriculture economics were reached. Changes/Problems: Nothing Reported What opportunities for training and professional development has the project provided? These findings provide science and experience based information on organic orchard management to producers, to extension agents, to federal agency staff, to consultants and directly to growers.Presentations were made at state and regional grower meetings, an organic professional development in-service training for extension agents, at national horticulture meetings, and an international symposium on organic fruit production. The research orchard was toured several times by individual growers, and used for classes. How have the results been disseminated to communities of interest? Presentations on the orchard project were made at state and regional grower meetings, an organic professional development in-service training for extension agents, at national horticulture meetings, and an international symposium on organic fruit production. The research orchard was toured several times by individual growers, and used for classes. The grower cooperator participated in a farm-to-school program providing fruit to a local school and tours for school children. Project leaders had numerous interactions with growers, extension workers, and consultants from around the region in relation to the project. A new university course was offered, "Applications of Sustainability" in which information, experiences and data from the study were presented. The research orchard was used in teaching 3 other courses including a course, Sustainable and Organic Horticulture Production. Through the project, undergraduate students have been hired to assist with orchard management, data collection, and data management giving students opportunities to learn organic production techniques. The project leader mentored an undergraduate honors student studying root and soil biological interactions in organic systems with the research occurring in the controlled study orchard as well as the on-farm trial orchard. The apprentice published a weekly blog of activities and observations. Several graduate students from horticulture, entomology, soil biology, and economics participated in the project and have thesis related to the project. What do you plan to do during the next reporting period to accomplish the goals? Nothing Reported

2010/09/01 TO 2011/08/31 OUTPUTS: Activities: The primary goal and activity of this project were to study and manage a developing organic apple orchard with replicated studies of the effects of ground cover management systems and nutrient sources. 2011 was the 6th growing season of the orchard. Cropping in this year was limited by unfavorable weather conditions during the post-bloom period when 26.8 inches of rain in 25 of the 35 days following bloom. Measurements of soil biology, soil fertility and health, tree growth and cropping, and pest occurrence were collected. A second goal was to establish on-farm trials with a commercial grower\'s orchard. This was initiated this year with both data collected from the grower as well as extensive consulting. A third project goal was to establish an apprentice for the project on the commercial grower\'s orchard contributing to orchard management and data collection. A project co-investigator and the orchard operator served as a mentor to the apprentice. The fourth project goal was develop economic analyses of the orchard. Data on all activities,

inputs and outputs of the orchard were recorded and a preliminary management budget for the orchard establishment period has been constructed. The fifth project goal was to extend information to growers through workshop, extension meetings, and grower meetings. Information was disseminated in multiple ways, in varied venues and to multiple audiences including users and consumers. Presentations on the orchard project were made at state and regional grower meetings as well as an organic professional development in-service training for extension agents attended by more than 50 persons. Additionally, the orchard was toured several times by individual growers, and used for classes. Project leaders had numerous interactions with growers, extension workers, and consultants from around the region in relation to the project. A new university course was offered, \"Applications of Sustainability\" in which information, experiences and data from the study were presented. The research orchard was used in teaching 3 other courses. Through the project, undergraduate students have been hired to assist with orchard management, data collection, and data management giving students opportunities to learn organic production techniques. The project leader is mentoring an undergraduate honors student studying root and soil biological interactions in organic systems. Events: A professional development program workshop attended by more than 50 cooperative extension service agents, NRCS staff, and university staff and faculty was conducted and considerations for organic crop management was presented. Presentations on the orchard were made at a regional horticulture grower meetings and regional and national scientific meetings. Services: Consulting was provided to three farms in organic transition for organic pest management, competitive vegetation management. Additional consulting and counseling regarding organic fruit management was provided via phone to several stakeholders. Products: A website was developed: - http://www.uark.edu/ua/uaecoag/. PARTICIPANTS: Nothing significant to report during this reporting period. TARGET AUDIENCES: Nothing significant to report during this reporting period. PROJECT MODIFICATIONS: Nothing significant to report during this reporting period.

2009/09/01 TO 2010/08/31 OUTPUTS: Activities The primary goal and activity of this project were to manage a developing organic apple orchard with replicated studies of the effects of ground cover management systems and nutrient sources. 2010 was the 5th growing season of the orchard. Cropping in this year was limited by unfavorable weather conditions during the post-bloom period, summer, and early autum. Measurements of soil biology, soil fertility and health, tree growth and cropping, and pest occurrence were collected. A second goal was to establish on-farm trials with a commercial grower\'s orchard transitioning to organic. This was initiated this year with both data collected from the grower as well as extensive consulting. A third project goal was to establish an apprentice for the project on the commercial grower\'s orchard contributing to orchard management and data collection. A project co-investigator and the orchard operator served as a mentor to the apprentice. The fourth project goal was develop economic analyses of the orchard. Data on all activities, inputs and outputs of the orchard were recorded and a preliminary management budget for the orchard establishment period has been constructed. The fifth project goal was to extend information to growers through workshop, extension meetings, and grower meetings. Presentations on the orchard project were made at state and regional grower meetings as well as an organic production field day which included a site tour by more than 60 persons. Additionally, the orchard was toured several times by individual growers, was featured on a television report on orcharding in the region, and used for classes. Project leaders had numerous interactions with growers, extension workers, and consultants from around the region in relation to the project. A new university course was offered, \"Sustainable and Organic Horticulture\" in which information and data from the study were presented. The research orchard was used in teaching 3 other courses. Consulting related to organic transition was done at two additional farms. Through the project, undergraduate students have been hired to assist with orchard management, data collection, and data management giving students opportunities to learn organic production techniques. The project leader is mentoring an undergraduate honors student studying root and soil biological interactions in organic systems with the research occurring in the controlled study orchard as well as the on-farm trial orchard. Events A workshop attended by 65 growers, extension agents, NRCS staff and university staff and faculty was conducted and considerations for organic fruit crop management was presented. Presentations on the orchard were made at a regional horticulture grower meeting. Services Consulting was provided to three farms in organic transition for organic pest management, competitive vegetation management. Additional consulting and counseling regarding organic fruit management was provided via phone to several stakeholders. Products A website was developed: - http://www.uark.edu/ua/uaecoag/. PARTICIPANTS: Individuals: Curt R. Rom, Professor of Horticulture, Principal investigator and project leader. Co-PI Donn Johnson, Professor of Entomology Elena Garcia, Professor of Horticulture Extension Mary Savin, Associate Professor of Crops, Soils, and Environmental Sciences Jennie Popp, Associate Professor of Agricultural Economics and Agribusiness John Aselange, owner A&A Orchards - grower/collaborator Stephen Steward, organic apprentice Training and Professional Development: Training for growers, extension workers and consultants were provided during workshops held in conjunction with the Oklahoma-Arkansas Horticultural Industries Show, Tulsa, OK, and a field day on organic and alternative production systems which occurred on the University of Arkansas Experiment Station Main Farm. Results from the orchard studies were presented and field tours of the replicaed trial were conducted. TARGET

AUDIENCES: The three primary target audiences are fruit growers and potential fruit growers interested in producing crops organically, extension agents, specialists and consultants who extend information to stakeholders and clientele and provide expert services to local growers, and students studying organic horticulture at the university. The project is designed to provide both fundamental and applicable knowledge of organic orchard systems in the southern region as well as demonstrate techniques used for organic production in the region. Although the project is focused on organic production, it is noted that many of the techniques and operations of an organic orchard are being adopted by conventional growers as a means of more sustainably managing their farms. PROJECT MODIFICATIONS: Nothing significant to report during this reporting period.

2008/09/01 TO 2013/08/31 Target Audience: The target audience was multi-dimensional including organic fruit producers, conventional fruit producers, commercial fruit grower trade associations, hobbyists, extension workers, consultants, other scientists, students, garden and food writers, and consumers. The project was not targeted towards a specific racial or ethnic population, or any specific disadvantaged population. The project was focused on developing science-based information that would serve to provide sustainable fruit production systems that could also be certified organic through the USDA National Organic Program. Efforts to reach the audiences included presenting information at grower and trade groups, at regional, national, and international science meetings attended by consultants, extension workers and scientists, and teaching in university classrooms. Field days and tours were used for individual growers, consultants and extension workers, as well as for groups. The research planting was used extensively by university classes on horticulture, soil and environmental science, fruit production, and organic and sustainable production systems. The project utilized an apprentice who worked part-time on a cooperating grower farm and part time within the research project. The apprentice and apprentice program maintained a pest scouting website and farm-work journal. Results of the project have been published in grower trade group proceedings, as presentation abstracts, and as journal papers. Changes/Problems: Nothing Reported What opportunities for training and professional development has the project provided? Trained apprentices, incorporated orchard into classroom educational activities for students, 3 PhD students , 2 MS students, 2 visiting scientists (China, Italy), 9 undergraduate employees. The orchard was used for several classes as served as a learning laboratory for students in horticulture and environmental, soil and water sciences. How have the results been disseminated to communities of interest? Project information and results were widely extended to various stakeholders and clientele groups through farm tours, workshops and conferences (regional, national, international). Two, day-long in-depth organic apple schools were held in conjunctions with the AR-OK Horticulture Industry Show in Fort Smith AR, January 2011 and January 2013. Additionally, presentations on the organic orchard project were delivered to growers at the Missouri Organic Conference (2013, 2014), Southern Sustainable Agriculture Working Group (2011, 2013). Scientific presentations have been delivered at annual conferences for the American Society of Horticulture Sciences, Soil Science Society of America, Entomological Society of America. Finally, a case study is being developed on the organic orchard for SSARE to share lessons learned and best practices with growers, extension agents and scientist. What do you plan to do during the next reporting period to accomplish the goals? Nothing Reported

2008/09/01 TO 2009/08/31 OUTPUTS: This was the first year of the project. Results of the project have been disseminated to various communities of interest through several means including presentations to local, regional, national and international grower audiences at conferences, training schools, or trade association meetings, to peer scientists, extension workers and educators at scientific meetings, to students at the university through classroom laboratory tours and activities, and to the general public through public media channels. These forms of dissemination will be continued throughout the entire life of the project. A partial planning budget for organic orchards in the mid-south region was produced. The budget is in software spreadsheet format and allows grower interaction and inputs. The budget is currently available on the website of the co-PI (Popp) and is in review for publication. PARTICIPANTS: Project Director: Curt Rom, Professor, Dept of Horticulture, 316 PTSC, Fayetteville AR 72701, crom@uark.edu Co-Project Directors: Elena Garcia, Associate Professor, Extension Fruit Specialist, Dept of Horticulture, 316 PTSC, Fayetteville AR 72701, megarcia@uark.edu; Donn Johnson, Professor Dept of Entomology, 311 AGRI, Fayetteville AR 72701, dtjohnso@uark.edu; Jennie Popp, Associate Professor, Dept of Agribusiness & Ag Economics, AGRI 217, Fayetteville AR 72701, jhpopp@uark.edu; Mary Savin, Associate Professor, Dept of Crop, Soils and Environmental Science, AGRI 105B Fayetteville AR 72701 msavin@uark.edu Training Opportunities College Classes: University of Arkansas, Principles of Horticulture Science, Laboratory; Dept of Horticulture University of Arkansas, Fruit Crops Science, Laboratory; Dept of Horticulture University of Arkansas, Integrated Pest Management; Dept of Entomology University of Arkansas, Organic Crop Production; Dept of Crop Sciences University of Arkansas, Student Organic Farm, Student/Faculty Organization Student Training Students were trained in this project including 1 in horticulture, 1 in entomology, and 2 in soil biology Training Sessions Integrated Pest Management Training Workshop for Commercial Market Gardeners - 3 workshops in Arkansas. Conducted by M. E. Garcia (Co-PI) and H. Friedrich (Project Technician) Building

Organic Agriculture Extension Training Capacity in the Southeast. - 2 day training for Extension agents in AR, AL, NC, SC. Conducted by M. E. Garcia (Co-PI) and H. Friedrich (Project Technician) TARGET AUDIENCES: The primary target audiences for this project were first growers/producers, and second extension specialists and consultants. The information generated in the project is aimed at sustaining and increasing organic fruit production in the region through extension activities and grower production. A secondary target audience would be peer scientists and extension specialists working in the area of organic fruit production. The results and experiences of this project contribute to the general body of knowledge of organic fruit science. A third target audience was students, staff and faculty of the university. The organic research orchard was used for classroom demonstrations and learning activities. The Student Organic Farm student organization on campus had workshops in the orchard, helped in some data collection, and used fruit produced in the orchard. The fourth target audience of the project is the general public. The nonprofit agriculture education group, AppleSeeds used the orchard for an elementary school field trip learning experience. The orchard has been featured in general media including print media and television. The university featured the organic orchard in its lay research publication \"Research Frontiers\" (fall 2009) and on its outreach website (http://researchfrontiers.uark.edu/15685.php and http://researchfrontiers.uark.edu/15696.php). Project activities and information was shared through four media releases to the general public from the Division of Agriculture Media Relations department. Media releases posted on the Division website resulted in more than 200 release downloads. PROJECT MODIFICATIONS: The project had to be modified due to the budget constraints in the award. The primary budget change was to reduce grower cooperators from two to one grower cooperator for the project. Because of a general crop failure due to frost and poor fruit set in the first project year (spring 2008), a grower cooperator could not participate in the project. Therefore, there was no activity in this portion of the project and a grower\'s apprentice was not used. Likewise, treatments on a grower location were not implemented at the grower\'s discretion. It is intended to be completed in the second year of the study.

IMPACT

2008/09 TO 2013/08 What was accomplished under these goals? Objective 1) Activities: Conducted and analyzed an 4 groundcovers x 3 organic nutrients in replicated study. Tree performance and growth, nutrient status, soil microbiology, chemical and physical characteristics and insect, disease and weed pest management were evaluated under treatments. Objectives met: The objective to determine the effects of ground cover management on tree growth and cropping, foliar nutrition, soil ecology, nutrient cycling competitive vegetation, and other aspects of orchard management was met. Results: Treatments delivered significant differences in nutrient quantity to the orchard. Compost (C) treatment applied nearly 20-times the amount of N recommended. Shredded paper (SP) and poultry litter treatments increased soil Na, thus pH to nearly alkaline levels. Trees treated with wood chips (WC) were the largest and trees receiving no supplemental nutrition were the smallest. Treatments affected leaf chlorophyll content and photosynthesis. Trees treated with wood chips (WC) had the highest estimated chlorophyll and photosynthesis and Mow Blow (MB) or SP the lowest. Yield was significantly reduced in the last 3 seasons due to weather extremes, resulting in minimal yields and no significant differences for yield. Ground cover treatments had a stronger effect on soil properties than fertilizers. At depth, ground cover or ground cover by year significantly effected enzyme activities. Compost resulted in the greatest increase in dissolved soil-extractable carbon, greatest increase in total organic matter and dissolved soil-extractable N pools. WC, C, and SP groundcovers enhanced the macrofaunal communities compared to MB. Push-pull tactic of Surround (push) combined with baited pyramid traps (pull) placed around the perimeter of the organic block reduced plum curculio damage and infestations to less than 42%. Codling moths and oriental fruit moths were managed with organic approved tactics resulting in less than 0.3% damage. San Jose scale was controlled with early applications of Pyganic and/or JMS Stylet Oil to reduce damage to less than 10%. Outcomes: A key outcome was to understand and determine best practices for managing under-tree competitive and supplying adequate nutrition. Compost application rate in this study supplied excessive N resulting in vigorous, nonproductive tree growth, late season N uptake, and early season weed suppression followed by strong competitive vegetation late-season. Shredded paper provided the best competitive vegetation control, though significantly increased soil pH. Wood chips resulted in adequate weed control through mid-season. Trees with no supplemental nutrition were smaller than average, had smaller than average leaves, lower physiological potential, and lowest cropping. Objective 2) Activities: On-farm research was conducted at two local orchards. Research at the first farm was discontinued in year 2 due to circumstances beyond the control of the project leaders. A second orchard was identified and used primarily for pest management studies, nutritional diagnosis, and apprentice training. Objectives met: An apprenticeship program was established and operated during the growing season. An upper level undergraduate student was placed in employment for the growing season working half-time with a cooperating grower and half-time with the replicated research trial. The student participated in application of

treatments, pest scouting, data collection, daily orchard and farm management. Significant results: Cropping data with the first grower was not collected from trial trees. The second grower did not establish treatments but was used to studying and monitoring sustainable and organic pest control studies. Three upper-level undergraduate students participated in the apprenticeship program. Apprentices increased knowledge in on-farm applications of nutrient, pest and horticultural management practices. Outcomes: Growers participating in the study have indicated change in pest management strategies, including changing methods of competitive vegetation control, using alternative nutrient sources, and implementing high level IPM pest scouting systems. Growers understand importance of providing annual nutritional supplements and adequately managing competitive vegetation. Objective3. Activities: A user-friendly interactive decision support tool was developed in Microsoft Excel using VBA programming interfaces to simulate organic apple production in Arkansas and across the south. Objectives met: The objective to develop a decision support tool was met. Results: The first user friendly interactive decision support tool for organic apple production that encompasses budgeting, economics and risk components was developed. The purpose of this tool is: 1) to assist producers in the evaluation of costs, revenues and risks associated with their apple orchard and 2) to assess the changes to cost, revenue and risk as expected costs, revenue prices and/or yields change. This tool includes additional economic components that: 1) estimate the operation's breakeven (price and yield) points, 2) conduct sensitivity analyzes (answering "What if" questions related to changes in costs and revenues), and 3) provide a risk assessment (regarding the probability of obtaining positive net returns during the life of the apple orchard). A copy of this tool and its accompanying user manual can be obtained by emailing jhpop@uark.edu. Outcomes: This tool can assist producers, educators and others in making economically sound assessments of production practices and decisions that can contribute to the growth of organic apple production acreage Arkansas and across the south. Objective 4) Major activities for this objective: Three apprentices were trained in organic orchard production methods, mentored by two local growers and co-PIs Rom and Johnson. Objectives met: The apprentices reported activities and skills acquired in 17 online issues of the Organic Apple Orchard Apprenticeship News from April 2010 to August 2012 (http://comp.uark.edu/\~dtjohnso/). . Results: Two of three apprentices continue to work on other funded organic fruit production projects at the University of Arkansas, and/or with local growers. One student is graduating and seeking employment as a manager in an organic production system. The apprentices acquired stills to make organic orchard management decisions and to operate an organic and conventional, high-IPM orchard. Apprentices learned to use farm vehicles and equipment, determine fruit maturity status, to harvest and grade fruit. Outcomes: Three apprentices have increased knowledge, skills and abilities and hands-on experiences regarding management issues surrounding organic apple production. Objective 5) Develop a multi-disciplinary Extension education program. Activities: Project information was extended through farm tours, workshops and conferences. Two, day-long in-depth organic apple schools were held at the AR-OK Horticulture Industry Show in Fort Smith AR, January 2011 and January 2013. Presentations on the organic orchard project were delivered to growers at the Missouri Organic Conference (2013, 2014), Southern Sustainable Agriculture Working Group (2011, 2013) and within the scientific community at annual association conferences by project leaders (2009-2014). Objectives met: Participants increased their knowledge of organic tree performance and management (Rom), organic insect pest management (Johnson), the influence of organic practices on soil chemistry and biology (Savin) and a newly developed economic budget tool for organic apple production (Popp). Outcomes: Growers and extension specialists were trained on best practices for organic orchard management and alternatives for controlling competitive vegetation and supplying adequate nutrition, managing soil quality and health, and controlling pests. **PUBLICATIONS (not previously reported):** 2008/09 TO 2013/08 1. Type: Conference Papers and Presentations Status: Published Year Published: 2011 Citation: Bough, R.A., C. R. Rom, and J. McAfee. 2011. Influence of Organic Mulches On Mycorrhizal Colonization of Apple Trees In An Organic Orchard. HortSci. 46(9): s257 \abst 342\. On-line at: http://hortsci.ashspublications.org/content/suppl/2011/10/31/46.9.DC2/2011HS-Ab 2. Type: Conference Papers and Presentations Status: Published Year Published: 2013 Citation: Bough, R. and C. R. Rom. 2013 Influence of Organic Groundcovers on Mycorrhizal Colonization and Symbiosis of Organically Managed Fruit Crops. HortSci. http://hortsci.ashspublications.org/content/suppl/2013/10/17/48.9.DC1/HS-Sept 2 3. Type: Conference Papers and Presentations Status: Published Year Published: 2013 Citation: Ford, J., M. Savin, C. Rom, and J. McAfee. 2013. Mineralization and nitrification in soil altered by ground cover and nutrient source in an organic apple orchard. In Annual Meetings Recordings and Abstracts. ASA, CSSA, and SSSA, Madison, WI. Available at https://scisoc.confex.com/crops/2013am/webprogram/Paper79973.html 4. Type: Conference Papers and Presentations Status: Published Year Published: 2012 Citation: Johnson, C., B. Smith, and M. Savin. 2012. Invertebrate abundances and diversity in surface litters of a six year old organic apple orchard in Northwest Arkansas. In Annual Meetings Recordings and Abstracts. ASA, CSSA, and SSSA, Madison, WI. Available at http://scisoc.confex.com/scisoc/2012am/webprogram/Person347809.html \ 5. Type: Conference Papers and Presentations Status: Published Year Published: 2012 Citation: Johnson, D.T., Barbara Lewis, Curt Rom, Heather Friedrich, Rolfe Bryant and Maciej A. Pszczolkowski. 2008. Organic fruit production needs in the Southeastern United States and organic pest management practices tested in Arkansas. Proceedings of the

Entom. Soc. Am., Reno, NV, http://esa.confex.com/esa/2008/webprogram/Paper38790.html 6. Type: Journal Articles Status: Published Year Published: 2010 Citation: Johnson, D., B. Lewis, C. Rom, H. Friedrich, R. Bryant, and M. Pszczolkowski. 2010. Organic fruit production needs and pest management practices in the Southeastern United States. Acta Hort. 873: 37-44. 7. Type: Journal Articles Status: Published Year Published: 2013 Citation: Johnson, D.T., C.R. Roubos, T.W. Nyoike, L.L. Stelinski, and O.E. Liburd. 2013. Lures, mating disruption and mass trapping of grape root borer. Acta Hort. (ISHS) 1001:129-137. 8. Type: Conference Papers and Presentations Status: Published Year Published: 2013 Citation: Rodríguez, H.G., J. Popp, C.R. Rom, H. Friedrich, J. McAfee, and H. Myrteza. 2013. A new economic assessment tool for organic apple producers. Supplement to HortScience Volume 48(9):S357. 9. Type: Conference Papers and Presentations Status: Published Year Published: 2012 Citation: Rom, C.R., M.E. Garcia, D.T. Johnson, M. Savin, J.H. Popp, J. McAfee, and H. Friedrich. 2012. Ground Cover Management and Nutrient Source Affect Soil and Foliar Nutrient Contents in an Organically Managed Apple Orchard in the Southern U.S. HortSci 49(7): S163 \abst\ 10. Type: Journal Articles Status: Published Year Published: 2010 Citation: Rom, C.R., M.E. Garcia, J. McAfee, H. Friedrich, H.S. Choi, D.T. Johnson, J. Popp and M. Savin. 2010. The effects of groundcover management and nutrient source during organic orchard establishment. Acta Hort. 873: 105-113. 11. Type: Conference Papers and Presentations Status: Published Year Published: 2008 Citation: Rom, C.R., J. McAfee, H. Friedrich, H. Choi, M.E. Garcia, D. Johnson, J. Popp and M. Savin. 2008. Early Performance During Establishment of an Organic Apple Orchard in the Upper Mid-south. HortSci 43 (3): 609 \abst\ 12. Type: Conference Papers and Presentations Status: Published Year Published: 2011 Citation: Rom,C.R., J. McAfee, H. Friedrich, M.E. Garcia, D.T. Johnson, J. Popp and M. Savin. 2011. Early Performance During the Establishment of An Organic Apple Orchard with Varied Ground Cover Management Treatments and Nutrient Sources. HortSci. 46(9): s256 \abst. 341) On-line at: http://hortsci.ashspublications.org/content/suppl/2011/10/31/46.9.DC2/2011HS-Ab 13. Type: Conference Papers and Presentations Status: Published Year Published: 2009 Citation: Savin, M. C., P. J. Tomlinson, C. Rom, H. Friedrich, and H. Choi. 2009. Differences in soil and tree responses to organic orchard fertilizer and ground cover management. In Annual Meetings Abstracts \CD-ROM\. ASA, CSSA, and SSSA, Madison, WI. 14. Type: Conference Papers and Presentations Status: Published Year Published: 2013 Citation: Johnson, D. 2013. Recent efforts in small farm IPM in Arkansas. Poster presentation to Southern Region Small Farm Working Group in IPM Meeting in Kissimmee, FL on August 2. 15. Type: Conference Papers and Presentations Status: Published Year Published: 2013 Citation: Johnson, D. and S. Kim. 2013. IPM considerations for organic fruit production: managing insect pests. pp. 95-97. In D. Collins (ed.), Proceedings Oklahoma/Arkansas Horticulture Industries Show Conference. 16. Type: Conference Papers and Presentations Status: Published Year Published: 2011 Citation: Johnson, D., S.H.S. Kim, B. Petty, C. Rom, D. Steinkraus, B. Lewis J. McAfee and H. Friedrich. 2011. Lessons in organic fruit pest management, pp. 41-47. In Proceedings of 30th Annual Oklahoma & Arkansas Horticulture Industries Show. 17. Type: Conference Papers and Presentations Status: Published Year Published: 2013 Citation: Rodriguez, H.G., J. Popp, C. Rom, H. Friedrich, J. McAfee. 2013. Development of an Economic Assessment Tool for Southern Organic Apple Production. Southern Sustainable Agriculture Working Group Annual Conference. January 23-26, Little Rock Arkansas 18. Type: Conference Papers and Presentations Status: Published Year Published: 2011 Citation: Rodriguez, H.G., J. Popp, R. Ruffin, H. Friedrich, C. Rom. 2011. Organic apple production using interactive budgets. Selected Presentation at the 2011 Horticultural Industry Show. Fort Smith, AR. January 14-15. 19. Type: Conference Papers and Presentations Status: Published Year Published: 2013 Citation: Rom, C. 2013. Organic apple production, pp. 90-94. In D. Collins (ed.), Proceedings Oklahoma/Arkansas Horticulture Industries Show Conference. 20. Type: Conference Papers and Presentations Status: Published Year Published: 2012 Citation: Rom, C.R., M.E.Garcia, D.T. Johnson, J. Popp, M. Savin, H. Friedrich, and J. McAfee. 2012. The effects of four ground cover management systems and three nutrient sources on the growth and performance of an organic apple orchard in the southern United States. International Symposium on Organic Fruit Production, International Society for Horticultural Sciences, Leavenworth, Wa. June 2012. 21. Type: Conference Papers and Presentations Status: Published Year Published: 2012 Citation: Rom, C.R. H. Friedrich and J. McAfee. 2012. Managing the Sustainable Orchard. Horticulture Industries Show. Tulsa, OK. Jan. 2012. 22. Type: Conference Papers and Presentations Status: Published Year Published: 2008 Citation: Rom, C.R. J. McAfee, H. Friedrich, H. Choi, D.T. Johnson, J. Popp, and M.E. Garcia. 2008. The effects of ground cover management and nutrient source on establishment and early growth of an organic apple orchard. SARE National Conference 23. Type: Conference Papers and Presentations Status: Published Year Published: 2011 Citation: Rom, C.R., J. McAfee, H. Friedrich, M.E. Garcia, D.T. Johnson, J. Popp, and M. Savin. 2011. Management Practices for Organic Orchard Ground Cover and Nutrition. Presented at the Annual Conference of the Southern Sustainable Working Group. Chattanooga, TN. 24. Type: Theses/Dissertations Status: Published Year Published: 2009 Citation: Choi, H.S.2009.Effects of different organic apple production systems on seasonal variation of soil and foliar nutrient concentration, PhD thesis, University of Arkansas, Fayetteville, AR. 25. Type: Theses/Dissertations Status: Other Year Published: 2014 Citation: Ford, J. 2014. Nitrification and denitrification in soil altered by ground cover and nutrient source in an organic apple orchard, M.S. thesis, University of Arkansas, Fayetteville, AR. 26. Type: Theses/Dissertations Status: Published Year Published: 2013 Citation: Mays, N. 2013.

Groundcover management system and nutrient source impact physical soil quality indicators in an organically managed apple orchard. MS Thesis, University of Arkansas ISBN 9781303058325 27. Type: Other Status: Published Year Published: 2013 Citation: Bough, Raven A. and Curt R. Rom. 2013. Influence of organic groundcovers on mycorrhizal colonization and symbiosis of organically managed fruit crops. Discovery The Student Journal of the Dale Bumpers College of Agricultural, Food, and Life Sciences. 14: 3-11. 28. Type: Conference Papers and Presentations Status: Published Year Published: 2011 Citation: Rom, C. R. J. McAfee, H. Friedrich, D. Johnson, E. Garcia, J. Popp, and M. Savin. 2011 Early Performance of an Organic Apple Orchard as affected by Nutrient Source and Ground Cover Management. In the Arkansas-Oklahoma Region. Proceedings of the 30th Arkansas-Oklahoma Horticulture Industries Show (CD-Rom, digital publication) 29. Type: Other Status: Published Year Published: 2012 Citation: Johnson, C., B. Smith, and M. C. Savin. 2012. Invertebrate abundances and diversity of a six year old organic apple orchard in Northwest Arkansas. Discovery The Student Journal of the Dale Bumpers College of Agricultural, Food, and Life Sciences. 13:38-45. 30. Type: Conference Papers and Presentations Status: Published Year Published: 2011 Citation: Savin, M. C. 2011. Soil management in perennial systems. 30th Annual Arkansas and Oklahoma Horticulture Industries Show, Fort Smith, AR, Jan 14 15. 31. Type: Conference Papers and Presentations Status: Published Year Published: 2013 Citation: Savin, M. C. 2013. The impacts of organic apple production practices on soil. 32nd Annual Horticulture Industries Show, Horticulture Production & Food Safety: Making Good During Tough Times. Fort Smith, AR, Jan. 11-12. 32. Type: Other Status: Published Year Published: 2008 Citation: Breaking New Ground for Organic Orchards. In Common Ground, SARE quarterly magazine. Oct. 2008. http://www.southernsare.uga.edu/commongrnd/08autumn.pdf 33. Type: Other Status: Published Year Published: 2008 Citation: Scientists develop holistic approach for organic production. May 2008. http://arkansasagnews.uark.edu/2370.htm 34. Type: Other Status: Published Year Published: 2009 Citation: Organic Fruit Production, In Research Frontiers, Fall, 2009. http://researchfrontiers.uark.edu/15685.php

2011/09/01 TO 2012/08/31 What was accomplished under these goals? After 7 cropping seasons, there was no significant difference in tree survival although trees with mow/blow ground cover management had the lowest survival, and those treated with compost as a ground cover management system had the highest. Similarly, trees receiving no supplemental nutrition had the lowest survival while those receiving either a formulated fertilizer or composted chicken litter had similar and highest survival. Cropping in this year was limited in all trials by high temperatures during the 2011 flower development season, unfavorable weather conditions during the bloom period limiting pollination, and by a post-bloom hailstorm. The 2012 growing season was typified as the hottest summer on record in the region leading to a high level of preharvest fruit drop for which there are no organic controls, sunburn and heat damage to the fruit. After 7 years, all trees have grown to fill their space and there were no significant differences in tree size as measured by trunk cross-sectional area, canopy height or spread, or calculated canopy volume. However, in all cases, trees with the mow/blow ground cover management system were the smallest. After the first 4 cropping seasons, trees treated with either compost or wood chips had the highest cumulative yield while trees with mow/blow were significantly less. However, there were no differences for ground cover treatments for cumulative yield efficiency, average fruit size, or fruit quality characteristics. Trees not receiving supplemental nutrition had the lowest yields compared to those receiving supplemental nutrition from a commercial fertilizer source or composted chicken litter. Since establishment, the all ground cover management systems have resulted in increased soil organic matter and reduced soil bulk density, and all were better than an adjacent conventionally managed orchard. Soil organic matter had increased three-fold since beginning the study and was more than twice as great as an adjacent, conventionally managed orchard. Compost and woodchip ground covers resulted in the lowest soil bulk density, and highest percentage of larger water stable aggregates. Compost resulted in higher plant available water and nutrient source had no effect on plant available water. Shredded paper ground cover resulted in the greatest water infiltration rates and the mow/blow treatments the lowest. Soil available nutrients measured by membrane probes indicated that compost ground cover had the highest available NO3-N at all sample periods during the growing season while shredded paper and mow/blow had the lowest. Composted poultry litter had the highest available NO3-N at all sample periods and no supplemental nutrition the lowest. There were no differences for any treatment for soil available NH4-N. There was a quadratic relationship between annual applied N from the treatments and tree trunk cross-sectional area and cumulative yield during the first 4 harvest seasons indicating that compost plus additional nutrients resulted in excessive tree growth and reduced cropping. Foliar nutrient contents of all treatments were in a normal or adequate range. However, trees treated with shredded paper or receiving no supplemental nutrition were in the very low range for adequate foliar N contents. Codling moth and Oriental fruit moths were monitored by pheromone traps set inside apple blocks. Plum curculio adults were monitored with black pyramid traps baited with plum essence and benzaldehyde and set along perimeter of apple blocks. A 100 terminal inspection detected presence of rosy apple aphids, green apple aphids. Emergence of San Jose scale crawlers were determined by wrapping double sticky tape traps around infested limbs. Demonstrated that several materials OMRI approved for organic production were effective in preventing pest damage of apples. Entrust

(spinosad) was applied against first generation by codling moth and Oriental fruit moth. Ten days later the trees were sprayed with a mixture of Cyd-X (granulosis virus) against codling moth and Deliver (Bt) against Oriental fruit moth. Egg laying of the two summer generations of both species was minimized by placement of 200 Isomate CM/OFM pheromone ties per acre for mating disruption. Once pheromone traps begin catching these moths in late August (indication of Isomate pheromone depleted), these moths were managed with one spray of Entrust followed ten days later with a mixed spray of Cyd-X and Deliver. This management program has been followed since 2010, resulting in no spider mite outbreaks, and less than 0.2% of apples were damaged by either codling moth or Oriental fruit moth. Well-timed sprays of JMS Stylet Oil killed crawlers of San Jose scale (SJS) and rosy apple aphids. Maintaining a whitewashed appearance of apple trees with Surround WP kaolin clay (5 to 10 sprays per season) from petal fall to harvest minimized sun scald of apples and prevented plum curculio (PC) larval tunneling. However, whitewashing since 2009 allowed from 23 to 41% of the harvested apples to have surface feeding damage by plum curculio. In past years, Japanese beetles did not cause any significant apple foliar damage except during short periods when the whitewash of Surround was rained off. Two additional pests in 2012 were birds, and the summer fruit rots, black rot and bitter rot. Bird damage was significant although abatement programs of distraction were implemented with somewhat marginal results. The high level of damage was extraordinary and likely related to the high temperatures and prolonged and severe drought. Fruit rots were higher in all research orchards this year with severe heat and presumed high levels of initial infection from excessive rain the previous season. These results provide a basis for making horticultural recommendations for best practices for organic pest management for organic orchards in the southern region. An interactive organic apple production economic assessment tool was created and trialed in 2012. Sample costs for labor, materials, equipment and custom services are based on current figures gathered from this trial, with data gathered from the grower-cooperator, and in discussion with research team and the grower-cooperator. The practices described are based on production procedures considered typical for northwest Arkansas. Information was placed into Microsoft Excel spreadsheet to make the budget interactive. The tool is in a beta-test and when completed will be available as an interactive web-based tool, or a downloadable form. The tool will allow growers to do "if-what" scenarios for budget predictions.

2010/09/01 TO 2011/08/31 These findings provide information on orchard management to producers, to extension agents, to federal agency staff, and to consultants. The information is directly applicable to organic producers but as the information is cross-translatable to sustainable and conventional growers. Direct outputs include; Information and technology for alternative weed control methods; Information and technology for alternative fertilization sources; Information and technology for alternative pest management; Information and technology for organic production systems; Implementing new technologies and recommendations with local growers; Developing new expertise and future farmers with the apprentice program; Providing new information and technology to extension agents, federal agency staff, and consultants on orchard operations and organic management. The impacts will be improved methods of production with fewer synthetic inputs and fewer environmental impacts; a stimulation of the local fruit industries of the southeast region; increased local and regional food supplies of high value products. The project is evaluated annually by project leaders and measured against project goals. The resources provided in this project have paid for supplies and equipment, and labor necessary to manage an organic orchard; for travel to workshops, conference and meetings to disseminate information; for graduate students who are conducting fundamental science related to the project; for an apprentice who is learning techniques for organic crop production; and to engage a grower directly in the project.

2009/09/01 TO 2010/08/31 Although the project is relatively new, at least two growers are simultaneously transitioning from conventional to organic production systems. Our group is interacting with a third grower who will consider beginning transition this coming year. The most notable impact is that although many growers are not converting to organic at this time, they are adopting some technologies that we have demonstrated as being useful for the control of pests and diseases, providing tree nutrition, managing under-tree competitive vegetation, and used in crop load management. These impacts are reducing grower reliance on conventional pesticides and fertilizers and thereby reducing those environmental impacts. Because organic production in this region is new and technologies are unproven, we are observing a very slow adoption of techniques which may lead to organic transition in the future. Although the project is young it is providing useful information that has been published both in scientific journals as well as published in grower publications.

2008/09/01 TO 2013/08/31 What was accomplished under these goals? Objective 1) Activities: Conducted and analyzed an 4 groundcovers x 3 organic nutrients in replicated study. Tree performance and growth, nutrient status, soil microbiology, chemical and physical characteristics and insect, disease and weed pest management were evaluated under treatments. Objectives met: The objective to determine the effects of ground cover management on tree growth and cropping, foliar nutrition, soil ecology, nutrient cycling competitive vegetation,

and other aspects of orchard management was met. Results: Treatments delivered significant differences in nutrient quantity to the orchard. Compost (C) treatment applied nearly 20-times the amount of N recommended. Shredded paper (SP) and poultry litter treatments increased soil Na, thus pH to nearly alkaline levels. Trees treated with wood chips (WC) were the largest and trees receiving no supplemental nutrition were the smallest. Treatments affected leaf chlorophyll content and photosynthesis. Trees treated with wood chips (WC) had the highest estimated chlorophyll and photosynthesis and Mow Blow (MB) or SP the lowest. Yield was significantly reduced in the last 3 seasons due to weather extremes, resulting in minimal yields and no significant differences for yield. Ground cover treatments had a stronger effect on soil properties than fertilizers. At depth, ground cover or ground cover by year significantly effected enzyme activities. Compost resulted in the greatest increase in dissolved soil-extractable carbon, greatest increase in total organic matter and dissolved soil-extractable N pools. WC, C, and SP groundcovers enhanced the macrofaunal communities compared to MB. Push-pull tactic of Surround (push) combined with baited pyramid traps (pull) placed around the perimeter of the organic block reduced plum curculio damage and infestations to less than 42%. Codling moths and oriental fruit moths were managed with organic approved tactics resulting in less than 0.3% damage. San Jose scale was controlled with early applications of Pyganic and/or JMS Stylet Oil to reduce damage to less than 10%. Outcomes: A key outcome was to understand and determine best practices for managing under-tree competitive and supplying adequate nutrition. Compost application rate in this study supplied excessive N resulting in vigorous, nonproductive tree growth, late season N uptake, and early season weed suppression followed by strong competitive vegetation late-season. Shredded paper provided the best competitive vegetation control, though significantly increased soil pH. Wood chips resulted in adequate weed control through mid-season. Trees with no supplemental nutrition were smaller than average, had smaller than average leaves, lower physiological potential, and lowest cropping. Objective 2) Activities: On-farm research was conducted at two local orchards. Research at the first farm was discontinued in year 2 due to circumstances beyond the control of the project leaders. A second orchard was identified and used primarily for pest management studies, nutritional diagnosis, and apprentice training. Objectives met: An apprenticeship program was established and operated during the growing season. An upper level undergraduate student was placed in employment for the growing season working half-time with a cooperating grower and half-time with the replicated research trial. The student participated in application of treatments, pest scouting, data collection, daily orchard and farm management. Significant results: Cropping data with the first grower was not collected from trial trees. The second grower did not establish treatments but was used to studying and monitoring sustainable and organic pest control studies. Three upper-level undergraduate students participated in the apprenticeship program. Apprentices increased knowledge in on-farm applications of nutrient, pest and horticultural management practices. Outcomes: Growers participating in the study have indicated change in pest management strategies, including changing methods of competitive vegetation control, using alternative nutrient sources, and implementing high level IPM pest scouting systems. Growers understand importance of providing annual nutritional supplements and adequately managing competitive vegetation. Objective3. Activities: A user-friendly interactive decision support tool was developed in Microsoft Excel using VBA programming interfaces to simulate organic apple production in Arkansas and across the south. Objectives met: The objective to develop a decision support tool was met. Results: The first user friendly interactive decision support tool for organic apple production that encompasses budgeting, economics and risk components was developed. The purpose of this tool is: 1) to assist producers in the evaluation of costs, revenues and risks associated with their apple orchard and 2) to assess the changes to cost, revenue and risk as expected costs, revenue prices and/or yields change. This tool includes additional economic components that: 1) estimate the operation's breakeven (price and yield) points, 2) conduct sensitivity analyzes (answering "What if" questions related to changes in costs and revenues), and 3) provide a risk assessment (regarding the probability of obtaining positive net returns during the life of the apple orchard). A copy of this tool and its accompanying user manual can be obtained by emailing jhpop@uark.edu. Outcomes: This tool can assist producers, educators and others in making economically sound assessments of production practices and decisions that can contribute to the growth of organic apple production acreage Arkansas and across the south. Objective 4) Major activities for this objective: Three apprentices were trained in organic orchard production methods, mentored by two local growers and co-PIs Rom and Johnson. Objectives met: The apprentices reported activities and skills acquired in 17 online issues of the Organic Apple Orchard Apprenticeship News from April 2010 to August 2012 (http://comp.uark.edu/\~dtjohnso/). . Results: Two of three apprentices continue to work on other funded organic fruit production projects at the University of Arkansas, and/or with local growers. One student is graduating and seeking employment as a manager in an organic production system. The apprentices acquired stills to make organic orchard management decisions and to operate an organic and conventional, high-IPM orchard. Apprentices learned to use farm vehicles and equipment, determine fruit maturity status, to harvest and grade fruit. Outcomes: Three apprentices have increased knowledge, skills and abilities and hands-on experiences regarding management issues surrounding organic apple production. Objective 5) Develop a multi-disciplinary Extension education program. Activities: Project information was extended through farm tours, workshops and conferences. Two, day-long in-depth organic apple schools were held at the AR-OK Horticulture Industry Show in

Fort Smith AR, January 2011 and January 2013. Presentations on the organic orchard project were delivered to growers at the Missouri Organic Conference (2013, 2014), Southern Sustainable Agriculture Working Group (2011, 2013) and within the scientific community at annual association conferences by project leaders (2009-2014). Objectives met: Participants increased their knowledge of organic tree performance and management (Rom), organic insect pest management (Johnson), the influence of organic practices on soil chemistry and biology (Savin) and a newly developed economic budget tool for organic apple production (Popp). Outcomes: Growers and extension specialists were trained on best practices for organic orchard management and alternatives for controlling competitive vegetation and supplying adequate nutrition, managing soil quality and health, and controlling pests.

2008/09/01 TO 2009/08/31 The resources of this project were used to provide orchard maintenance and operations needs, for labor including technical assistance and university student/trainee hourly labor, instrumentation use and operation, and for analytical services of soil and foliar nutrition, and soil biology. The ground cover management treatments resulted in differences in tree size with trees grown with wood chip or compost mulches being \>80% larger than trees with either mow-and-blow or shredded paper mulch. Similar to tree size, trees with woodchip or compost mulch had \>70% more flowers during bloom and greater fruit set than other ground cover treatments. Trees with no added nutrient source were smaller than those receiving either composted poultry litter or certified commercial organic fertilizers. Likewise, trees with no added nutrients had fewer flowers and less fruit set. However, because of bloom-time frost, all trees had minimal crops and there were no treatment difference for yield, fruit size or fruit quality. The cumulative yields over the first two seasons were greatest in the mow-and-blow and wood chip mulch treatments and least in the compost mulch system. Trees grown with no additional nutrient sources had \<45% of the cumulative yield compared to either poultry litter or commercial fertilizers. Initial results suggest that ground covers seem to impact soil microbial community size (biomass) and biological activity (enzyme activities) differently than dissolved nutrients. Transitioning orchard soil to organic management practices may have different initial responses than tree growth indicates and the effects on soil health may not be completely manifest in the trees for several years as the system stabilizes and trees achieve their final size. As this was the first year of a multi-year project, and because of the nature of a newly established orchard, there were no measurable impacts in the first year. The orchard has been used for class instruction, and grower outreach educational activities including pruning and pest management demonstrations. The findings of this year\'s growth, cropping, pest management, and soil nutrition and biology studies will be presented to grower meetings in the coming calendar year.

PUBLICATIONS

2011/09/01 TO 2012/08/31 1. Type: Conference Papers and Presentations Status: Accepted Year Published: 2012 Citation: Mays, N., C. R. Rom, M. Savin, K. Brye, J. McAfee. 2012. Ground Cover Management and Nutrient Source Increase Soil Carbon Sequestration in an Organically Managed Orchard. HortSci 49(7): S161 \abst\ 2. Type: Conference Papers and Presentations Status: Accepted Year Published: 2012 Citation: Rom, C.R. H. Friedrich and J. McAfee. 2012. Managing the Sustainable Orchard. Horticulture Industries Show. Tulsa, OK. Jan. 2012. Invited presentation 3. Type: Conference Papers and Presentations Status: Accepted Year Published: 2012 Citation: Rom, C.R., M.E.Garcia, D.T. Johnson, J. Popp, M. Savin, H. Friedrich, and J. McAfee. 2012. The effects of four ground cover management systems and three nutrient sources on the growth and performance of an organic apple orchard in the southern United States. International Symposium on Organic Fruit Production, International Society for Horticultural Sciences, Leavenworth, Wa. June 2012. http://www.youtube.com/watch?v=Qc09YmGxh1U&list=PLE816E610DF986E58&index=21 -Abstract was published in preconference program and on the web; http://www.tfrec.wsu.edu/pages/organicfruit2012/Scientific Program 4. Type: Conference Papers and Presentations Status: Accepted Year Published: 2012 Citation: Rom, C.R., M.E. Garcia, D.T. Johnson, M. Savin, J.H. Popp, J. McAfee, and H. Friedrich. 2012. Ground Cover Management and Nutrient Source Affect Soil and Foliar Nutrient Contents in an Organically Managed Apple Orchard in the Southern U.S. HortSci 49(7): S163 \abst

2010/09/01 TO 2011/08/31 1. Rom, C. R., D.T. Johnson, J. McAfee, J. McKern, E. Stafne, J. R. Clarke. 2010 Differences in Defoliation of Fruit Genotypes by Adult Japanese Beetle Feeding. Jrnl. Amer. Pom. Soc. 64(4): 186-198. 2. Rom, C., E. Garcia, D. Johnson, J. Popp and M. Savin. 2011. Best Management Practices for Organic Apple Production. Poster presented at the USDA Organic Farming Systems Research Conference. Washington DC March 16-18. 3. Choi, Hyun-Sug and C. R. Rom 2011. Estimated nitrogen use efficiency, surplus, and partitioning in young apple trees grown in varied organic production systems. Sci. Hort. 129 (4): 674-

679. 4. Choi, Hyun-Sug, C. R. Rom, and M. Gu. 2011. Plant Performance, and Seasonal Soil and Foliar Nutrient Variations in an Organic Apple Orchard under Four Ground Cover Management Systems. J. Amer. Pom. Soc. 65(3): 66-82. Choi, Hyun-Sug and C. R. Rom. 2011 Effects of Ground Cover Treatments on Growth and Photosynthesis in Young \'Enterprise\' Apple Trees. J. Amer. Pom. Soc. 65(3): 83-93. 5. Choi, Hyun-Sug and C. R. Rom. 2011. Effects of Organic Apple Production Systems on Foliar Macronutrient Concentrations (accepted for publication in Proceedings of IFOAM/ISOFAR Organic Congress, 2011, Seoul, Korea). Rom,C.R., J. McAfee, H. Friedrich, M.E. Garcia, D.T. Johnson, J. Popp and M. Savin. 2011. Early Performance During the Establishment of An Organic Apple Orchard with Varied Ground Cover Management Treatments and Nutrient Sources. HortSci. 46(9): s256 \abst. 341) On-line at: http://hortsci.ashspublications.org/content/suppl/2011/10/31/46.9.DC2 /2011HS-Abstract-Supplement.pdf. 6. Bough, R.A., C. R. Rom, and J. McAfee. 2011. Influence of Organic Mulches On Mycorrhizal Colonization of Apple Trees In An Organic Orchard. HortSci. 46(9): s257 \abst 342\. On-line at: http://hortsci.ashspublications.org/content/suppl/2011/10/31/46.9.DC2 /2011HS-Abstract-Supplement.pdf 7. Rodriguez, G. J. Popp, R. Ruffin, H. Friedrich and C. Rom. 2011. Organic Apple Production Using Interactive Budgets. Selected presentation at the Horticultural Industry Show. Fort Smith, AR. Jan 14-15. 8. Johnson, D.T. 2011. Using biological control and other organic pest management tactics. Invited speaker to 40 growers at the Mississippi Fruit and Vegetable Growers Conference in Vicksburg, MS on 16 November. 9. Johnson, D., S. Kim, B. Lewis, C. Vincent, C. Rom, and E. Garcia. 2011. Improving pest management for fruits in the Ozark mountain region. Invited talk at the SEB-ESA Meeting in Puerto Rico on 22 March. 10. Rom, C.R., J. McAfee, H. Friedrich, M.E. Garcia, D.T. Johnson, and B. Lewis. 2011. Progress and Challenges for Organic Fruit Production in Arkansas and Oklahoma. Presented at the Arkansas-Oklahoma Horticulture Industries Show. Invited presentation. 11. Rom, C.R. 2011 Sustainable and Organic Fruit Production in the Southern Region. Presented at the Annual Conference of the Southern Sustainable Working Group. Chattanooga, TN. Invited presentation. 12. Rom, C.R., J. McAfee, H. Friedrich, M.E. Garcia, D.T. Johnson, J. Popp, and M. Savin. 2011. Management Practices for Organic Orchard Ground Cover and Nutrition. Presented at the Annual Conference of the Southern Sustainable Working Group. Chattanooga, TN. Invited presentation. 13. Rom, C.R., M.E. Garcia, D. T. Johnson, J. Popp, and M. Savin. 2011. Developing Organic Production Systems for Arkansas and the Upper Mid-South. Presented at the USDA-NIFA OREI Project Leaders Conference, Washington, D.C. Invited presentation. 14. Rom, C.R. 2011. Tree Fruit Propagation; Rules and Techniques. Missouri Organic Growers Association. Springfield, MO. Invited presentation. Rom, C.R. 2011. Primer on Sustainable and Organic Fruit Production: You are the Experts. Presented to the NCCC212 Annual Conference. Fayetteville, AR. Invited Presentation. 15. Rom, C.R. 2011. The Organic System. Presented at the UA-CES, SARE In-Service Training Workshop on Organic Production. Little Rock, AR. Invited Presentation.

2009/09/01 TO 2010/08/31 1. Johnson, D., B. Lewis, C. Rom, H. Friedrich, R. Bryant, and M. Pszczolkowski. 2010. Organic fruit production needs and pest management practices in the Southeastern United States. Acta Hort. 873: 37-44 2. Garcia, M.E., R. Moran, T.L. Bradshaw, L.P. Berkett, S.L. Kingsley-Richards, and M.L. Cromwell. 2010. Using new alternatives to enhance adoption of organic apple production. Acta Hort. 873: 277-283 3. Rom, C.R., M.E. Garcia, J. McAfee, H. Friedrich, H.S. Choi, D.T. Johnson, J. Popp and M. Savin. 2010. The effects of groundcover management and nutrient source during organic orchard establishment. Acta Hort. 873: 105-113 4. Rom, C.R., J. McAfee, H. Friedrich, D. Johnson, E. Garcia, and J. Popp. 2010. Early performance of an organic apple orchard as affected by nutrient source and ground cover management. Proceedings OK & AR Horticulture Industries Show 29:80-83.

2008/09/01 TO 2013/08/31 1. Type: Conference Papers and Presentations Status: Published Year Published: 2011 Citation: Bough, R.A., C. R. Rom, and J. McAfee. 2011. Influence of Organic Mulches On Mycorrhizal Colonization of Apple Trees In An Organic Orchard. HortSci. 46(9): s257 \abst 342\. On-line at: http://hortsci.ashspublications.org/content/suppl/2011/10/31/46.9.DC2/2011HS-Ab 2. Type: Conference Papers and Presentations Status: Published Year Published: 2013 Citation: Bough, R. and C. R. Rom. 2013 Influence of Organic Groundcovers on Mycorrhizal Colonization and Symbiosis of Organically Managed Fruit Crops. HortSci. http://hortsci.ashspublications.org/content/suppl/2013/10/17/48.9.DC1/HS-Sept 2 3. Type: Conference Papers and Presentations Status: Published Year Published: 2013 Citation: Ford, J., M. Savin, C. Rom, and J. McAfee. 2013. Mineralization and nitrification in soil altered by ground cover and nutrient source in an organic apple orchard. In Annual Meetings Recordings and Abstracts. ASA, CSSA, and SSSA, Madison, WI. Available at https://scisoc.confex.com/crops/2013am/webprogram/Paper79973.html 4. Type: Conference Papers and Presentations Status: Published Year Published: 2012 Citation: Johnson, C., B. Smith, and M. Savin. 2012. Invertebrate abundances and diversity in surface litters of a six year old organic apple orchard in Northwest Arkansas. In Annual Meetings Recordings and Abstracts. ASA, CSSA, and SSSA, Madison, WI. Available at http://scisoc.confex.com/scisoc/2012am/webprogram/Person347809.html \ 5. Type: Conference Papers and

Presentations Status: Published Year Published: 2012 Citation: Johnson, D.T., Barbara Lewis, Curt Rom, Heather Friedrich, Rolfe Bryant and Maciej A. Pszczolkowski. 2008. Organic fruit production needs in the Southeastern United States and organic pest management practices tested in Arkansas. Proceedings of the Entom. Soc. Am., Reno, NV, http://esa.confex.com/esa/2008/webprogram/Paper38790.html 6. Type: Journal Articles Status: Published Year Published: 2010 Citation: Johnson, D., B. Lewis, C. Rom, H. Friedrich, R. Bryant, and M. Pszczolkowski. 2010. Organic fruit production needs and pest management practices in the Southeastern United States. Acta Hort. 873: 37-44. 7. Type: Journal Articles Status: Published Year Published: 2013 Citation: Johnson, D.T., C.R. Roubos, T.W. Nyoike, L.L. Stelinski, and O.E. Liburd. 2013. Lures, mating disruption and mass trapping of grape root borer. Acta Hort. (ISHS) 1001:129-137. 8. Type: Conference Papers and Presentations Status: Published Year Published: 2013 Citation: Rodr?guez, H.G., J. Popp, C.R. Rom, H. Friedrich, J. McAfee, and H. Myrteza. 2013. A new economic assessment tool for organic apple producers. Supplement to HortScience Volume 48(9):S357. 9. Type: Conference Papers and Presentations Status: Published Year Published: 2012 Citation: Rom, C.R., M.E. Garcia, D.T. Johnson, M. Savin, J.H. Popp, J. McAfee, and H. Friedrich. 2012. Ground Cover Management and Nutrient Source Affect Soil and Foliar Nutrient Contents in an Organically Managed Apple Orchard in the Southern U.S. HortSci 49(7): S163 \abst\ 10. Type: Journal Articles Status: Published Year Published: 2010 Citation: Rom, C.R., M.E. Garcia, J. McAfee, H. Friedrich, H.S. Choi, D.T. Johnson, J. Popp and M. Savin. 2010. The effects of groundcover management and nutrient source during organic orchard establishment. Acta Hort. 873: 105-113. 11. Type: Conference Papers and Presentations Status: Published Year Published: 2008 Citation: Rom, C.R., J. McAfee, H. Friedrich, H. Choi, M.E. Garcia, D. Johnson, J. Popp and M. Savin. 2008. Early Performance During Establishment of an Organic Apple Orchard in the Upper Mid-south. HortSci 43 (3): 609 \abst\ 12. Type: Conference Papers and Presentations Status: Published Year Published: 2011 Citation: Rom,C.R., J. McAfee, H. Friedrich, M.E. Garcia, D.T. Johnson, J. Popp and M. Savin. 2011. Early Performance During the Establishment of An Organic Apple Orchard with Varied Ground Cover Management Treatments and Nutrient Sources. HortSci. 46(9): s256 \abst. 341) On-line at: http://hortsci.ashspublications.org/content/suppl/2011/10/31/46.9.DC2/2011HS-Ab 13. Type: Conference Papers and Presentations Status: Published Year Published: 2009 Citation: Savin, M. C., P. J. Tomlinson, C. Rom, H. Friedrich, and H. Choi. 2009. Differences in soil and tree responses to organic orchard fertilizer and ground cover management. In Annual Meetings Abstracts \CD-ROM\. ASA, CSSA, and SSSA, Madison, WI. 14. Type: Conference Papers and Presentations Status: Published Year Published: 2013 Citation: Johnson, D. 2013. Recent efforts in small farm IPM in Arkansas. Poster presentation to Southern Region Small Farm Working Group in IPM Meeting in Kissimmee, FL on August 2. 15. Type: Conference Papers and Presentations Status: Published Year Published: 2013 Citation: Johnson, D. and S. Kim. 2013. IPM considerations for organic fruit production: managing insect pests. pp. 95-97. In D. Collins (ed.), Proceedings Oklahoma/Arkansas Horticulture Industries Show Conference. 16. Type: Conference Papers and Presentations Status: Published Year Published: 2011 Citation: Johnson, D., S.H.S. Kim, B. Petty, C. Rom, D. Steinkraus, B. Lewis J. McAfee and H. Friedrich. 2011. Lessons in organic fruit pest management, pp. 41-47. In Proceedings of 30th Annual Oklahoma & Arkansas Horticulture Industries Show. 17. Type: Conference Papers and Presentations Status: Published Year Published: 2013 Citation: Rodriguez, H.G., J. Popp, C. Rom, H. Friedrich, J. McAfee. 2013. Development of an Economic Assessment Tool for Southern Organic Apple Production. Southern Sustainable Agriculture Working Group Annual Conference. January 23-26, Little Rock Arkansas 18. Type: Conference Papers and Presentations Status: Published Year Published: 2011 Citation: Rodriguez, H.G., J. Popp, R. Ruffin, H. Friedrich, C. Rom. 2011. Organic apple production using interactive budgets. Selected Presentation at the 2011 Horticultural Industry Show. Fort Smith, AR. January 14-15. 19. Type: Conference Papers and Presentations Status: Published Year Published: 2013 Citation: Rom, C. 2013. Organic apple production, pp. 90-94. In D. Collins (ed.), Proceedings Oklahoma/Arkansas Horticulture Industries Show Conference. 20. Type: Conference Papers and Presentations Status: Published Year Published: 2012 Citation: Rom, C.R., M.E.Garcia, D.T. Johnson, J. Popp, M. Savin, H. Friedrich, and J. McAfee. 2012. The effects of four ground cover management systems and three nutrient sources on the growth and performance of an organic apple orchard in the southern United States. International Symposium on Organic Fruit Production, International Society for Horticultural Sciences, Leavenworth, Wa. June 2012. 21. Type: Conference Papers and Presentations Status: Published Year Published: 2012 Citation: Rom, C.R. H. Friedrich and J. McAfee. 2012. Managing the Sustainable Orchard. Horticulture Industries Show. Tulsa, OK. Jan. 2012. 22. Type: Conference Papers and Presentations Status: Published Year Published: 2011 Citation: Rom, C. R. J. McAfee, H. Friedrich, D. Johnson, E. Garcia, J. Popp, and M. Savin. 2011 Early Performance of an Organic Apple Orchard as affected by Nutrient Source and Ground Cover Management. In the Arkansas-Oklahoma Region. Proceedings of the 30th Arkansas-Oklahoma Horticulture Industries Show (CD-Rom, digital publication) 23. Type: Conference Papers and Presentations Status: Published Year Published: 2011 Citation: Savin, M. C. 2011. Soil management in perennial systems. 30th Annual Arkansas and Oklahoma Horticulture Industries Show, Fort Smith, AR, Jan 14 15. 24. Type: Conference Papers and Presentations Status: Published Year Published: 2013 Citation: Savin, M. C. 2013. The impacts of organic apple production practices on soil. 32nd Annual Horticulture Industries Show, Horticulture Production & Food Safety: Making Good During Tough

Times. Fort Smith, AR, Jan. 11-12. 25. Type: Theses/Dissertations Status: Published Year Published: 2009 Citation: Choi, H.S.2009.Effects of different organic apple production systems on seasonal variation of soil and foliar nutrient concentration, PhD thesis, University of Arkansas, Fayetteville, AR. 26. Type: Theses/Dissertations Status: Other Year Published: 2014 Citation: Ford, J. 2014. Nitrification and denitrification in soil altered by ground cover and nutrient source in an organic apple orchard, M.S. thesis, University of Arkansas, Fayetteville, AR. 27. Type: Conference Papers and Presentations Status: Published Year Published: 2008 Citation: Rom, C.R. J. McAfee, H. Friedrich, H. Choi, D.T. Johnson, J. Popp, and M.E. Garcia. 2008. The effects of ground cover management and nutrient source on establishment and early growth of an organic apple orchard. SARE National Conference 28. Type: Conference Papers and Presentations Status: Published Year Published: 2011 Citation: Rom, C.R., J. McAfee, H. Friedrich, M.E. Garcia, D.T. Johnson, J. Popp, and M. Savin. 2011. Management Practices for Organic Orchard Ground Cover and Nutrition. Presented at the Annual Conference of the Southern Sustainable Working Group. Chattanooga, TN. 29. Type: Theses/Dissertations Status: Published Year Published: 2013 Citation: Mays, N. 2013. Groundcover management system and nutrient source impact physical soil quality indicators in an organically managed apple orchard. MS Thesis, University of Arkansas ISBN 9781303058325 30. Type: Other Status: Published Year Published: 2013 Citation: Bough, Raven A. and Curt R. Rom. 2013. Influence of organic groundcovers on mycorrhizal colonization and symbiosis of organically managed fruit crops. Discovery The Student Journal of the Dale Bumpers College of Agricultural, Food, and Life Sciences. 14: 3-11. 31. Type: Other Status: Published Year Published: 2012 Citation: Johnson, C., B. Smith, and M. C. Savin. 2012. Invertebrate abundances and diversity of a six year old organic apple orchard in Northwest Arkansas. Discovery The Student Journal of the Dale Bumpers College of Agricultural, Food, and Life Sciences. 13:38-45. 32. Type: Other Status: Published Year Published: 2008 Citation: Breaking New Ground for Organic Orchards. In Common Ground, SARE quarterly magazine. Oct. 2008. http://www.southernsare.uga.edu/commongrnd/08autumn.pdf 33. Type: Other Status: Published Year Published: 2008 Citation: Scientists develop holistic approach for organic production. May 2008. http://arkansasagnews.uark.edu/2370.htm 34. Type: Other Status: Published Year Published: 2009 Citation: Organic Fruit Production, In Research Frontiers, Fall, 2009. http://researchfrontiers.uark.edu/15685.php

2008/09/01 TO 2009/08/31 1. Choi, H.S. 2009. Effects of different organic apple production systems on seasonal variation of soil and foliar nutrient concentration. Ph.D. Dissertation. University of Arkansas. 175 pages. 2. Rom, C.R., M.E. Garcia, D.T. Johnson, J. Popp, M. Savin, J. McAfee and H. Friedrich. 2009. The effects of groundcover management and nutrient source during organic orchard establishment. Acta Hort. (accepted/pending publication) 3. Rom, C.R. 2009. Understanding and assessing sustainability in horticulture: Use of life cycle assessment to study and improve horticulture sustainability. HortScience 44(4):970 (abst) 4. Rom, C.R., M.E. Garcia, D.T. Johnson, J. Popp, and M. Savin. 2009. Early performance of an organic apple orchard as affected by ground cover management and nutrient sources. HortScience 44(4):10801-1082 (abst) 5. Garcia, M.E., H.F. Friedrich, and C.R. Rom. 2009. Expanding sustainable and organic training opportunities in Arkansas. HortScience 44(4):1152 (abst) 6. McAfee, J., C.R. Rom, H. Friedrich, H. Choi, M.E. Garcia, D.T. Johnson, J. Popp, and M. Savin. 2009. Ground cover management and nutrient source affect weed density, vole damage, and survival during establishment of an organic apple orchard. HortScience 44(4):1114 (abst) 7. Choi, H.S., and C.R. Rom. 2009. Estimated nitrogen balance of young apple trees grown in response to various organic apple production systems. HortScience 44(4):1113 (abst) 8. Savin, M.C., P. Tomlinson, C. Rom, H. Friedrich, and H. Choi. 2009. Difference in soil and tree responses to organic orchard fertilizer and ground cover management. In Annual Meetings Abstracts (CD-Rom). ASA, CSSA, and SSSA, Madison, WI.

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Integrating Weed Management and Fertility in Organic Highbush Blueberry Production Systems to Optimize Plant Growth, Yield and Grower Return

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Investigator(s)	Strik, B.; Bryla, D.; Sullivan, D.; Seavert, C.
Performing Institution	HORTICULTURE, OREGON STATE UNIVERSITY, CORVALLIS, OREGON 97331

NON-TECHNICAL SUMMARY

The goal of this project is to develop an organic production system for highbush blueberry that maximizes plant growth and yield; facilitates weed, water, and nutrient management; and provides the greatest economic benefit to growers. This proposal responds to research needs identified by growers and university personnel. To achieve our goals, the following objectives were developed: 1) evaluate effectiveness and impacts of organic weed management, fertility, and production systems; 2) develop a ocustomo compost; 3) develop economic enterprise budgets; 4) disseminate research findings to industry; 5) use eOrganic to facilitate clientele involvement and package our findings for a national audience; and 6) assess changes in grower knowledge, intentions, and practices resulting from the project. Our advisory committee (industry and research members) has been involved in selecting the site, developing objectives and treatments, and management. This project seeks to add greater scientific depth to our knowledge of best practices for organic blueberry production. Treatments consist of 2 cultivars (Duke and Liberty), 2 production methods (raised bed or flat ground), 3 weed management practices, and 2 types and rates of organic fertilizer. From 1995 to 2005, worldwide highbush blueberry acreage increased by 90%. The market for organic blueberries is very strong. However, there were only an estimated 194 ha of organic blueberries in North America in 2003, less than 1% of total. Even with record prices for blueberries in 2006 and 2007, organic prices were 20-50% higher than conventional. In 2003, a survey we conducted indicated that weed management was one of the top challenges nationwide. Organic mulches have been shown to be effective at controlling many annual weeds. However, using organic mulches, particularly those with a high C:N ratio, complicates management of plant fertility. Our research has shown that in plantings on raised beds, irrigation management and mechanical weed control is more difficult. Research is needed on the impact of raised and flat ground plantings on weed management and blueberry plant growth and yield. We have looked at the impact of mulch on nutrient uptake and have provided growers with revised fertilizer recommendations. However, we have not assessed whether these findings can be extrapolated to organic production systems. Can we use similar rates of organic sources of N? What are the best timings of application to ensure the fertilizer N is

available when the plant needs it? How will mulch type impact fertilizer availability? Will the compost we apply provide any measurable advantage in this production system? After this study, we will have science-based information on how growers might be able to establish and manage organic blueberries. We will have concrete information on the effectiveness of organic weed management techniques and fertilization methods. We will also be able to provide advice on the irrigation requirements of flat ground and raised bed planting systems as affected by mulching or weed mat. We will maintain detailed records in order to be able to provide some economic cost/benefit analyses.

OBJECTIVES

The long-term goal of this project is to develop organic production systems for highbush blueberry that maximize plant growth, yield, and fruit quality; facilitate weed, water and nutrient management; and provide economic benefit to growers. Research objectives of this project are: 1) Evaluate organic weed management, fertility, and production systems for effectiveness and impacts on shoot growth and production, root distribution, and availability of water and nutrients; and 2) Develop a compost specifically designed for blueberry that will provide a long-term boost in soil N mineralization potential without causing damage to plants due to high pH and/or high salts. Extension and outreach objectives of the project are to: 1) Develop economic enterprise budgets for establishment and management of organic blueberries as affected by production method. 2) Produce workshops, field days, publications and web-based tools to effectively disseminate research findings to industry. 3) Use eOrganic to facilitate involvement of clientele during the project, and to package our research findings and traditional Extension activities into products that are useful to a national audience; and 4) Assess changes in grower knowledge, intentions, and practices resulting from the project. Measurable research outcomes for the Integrated Systems Trial will be in the form of answers to these questions: 1) What is the most effective way to control weeds? 2) Can we use weed mat to substitute for sawdust mulch (industry standard practice) for weed control? 3) What fertility inputs can be used to supply the crop with adequate nitrogen? 4) Can compost be used as a fertility source in organic production? 5) Do blueberries need to be grown on raised beds? 6) What impact will altered production practices have on long-term plant health and sustainability? and 7) Can blueberries be grown economically using the recommended sustainable organic production systems? Each year, the project advisory group will meet and conduct a group assessment of project progress. Specifically, the advisory group will review project outcomes to date, and discuss future project opportunities and obstacles. Based on advisory committee inputs, our plan of work will be adjusted for the next year, as necessary. Measurable short-term and medium-term outcomes of this project have been discussed with the project advisory committee, and have been considered in the planning process. Short-term outcomes will include changes in knowledge, skills, attitude, motivation, awareness. Medium-term outcomes will include changes in behaviors, practices, policies, procedures. Short and medium term outcomes will be assessed by participant surveys at outreach events. In the final year of the project, blueberry industry participants will be surveyed to assess short and medium term project outcomes.

APPROACH

Integrated Systems Trial: Treatments consist of 2 cultivars (Duke and Liberty), 2 production methods (raised bed or flat ground), 3 weed management practices \sawdust mulch+hand weed removal; compost+sawdust mulch+acetic acid; and weed mat\, and 2 types and rates of fertilizer (feather meal and liquid fish emulsion at 28 or 55kgN/ha). Plants are drip irrigated. Design is a split-split plot with 5 reps and 240 plots. Each sub-subplot is 4.6-m long with 6 plants at 0.76 m apart, planted Oct. 2006. Soil samples will be collected annually and bulk density 2x per year. Weed pressure as coverage will be recorded every 3 weeks. One plant/plot will be destructively harvested and dry weight determined and shoot growth will be evaluated each season. Root samples will be collected periodically by using root in-growth cores to estimate standing root biomass and vitality. Images of roots that grow along the surface of minirhizotron tubes will be recorded and analyzed for root production and root longevity. Soil temperature will be measured. Soil water dynamics will be measured using a time-domain reflectometry (TDR) system. To determine the distribution of mineral nutrients in each treatment, soil solution samplers (Rhizon Samplers, Soilmoisture Equipment Corp.) will be installed near each TDR probe. Soil solutions will be collected weekly and analyzed. We will use ion-exchange membranes \Plant-Root Simulator probes (PRS), Western Ag Innovations, Saskatchewan\ to assess treatment effects on nutrient supply rates to plant roots. The water and nutrient status of the plants will be monitored seasonally using tissue analyses and a pressure chamber. Yield, berry weight, and firmness will be obtained by hand harvesting. We have collected accurate data on the costs of establishment and are recording labor requirements and products throughout for an economic analysis by treatment. At the completion of this project, we will produce an organic blueberry enterprise budget and interactive spreadsheet for the A Grower\'s TEAM software program. Custom Compost Trials: We will use combinations of locally-available byproducts to create a suitable compost. In a screening study, compost

feedstock mixtures will be enclosed in porous nylon mesh bags, placed within a large hot compost pile, and harvested periodically to determine compost chemical characteristics. We will leach selected finished composts with water and use the leachate to irrigate containerized blueberry plants, evaluating survival and root health. We will conduct lab incubations with soil to determine compost decomposition rate and plant-available N release. Finished composts will be incubated in soil to determine decomposition rate and release of plant-available N, and incubated and leached repeatedly to determine nutrient concentration, pH, and salts in the leachate. Select compost mixtures will be evaluated in the field by planting blueberries in compost-amended soil or soil mulched with the compost. The data for this split-split plot design will be analyzed using Proc Mixed, analysis of variance or repeated measures, as appropriate.

PROGRESS

2008/08 TO 2011/08 OUTPUTS: We established a 0.4 ha planting in Oct. 2006 to evaluate the effects of cultivar (Duke; Liberty), bed type (flat; raised), weed management (sawdust mulch and hand-weeding; compost topped with sawdust with acetic acid, lemongrass oil and hand weeding; weed mat), and fertilizer (feather meal and fish emulsion at 29 and 57 kg of N/ha (2007-2009) and 57 and 102 kg/ha (2010-11). The site was certified organic in 2008. Research: 1. Evaluate organic weed management, fertility, and production systems. Weeds never exceeded 20-25% coverage in 2007-2010; weed mat resulted in the fewest weeds and compost plus sawdust had the most. Acetic acid or lemongrass oil applied every 3 wks in summer was effective on small weeds. Hand-weeding was required in all treatments. Plants grown on raised beds were larger and had 48% greater cumulative yield than those on flat ground (years 1-4). Raised beds with weed mat required double the irrigation volume than flat plantings in years 1-3, but not in year 4. In 2010, yield averaged 1.8 kg/plant. Fertilization with the low rate of fish emulsion or the high rate of feather meal resulted in high yields in 2009 and 2010. Yield was higher with weed mat or sawdust plus compost than with only sawdust. Weed mat reduced fruit firmness compared to organic mulches in all years except 2010. Plant-available N was greater under weed mat than sawdust but availability of Ca and K was lower. Soil pH was lowest under weed mat and highest under sawdust plus compost. 2. Develop a compost for blueberry. Compost feedstocks evaluated included animal manure solids + bedding (horse or dairy), urban yard debris, and farm by-products (grass seed screenings, spent hops, or peppermint distillation residue). Elemental S required to acidify compost to below pH 6 ranged from 3 to 12 kg S per metric ton dry compost. Plants grew better in plant-derived composts than in manure-derived composts, and compost acidification increased growth. Compost pH limited growth more than soluble salts. Composts for blueberry typically have a low to medium pH buffering capacity, requiring addition of 3 to 6 kg S per metric ton dry compost to reduce pH to less than 5.5. Extension: 1. Develop economic enterprise budgets. Inputs were documented and organic fruit sold throughout the project to document costs/returns. An extension cost of establishment publication was developed with information shared with peers at conferences. 2. Produce workshops, field days, publications and web-based tools. We have given the following presentations, 2008-11: field days for growers (17); grower meetings (6); webinars (3); scientific meetings (7); and international invited (4). 3. eOrganic. We used eOrganic to enhance project outreach. Three webinars were conducted describing the ongoing project and providing research-based information to clientele. The webinar outreach included participation from all 3 project PIs, 1 graduate research assistant and 1 postdoctoral research associate (webinars reached more than 158 listeners from 32 states and 2 countries). Peer-reviewed, online materials (pages in eOrganic) were developed describing the project. PARTICIPANTS: Participants: Bernadine C. Strik, Professor of Horticulture, Oregon State University David Bryla, Research Horticulturist, USDA-ARS, HCRL, Corvallis Dan Sullivan, Assoc. Professor of Crop and Soil Science, Oregon State University Clark Seavert, Professor, NWREC, Oregon State University, Aurora Gil Buller, Senior Research Assistant, NWREC, Oregon State University Handell Larco, M.S. graduate student, Dept. Horticulture, OSU Ryan Costello, M.S. graduate student, Dept. Crop and Soil Sci, OSU Luis Valenzuela, post-doctoral associate, USDA-ARS, HCRL and Dept. Hort., OSU James Julian, Research Assistant, NWREC, OSU, Wei Yang, Assoc. Professor, NWREC, OSU Nick Andrews, Small Farms Agent, NWREC, OSU Eric Pond, Riverbend Farms, Jefferson, Ore. Adam Wagner, Fall Creek Farm and Nursery, Lowell, Ore. Steve Erickson, Pan-American Berry Growers, Salem, Ore. Chrislyn Particka, Sakuma Bros. research, Wash. Joe Bennett, Small Planet Foods, Wash. Partner organizations: Oregon Blueberry Commission Washington Blueberry Commission Northwest Center for Small Fruits Research USDA-ARS, HCRL, Corvallis Growers in Oregon and Washington TARGET AUDIENCES: Commercial berry crop growers Organic growers Crop consultants Academic peers PROJECT MODIFICATIONS: Nothing significant to report during this reporting period.

2009/08/15 TO 2010/08/14 OUTPUTS: Outputs are described under each objective Research: 1. Evaluate organic weed management, fertility, and production systems. Weeds never exceeded 20-25% coverage in 2007-2009; weed mat resulted in the fewest weeds and compost plus sawdust had the most. Flaming in spring and acetic acid applied every 3 wks in summer was effective on small weeds. Hand-weeding was required in all

treatments. Plants grown on raised beds were larger and had 63% greater cumulative yield than those on flat ground (years 1-3). Raised beds, particularly with weed mat, required up to 269 L/plant/season more irrigation than flat ground plantings. In 2009, yield averaged 1.7 kg/plant and was highest with 29 kg/ha N of fish or 57 kg/ha of feather meal and lowest with 57 kg/ha of fish. Yield was higher with weed mat or sawdust plus compost than with only sawdust. Weed mat reduced fruit firmness compared to organic mulches. Plant-available N was greater under weed mat than sawdust but availability of Ca and K was lower. Soil pH was lowest under weed mat and highest under sawdust plus compost. 2. Develop a compost for blueberry. Two plant growth trials evaluated compost effects on root and above-ground growth. Composts were added to soil at a high rate (30% v/v). Controls were soil alone and soil + sawdust (industry standard). Trials were done in winter in greenhouse (1-gal pots; Jan-May) and outdoors in summer (5-gal pots; May-Sept). In the greenhouse, plant growth was limited when composts having pH above 7.5 and EC above 4 mS/cm were incorporated into soil. Plant-derived composts performed better than manure-derived. Acidification of composts with elemental S increased plant growth. Compost pH was a greater limiting factor to plant growth than soluble salts. Elemental S addition increased compost EC, but also increased plant growth. When grown at low levels of N addition (winter trial), compost increased plant growth above that observed with sawdust addition. At higher rates of fish fertilizer (summer trial), plant growth with compost was equal to, or less than growth with sawdust. Extension: 1. Develop economic enterprise budgets. Costs have been documented to date. Certified organic fruit were sold in 2009-10 to document returns. Development of an extension cost of establishment publication is in progress. 2. Produce workshops, field days, publications and web-based tools. We have given the following presentations: field days (11); grower meetings (6); scientific meetings (4); and international invited (4). This project was highlighted at the Blueberry Field Day at the NWREC in 2008-10. 3. eOrganic. We used eOrganic to enhance project outreach. Two webinars were conducted describing the ongoing project and providing research-based information to clientele. The webinar outreach included participation from all 3 project PIs, 1 graduate research assistant and 1 postdoctoral research associate (webinars reached more than 158 listeners from 32 states and 2 countries). Online materials (pages in eOrganic) were developed describing the project. These are under review. Video recorded at the OSU Blueberry Field Day (July 2010) is being edited for release via eOrganic. PARTICIPANTS: Participants: Bernadine C. Strik, Professor of Horticulture, Oregon State University David Bryla, Research Horticulturist, USDA-ARS, HCRL, Corvallis Dan Sullivan, Assoc. Professor of Crop and Soil Science, Oregon State University Clark Seavert, Professor, NWREC, Oregon State University, Aurora Gil Buller, Senior Research Assistant, NWREC, Oregon State University Handell Larco, M.S. graduate student, Dept. Horticulture, OSU Ryan Costello, M.S. graduate student, Dept. Crop and Soil Sci, OSU Luis Valenzuela, post-doctoral associate, USDA-ARS, HCRL and Dept. Hort., OSU James Julian, Research Assistant, NWREC, OSU, Wei Yang, Assoc. Professor, NWREC, OSU Nick Andrews, Small Farms Agent, NWREC, OSU Eric Pond, Riverbend Farms, Jefferson, Ore. Adam Wagner, Fall Creek Farm and Nursery, Lowell, Ore. Steve Erickson, Pan-American Berry Growers, Salem, Ore. Chrislyn Particka, Sakuma Bros. research, Wash. Joe Bennett, Small Planet Foods, Wash. Partner organizations: Oregon Blueberry Commission Washington Blueberry Commission Northwest Center for Small Fruits Research USDA-ARS, HCRL, Corvallis Growers in Oregon and Washington TARGET AUDIENCES: Target audiences: Commercial berry crop growers, Organic growers, Crop consultants, Academic peers PROJECT MODIFICATIONS: Nothing significant to report during this reporting period.

2008/08/15 TO 2009/08/14 OUTPUTS: Outputs are described under each objective Research: 1. Evaluate organic weed management, fertility, and production systems. A research assistant maintained weed management and fertility treatments. Data were collected on weed presence, plant growth, and yield. Records on all costs were maintained. We hired and trained a postdoc to monitor root growth and measure availability of soil water and nutrients. In 2008, the sawdust+compost mulch had more weeds than the sawdust or weed mat and required hand pulling of weeds plus one application of 20% acetic acid and 2 propane flaming treatments. Weed mat had the fewest weeds, although hand pulling was required around the plants. Plant-available N was greater under weed mat than sawdust but availability of Mg was lower. The weed mat also had greater availability of P, S, Mn and Zn later in the season (July) compared to sawdust. In Oct. 2008, total plant dry weight (DW) was greater in Liberty, on raised beds, and at a N rate of 29 kg/ha of fish in Duke and 57 kg/ha of fish in Liberty. Root DW was greater with organic mulches fertilized with 29 kg/ha N of fish. Yield in 2008 (second growing season) was greater in Liberty than Duke, on raised beds, and on plants fertilized with fish. Weed mat reduced fruit firmness compared to organic mulches. 2. Develop a compost for blueberry. A graduate student (Costello) began work in Apr. 2009. Ten composts were produced from locally-available organic materials in preparation for blueberry growth trials. Feedstocks for compost production included separated dairy solids, ground yard debris, bean and corn cannery byproducts, spent peppermint hay, horse manure+sawdust bedding, spent hops from a brewery, and grass clippings from urban landscaping. Composting was performed in small produce bins. Compost temperatures during the first 4-6 wks exceeded 50C for most mixtures, simulating realistic composting-process conditions. Most composts met NOP time/temperature standards for human pathogen elimination. We measured compost pH and electrical conductivity (EC) in 1:10 compost:water extracts. After 10-wk of composting, pH and EC for the

composts were greater than desired for blueberry (pH\< 6.5 and EC\<1.5). The most promising composts were made from separated dairy solids and peppermint hay. We conducted 3-d laboratory incubations to determine the quantity of acid required to decrease compost pH to the desired range. For the 5 composts evaluated so far, we estimate that addition of 1-2 kg fine elemental S per m3 would be required to decrease compost pH to below 6. Extension: 1. Develop economic enterprise budgets. Costs have been documented to date. Certified organic fruit were sold in 2009 with documentation of returns. Development of an extension cost of establishment publication is in progress. 2. Produce workshops, field days, publications and web-based tools. We have given the following presentations: field days (4); grower meetings (5); scientific meetings (2); and international invited (3). This project was highlighted at the Blueberry Field Day at the NWREC in 2008 and 2009. 3. eOrganic. We developed an eOrganic community of practice related to this project PARTICIPANTS: Bernadine C. Strik, Professor of Horticulture, Oregon State University David Bryla, Research Horticulturist, USDA-ARS, HCRL, Corvallis Dan Sullivan, Assoc. Professor of Crop and Soil Science, Oregon State University Clark Seavert, Professor, NWREC, Oregon State University, Aurora Gil Buller, Senior Research Assistant, NWREC, Oregon State University Handell Larco, M.S. graduate student, Dept. Horticulture, OSU Ryan Costello, M.S. graduate student, Dept. Crop and Soil Sci, OSU Luis Valenzuela, post-doctoral associate, USDA-ARS, HCRL and Dept. Hort., OSU James Julian, Research Assistant, NWREC, OSU, Wei Yang, Assoc. Professor, NWREC, OSU Nick Andrews, Small Farms Agent, NWREC, OSU Eric Pond, Riverbend Farms, Jefferson, Ore. Adam Wagner, Fall Creek Farm and Nursery, Lowell, Ore. Steve Erickson, Pan-American Berry Growers, Salem, Ore. Chrislyn Particka, Sakuma Bros. research, Wash. Joe Bennett, Small Planet Foods, Wash. Partner organizations: Oregon Blueberry Commission Washington Blueberry Commission Northwest Center for Small Fruits Research USDA-ARS, HCRL, Corvallis Growers in Oregon and Washington TARGET AUDIENCES: Target audiences: Commercial berry crop growers Organic growers Crop consultants Academic peers PROJECT MODIFICATIONS: Not relevant to this project.

IMPACT

2008/08 TO 2011/08 The following questions were listed as research outcome goals: 1. What is the most effective way to control weeds Weed mat has been the most effective mulch for weed control. Propane flaming and acetic acid have been effective contact weed control methods provided weeds are small and environmental conditions are favorable. Lemongrass oil was an effective contact herbicide against small weeds in 2010-11. 2. Can we use weed mat to substitute for sawdust mulch (industry standard practice) for weed control Weed mat is effective for weed control, but the impact of higher soil temperature on plant growth needs more assessment. Root production was lower under weed mat than under organic mulches, and raised beds with weed mat required more irrigation than flat beds or beds covered with sawdust. 3. What fertility inputs can be used to supply the crop with adequate N Fish emulsion was equal or superior to feather meal for plant growth and was most effectively applied by fertigation. Soil N availability was relatively consistent with fish but higher under weed mat than under sawdust mulch. Higher N availability under weed mat was associated with higher soil temperatures and thus a more rapid conversion of organic N (fish and organic matter) to ammonium- and nitrate-N. The use of fish resulted in stable or a slight decrease in soil pH over the course of the study while soil EC remained very low and therefore had little to no impact on plant growth. The lower rate of fish fertilizer has resulted in the highest yields. 4. Can compost be used as a fertility source in organic production Plant-derived composts show promise to enhance organic blueberry production. Compost pH, not salt content, has been the major obstacle to compost use for blueberry. Our research shows that compost can be acidified via elemental S addition, and that plants grow better in acidified compost. We have developed and verified a quick test to determine how much S needs to be added to acidify compost to pH 5 to 5.5 (ideal for blueberry). 5. Do blueberries need to be grown on raised beds Growth and production were greater in plants grown on raised beds than in those grown on flat ground. Raised beds reduced soil water holding capacity but increased root growth and rooting depth to enable plants to acquire more water and nutrients. 6. What impact will altered production practices have on long-term plant health and sustainability Plant rooting differed among production practices. The low rate of fish fertilizer, for example, produced deeper and 30% more roots than the higher rate of fish fertilizer, while plants on raised beds produced deeper and 45% more roots than on flat ground. Plants with sawdust mulch produced more roots than with weed mat. Such practices increase the ability of blueberry to acquire water and nutrients and therefore reduce the need for irrigation and fertilizers. 7. Can blueberries be grown economically using the recommended sustainable organic production systems Cumulative net production costs (years 0-3) varied as much as 65% among treatments, ranging from -\$32,690/ha to -\$54,050/ha (net loss), similar to costs expected for conventional production. **PUBLICATIONS (not previously reported):** 2008/08 TO 2011/08 1. Larco, H., D.M. Sullivan, B. Strik, and D. Bryla. 2011. Mulch effects on highbush blueberry under organic management. p. 53 In: Abstracts, ISHS Intl. Symposium Organic Matter & Compost Use in Horticulture. Apr. 2011. Adelaide, AU. Acta Hort.(in press) 2. Strik, B.C., D. Bryla, H. Larco, and J. Julian. 2011. Organic Highbush Blueberry Production Systems

Research - Management of Plant Nutrition, Irrigation Requirements, Weeds, and Economic Sustainability. Intern. Hort. Congress, Lisbon, Portugal. Acta Hort. (in press) 3. Julian, J., B. Strik, E. Pond., and W. Yang. 2011. Blueberry economics: The Costs of Establishing and Producing Organic Blueberries in the Willamette Valley, Oregon. AEB 0023, July 4. Valenzuela-Estrada, L.R., D.R. Bryla, D.M. Sullivan, and B.C. Strik. 2011. Influence of weed mat and surface sawdust mulch on soil nutrient availability and soil chemical properties under organic blueberry production. 2011 ASHS Annual Conference, Hilo, Hawaii, 25-28 September 2011 (abstract). 5. Costello, Ryan C., Shannon B. Andrews and Dan M. Sullivan. 2011. Laboratory titration to predict S required for compost acidification. SSSA Annual Meeting. San Antonio, TX. 16-20 Oct. 2011. http://a-c-s.confex.com/crops/2011am/webprogram/Paper66759.html 6. Costello, R.C., D.M. Sullivan, D.R. Bryla, B.C. Strik and J. Owen. Highbush blueberry response to compost and sulfur. p. 67-72. In: Proc. Western Nutrient Mgmt. Conf. 3-4 Mar 2011. Reno, NV. Online at: https://sites.google.com/site/westernregion103/committee-output/conference-proceedings-2011 7. Strik, B.C., D. Bryla, and D. Sullivan. 2010. Organic Blueberry Production Research Project. Available at: http://www.extension.org/article/31680 8. Valenzuela, L., D. Bryla, D. Sullivan, and B.C. Strik. 2011. Organic Blueberry Production Research Project: Roots. Available at: http://www.extension.org/article/32763 9. Strik, B., Vollmer, E., Buller, G., Bryla, D. and Sullivan, D. 2011. Organic blueberry production reseach project. Oregon Blueberry Update, spring, 2011 10. Costello, R. and D. Sullivan. 2010. Development of Custom Compost for Highbush Blueberry. Soil Science Soc. Am. annual meeting, Long Beach, CA. Available at: http://a-c-s.confex.com/crops/2010am/webprogram/Paper60079.html 11. Larco, Handell O. 2010. Effect of planting method, weed management, and fertilizer on plant growth and yield of newly established organic highbush blueberries. M.S. thesis. Oregon State University. http://hdl.handle.net/1957/18065 12. Sullivan, Dan M. and Ryan Costello. 2010. Breaking it down: Growers can get the most value from their compost by having it analyzed first. Digger (Oregon Association of Nurseries). 54 (10): 42-46. 13. Valenzuela-Estrada, L., O.L. Vargas, D.R. Bryla, D.M. Sullivan, and B.C. Strik. 2010. Blueberry root dynamics and nutrient management under organic and conventional production. HortScience 45:S34 (Abstr.). 14. Strik, B. and D. Bryla. 2010. Weed, water, and nutrient management practices for organic blackberry production. Proc. Northwest Center for Small Fruits Research, Dec., 2010, Boise, ID 19:92-93

2009/08/15 TO 2010/08/14 The following questions were listed as research outcome goals: 1. What is the most effective way to control weeds Weed mat has been the most effective mulch for weed control. Propane flaming and acetic acid have been effective contact weed control methods provided weeds are small and environmental conditions are favorable. 2. Can we use weed mat to substitute for sawdust mulch (industry standard practice) for weed control Weed mat is effective for weed control, but the impact of higher soil temperature on plant growth needs more assessment. Root DW was lower under weed mat than under organic mulches and raised beds with weed mat required extra irrigation in year 2. 3. What fertility inputs can be used to supply the crop with adequate N Fish emulsion was equal or superior to feather meal for plant growth. Inorganic N availability was relatively consistent with fish over a 14-wk period (late Apr thru July) for weed mat and sawdust mulches. Soil N, nitrate, and ammonium were higher with weed mat than with sawdust and higher near the soil surface in flat than in raised beds. Soil pH was higher with sawdust than with weed mat and lower as more N fertilizer was applied, while EC increased as more N was applied but only on raised beds; pH and EC were within the range considered \"safe\" for blueberry. 4. Can compost be used as a fertility source in organic production Plant-derived composts show promise to enhance organic blueberry production. Compost pH, not salt content, has been the major obstacle to compost use for blueberry. Our research shows that compost can be acidified via elemental S addition, and that plants grow better in acidified compost. We have developed and verified a quick test to determine how much S needs to be added to acidify compost to pH 5 to 5.5 (ideal for blueberry). 5. Do blueberries need to be grown on raised beds After the second growing season, total plant DW was greater in raised beds than on flat. Soil water content was lower in raised beds than in flat ground with sawdust but was higher in raised beds than in flat ground with weed mat. Soil N was lower at 15 cm than at 35 cm in raised beds, but more roots were located at the 35 cm depth. 6. What impact will altered production practices have on long-term plant health and sustainability Root production was monitored starting in 2009 using 90 minirhizotron tubes. More than 8,000 digital images were captured bi-weekly throughout the last two growing seasons. So far, most roots were produced shortly after harvest, implying root production is C-source limited and will differ depending on pruning and fruit set. In general, the low rate of fish fertilizer produced deeper and 1.3 times as many roots as the high rate of fish fertilizer, while raised beds produced deeper and 45% more roots than flat beds, and sawdust mulch produced more roots than weed mat. 7. Can blueberries be grown economically using the recommended sustainable organic production systems Cumulative net production costs (years 0-3) varied as much as 60% among treatments, ranging from -\$32,690/ha to -\$51,990/ha (net loss), similar to costs expected for conventional production.

2008/08/15 TO 2009/08/14 The following questions were listed as research outcome goals: 1. What is the most effective way to control weeds Weed mat has been the most effective mulch for weed control. Propane flaming and acetic acid have been effective contact weed control methods provided weeds are small and environmental conditions are favorable. 2. Can we use weed mat to substitute for sawdust mulch (industry standard practice) for weed control Weed mat is effective for weed control, but the impact of higher soil temperature under weed mat on plant growth needs more assessment. Root DW was lower under weed mat than under organic mulches. Raised beds with weed mat required 300 L/plant of extra irrigation in year 2. 3. What fertility inputs can be used to supply the crop with adequate N Fish emulsion was equal or superior to feather meal for total plant growth. Inorganic N availability was relatively consistent with fish over a 14-wk period (late Apr thru July) for weed mat and sawdust mulches. In general, pH was higher with sawdust than with weed mat and lower as more N fertilizer was applied, while EC increased as more N was applied but only on raised beds; neither pH or EC were unusual for blueberry, and both were within the range considered \"safe\". 4. Can compost be used as a fertility source in organic production Yard debris compost+sawdust mulch at planting gave 25% more yield, but increased labor cost for controlling weeds by 63% compared to sawdust mulch alone. Produced novel composts from locally-available feedstocks, all of which had pH\>6 (require elemental S or other acidifying agent to reduce pH for blueberry). Developed a \"quick test\" to estimate the amount of acidifying agent needed to overcome high pH. Composted dairy solids and peppermint hay best fit target pH and salt levels for blueberry. 5. Do blueberries need to be grown on raised beds After the second growing season, total plant DW was greater in raised beds than on flat ground. Soil water content was lower in raised beds than in flat ground with sawdust but was higher in raised beds than in flat ground with weed mat. Raised beds required 190 L/plant more irrigation water than flat ground in year 2. 6. What impact will altered production practices have on long-term plant health and sustainability Root production was monitored starting in 2009 using 90 minirhizotron tubes. A total of 3,960 digital images were captured bi-weekly throughout the growing season. So far, we determined that most roots were produced shortly after harvest, implying root production is carbon-source limited and will differ depending on pruning and fruit set. 7. Can blueberries be grown economically using the recommended sustainable organic production systems The total costs of land preparation, planting establishment, and maintenance after year 1 ranged from \$30,311 to \$35,534/ha depending on treatment. Raised beds increased costs \$1,263, on average, compared to planting on flat ground. Adding compost to the mulch increased costs \$976 in flat ground and \$1,156 in raised beds for materials and labor, but also increased weed management costs by \$1,519 due to higher weed pressure and use of acetic acid.

PUBLICATIONS

2009/08/15 TO 2010/08/14 1. Strik, B., D. Bryla, and H. Larco. Organic Blueberry Production Webinar. Presented March, 2010 via eOrganic. Available at: http://www.extension.org/article/26115 2. Sullivan, D., L. Valenzuela, and R. Costello. 2010. Undercover Nutrient Investigation: The Effects of Mulch on Nutrients for Blueberry Webinar. Presented Jan, 2010 via eOrganic. Available at: http://www.extension.org/article/25232. 3. Costello, R. and D. Sullivan. 2010. Development of Custom Compost for Highbush Blueberry. Soil Science Soc. Am. annual meeting, Long Beach, CA. Available at: http://a-c-s.confex.com/crops/2010am/webprogram/Paper60079.html 4. Larco, Handell O. 2010. Effect of planting method, weed management, and fertilizer on plant growth and yield of newly established organic highbush blueberries. M.S. thesis. Oregon State University. http://hdl.handle.net/1957/18065 5. Valenzuela-Estrada, L., O.L. Vargas, D.R. Bryla, D.M. Sullivan, and B.C. Strik. 2010. Blueberry root dynamics and nutrient management under organic and conventional production. HortScience 45:S34 (Abstr.). 6. Costello, Ryan. Composting and Blueberry Production. p. 15-16. In: Small Farm News. OSU Extension. Fall, 2009.

2008/08/15 TO 2009/08/14 1. Strik, B.C., G. Buller, H. Larco, and J. Julian. 2009. The economics of establishing blueberries for organic production in Oregon. A comparison of weed management systems. Acta Hort. 810:457-464 2. Larco, H., B.C. Strik, D. Bryla, and D. Sullivan. 2009. Establishing Organic Highbush Blueberry Production Systems. The Effect of Raised Beds, Weed Management, Fertility, and Cultivar. HortScience (abstr.), 44:1120-21. 3. Strik, B.C. 2009. Organic blueberry production: is it viable in the Northwest Proc. Lower Mainland Hort. Improvement Assoc., Abbotsford, B.C., Feb. 19-21: 135-136 4. Strik, B. 2009. Weed and fertility management of a newly established organic blueberry field. eOrganic Updates!, May 2009:3. 5. Strik, B. 2009. Weed and fertility management of a newly established organic blueberry field. Proc. Northwest Center for Small Fruits Research, Dec., 2008, Corvallis, OR 17:43-45 6. Strik, B. and H. Larco. 2008. Weed and fertility management of a newly established organic blueberry field. Proc. Northwest Center for Small Fruits Research, Nov. 29, Boise, ID. 16:55-57 7. Costello, Ryan. Composting and Blueberry Production. p. 15-16. In: Small Farm News. OSU Extension. Fall, 2009.

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Predictive Management of Soil Microbial Communities Using Defined Amendments to Enhance Production in Organic Cropping Systems

Accession No.	0213651
Subfile	CRIS
Project No.	WNW-2008-01245
Agency	NIFA WN.W
Project Type	OTHER GRANTS
Project Status	TERMINATED
Contract / Grant No.	2008-51300-04456
Proposal No.	2008-01245
Start Date	15 AUG 2008
Term Date	14 AUG 2012
Fiscal Year	2009
Grant Amount	$517,798
Grant Year	2008
Investigator(s)	Mazzola, M.
Performing Institution	USDA, ARS, Tree Fruit Research Laboratory, 1104 North Western Avenue, Wenatchee, WASHINGTON 98801

NON-TECHNICAL SUMMARY

Numerous studies have attempted to develop soilborne disease control and fertility management programs that are compatible with organic crop production systems. Often times, plant-derived or manure-based amendments have been the foundation of such programs. However, in the majority of instances the potential of such a strategy has not been realized due to a lack of understanding of functional mechanisms resulting in an inability to utilize organic amendments with predictable outcomes. Our objective is to garner a greater capacity to manage and predict development of native soil biology-mediated processes that contribute to disease suppression and nitrogen availability in organic crop production systems. This will entail formulation and optimization of brassicaceous seed meal amendments, and evaluation of these materials in advanced on-farm research as a novel disease control and soil fertility management program. This is a pivotal management issue in light of the desire to employ the multitude of resources native to organic ecosystems as a biologically-sustainable disease control option, realization of the complexity of microbial systems and the myriad ways they impact other organisms, and need to identify more cost-effective nitrogen sources while minimizing loss from organic production systems. Our study system has the advantage of pairing a well-characterized overall effect with a microbial community for which we have considerable background information, including demonstrated mechanisms for how soil biology and the amendment are contributing to the overall effect. As many of the focal microorganisms, both deleterious and beneficial, are common in agricultural soils, results will be relevant across a diversity of crop production systems.

OBJECTIVES

This research program seeks to identify and implement methods compatible with organic production systems for the control of soilborne disease phenomena that are biologically complex. Our goal is to develop a management

program that ensures successful crop establishment on sites previously planted to the same or closely related species, and sustains productivity of these plantings through maximizing the efficiency of the biological resources resident to the soil ecosystem. Additionally, the effect of the central input (brassicaceous seed meals) on biological elements contributing to N cycling and the availability of N will be ascertained. The overall objective of the proposed studies is to garner a greater capacity to manage and predict development of a native diversity of biologically-mediated processes that contribute to disease suppression and nitrogen availability in organic crop production systems. This is a pivotal management issue in light of 1) the desire employ the multitude of resources native to organic systems as a biologically-sustainable disease control option, 2) realization of the complexity of microbial systems and the myriad of ways they impact other organisms, and 3) need to identify more cost-effective N sources while minimizing loss from organic production systems. As many of the functional biological agents, both deleterious and beneficial, are common in agricultural soils, findings will be relevant across a number of crop production systems. Specific objectives are to: 1. Assess the impact of brassicaceous seed meal particle size on disease control efficacy. 2. Dissect the relative function of chemical and biological factors contributing to brassicaceous seed meal-induced pathogen suppression 3. Evaluate efficacy of a composite brassicaceae seed meal formulation for disease control in organic production systems when integrated with host resistance 4. Determine the effect of individual and composite brassicaceous seed meal on soil nematode communities and nitrogen availability 5. Based on findings develop conduct outreach programs to communicate the economic viability of this management strategy to organic producers

APPROACH

Studies will be conducted to assess the capacity of brassicaceous seed meal particle size to enhance populations of resident microbial antagonists, suppress soilborne pathogens and enhance growth of apple in replant orchard soils. Impact on plant beneficial populations (e.g. Streptomyces spp.) and the target soilborne pathogens will be determined using culture-based approaches and real-time quantitative PCR. Effect of particle size on emission of active chemistries resulting from hydrolysis of glucosinolates from Brassica juncea (BjSM)seed meal will be determined by gas chromatography. Studies will clarify the plausible roles of soil biology and chemistry in the brassicaceous seed meal (BSM)-induced suppression of a group of fungi/oomycetes that in concert contribute to apple replant disease. Seed meal will be applied to native and pasteurized orchard soils, infested with inoculum of the individual target pathogens, and planted to apple. Significant reduction in root infection attained with BSM amendment in a pasteurized soil system would suggest a role for glucosinolate hydrolysis products or other chemical factors in disease suppression. Alternatively, disease control realized in a native soil system, but not in the same soil pasteurized prior to pathogen introduction, would be suggestive of soil biology having a significant role in disease suppression. The latter has been documented in the suppression of R. solani in response to B. napus seed meal amendment. Sensitivity of individual fungal/oomycete isolates to the volatile allyl isothiocyanate (AITC) produced in (BjSM)amended soils will be assessed. Preliminary experiments suggest that modification of the fungal community resident to the soil system contributes to the seed meal induced suppression of root rot incited by Pythium spp. Thus, changes in structure of fungal communities in seed meal amended orchard soils will be monitored using culture-based methods and DNA-array analysis. Specific taxa which respond positively to seed meal amendment in a manner that is temporally linked to the initiation of Pythium suppression will be assayed for the capacity to provide disease control. We will explore the effectiveness of host tolerance in conjunction with a novel composite brassicaceous seed meal formulation for control of replant disease and do so at field sites possessing all components of the pathogen complex. Studies will evaluate the efficacy of seed meal amendments made in the autumn prior to planting and in the spring of planting. Nematodes play an important role in nutrient cycling, estimated to contribute approximately 20% of mineralized N in integrated farming systems. The nematicidal activity of certain isothiocyanates, including AITC generated by BjSM, suggests that certain BSMs could negatively impact this community and alter N availability. The effect of individual BSMs and the composite seed meal on nematode population dynamics will be determined over time. The nematode community diversity will be ascertained using T-RFLP analysis and quantitative attributes of the population will be determined using standard isolation methods.

PROGRESS

2008/08 TO 2012/08 OUTPUTS: Studies were completed which determined the modes of action functional in the Brassicaceae seed meal induced control of the various elements that comprise the causal pathogen complex inciting apple replant disease. The relative importance of biological and chemical mechanisms, the operative biological entities, the temporal dynamics of the disease control response, and the effect on long-term organic system resilience to pathogen/parasite recolonization of organic orchard soils was determined. The effect of soil type, season of application, apple rootstock genotype, seed meal formulation and duration of plant back period on

potential for phytotoxicity, disease control, tree growth and yield were determined in three trials conducted in organic orchard systems. These field trials were used as a resource for numerous educational, grower tour and international meetings including the annual Washington State University Sunrise Orchard Field tour, Washington State University Department of Horticulture and Department of Plant Pathology field courses and served as a major component of the field program conducted at the 2nd International Organic Fruit Research Symposium, where the sites were toured as part of the presentation \"Advances in application protocol and Brassica seed meal formulation for management of replant disease\". Findings from these studies were presented by invitation at numerous grower and industry supported conferences, and not limited to tree fruits, including the Organic Session of the Washington State Horticultural Association, 2nd International Organic Fruit Research Symposium, the Mid-Columbia Cherry Day research symposium sponsored by Oregon State University, the Ecoraz Symposium sponsored by the Washington Red Raspberry Association, Snohomish County Focus on Farming Conference, the Western Region SARE, Washington State University Center for Sustaining Agriculture and Natural Resources, and the National Integrated Pest Management Symposium. The work conducted in this program has fostered new collaborations with scientists, both nationally and internationally, at the University of California-Santa Cruz, the University of California-Davis, Wageningen University the Netherlands and Stellenbosch University South Africa. The technology developed in this program is being evaluated for use in other plant production systems and the seed meal formulation developed is being made available. This project led to the hosting and mentoring of numerous undergraduate students, graduate students, as well as visiting scientists from Spain, Kenya and Egypt. PARTICIPANTS: Mark Mazzola, the PD, managed the overall research program including the conduct of field trials and the dissemination of findings to the grower and research community. This project served as the vehicle to provide training to numerous graduate students of the plant/microbial sciences including Ms. Muditha Weerakoon (Washington State University), Ms. Shashika Hewavitharana (Washington State University), Mr. Maxwell Handiseni (Univ. of Idaho), Mr. Aaron Agostini (Sonoma State University) and Ms. Manuela Vincente Domingues (Cordoba University, Spain). In addition, undergraduate students including Ms. Irene Mendoza, Ms. Laurie Bazan (University of Washington, and Mr. Alec Schmidt (Central Washington University obtained training in soil biology and organic management systems through this program. The program also provided training and development to two post-doctoral research associates. TARGET AUDIENCES: The program provided practicum experience for two undergraduate students (Ms. Irene Mendoza and Ms. Laurie Bazan) from the local Hispanic population, which is characteristically under-represented in the field of plant/microbial science research fields. Field days were conducted at the Washington State University Sunrise orchard and the Stormy Mountain Ranch commercial orchard to demonstrate the efficacy of seed meal formulations for the control of apple replant disease. These events were attended by growers, industry representatives, graduate students and the general public. Additional events were conducted in these orchard trials as part of formal Washington State University horticultural classes. Findings from these trials were also presented to growers at the International Fruit Tree Association conference, the Annual Meeting of the Washington State Horticultural Association, the Washington State Tree Fruit Research Commission Review, a Washington Red Raspberry Commission sponsored symposium on ecological farming, the Focus on Farming conference sponsored by Snohomish County Washington, and the Mid-Columbia Cherry Research Symposium sponsored by Oregon State University. PROJECT MODIFICATIONS: Not relevant to this project.

2010/08/15 TO 2011/08/14 OUTPUTS: Tree growth in response to brassicaceae seed meal amendments at three orchard replant field trials established at three different commercial and research organic orchards were monitored. The efficacy of different brassicaceae seed meal formulations on control of the pathogen complex that incites apple replant disease was determined at these three sites. The effect of plant plant back period on phytotoxicity and the interaction with apple rootstock genotype was assessed. Findings from these trials was disseminated to the producer community at various grower meetings including the International Fruit Tree Association meeting, at the annual meeting of the Washington State Horticultural Association, and at the annual scientific review of the Washington Tree Fruit Research Commission. Interest in this model as a potential soil-borne disease control strategy in other cropping systems was evidenced by invitation to discuss findings at the ECORAZ symposium sponsored by the Washington Red Raspberry commission, Western Region SARE and the Washington State University Center for Sustaining Agiculture and Natural Resources. This work as fostered new collaborations with scientists at the University of California-Santa Cruz and University of California-Davis in which the use of this technology for soil-borne pest control in strawberry production systems will be evaluated. This project has resulted in the hosting and mentoring of numerous graduate and undergraduate students currently conducting studies at the University of Washington, Washington State University, Sonoma State University, and Stellenbosch University (South Africa). PARTICIPANTS: Mark Mazzola, the PD, managed the overall research program including conduct of field trials and dissemination of findings to the grower and research community. Ms. Muditha Weerakoon, graduate student was trained through the conduct of this program and completed requirements for the MSc degree in plant pathology through the course of this program. She conducted studies concerning the development of long-term soil suppressiveness towards Pythium abappressorium in response to

Brassica juncea seed meal amendment. Ms. Shashika Hewavitharana has commenced graduate studies in plant pathology and is contributing to this research program. Ms. Xiaowen Zhao conducted studies that addressed the effect of seed meal particle size on generation of biologically active chemistries in response to Brassica juncea seed meal amendment and control of plant pathogens and parasites. Mr. David Granatstein from the Washington State University Center for Sustaining Agriculture has provided extension resources for the dissemination of findings from this program to growers at various meetings. This project has served as a vehicle to provide training to a number of graduate students at various institutions including Mr. Maxwell Handiseni (University of Idaho), Mr. Aaron Agostini (Sonoma State University) and Ms. Manuela Vincente Domingues (Cordoba University, Spain), as well as the PDs own graduate students. In addition, undergraduate students Ms. Irene Mendoza and Ms. Laurie Bazan currently attending the University of Washington obtained training in soil biology and organic management systems through this research program. TARGET AUDIENCES: This program provided practicum experience to two undergraduate students (Ms. Irene Mendoza and Ms. Laurie Bazan) from the local Hispanic population, which is characteristically under-represented in the field of plant/microbial science research fields. Field days were conducted at the Washington State University Sunrise Orchard and at the Stormy Mountain Ranch Commercial Orchards to demonstrate the efficacy of seed meal formulations for the control of apple replant disease. These events were attended by growers, industry representatives, graduate students and the general public. Additional events were conducted in these orchard trials as part of formal Washington State University horticultural classes. Findings from these trials were also presented to growers at the International Fruit Tree Association conference, the annual meeting of the Washington State Horticultural Association, the Washington Tree Fruit Research Commission review and a Washington Red Raspberry Commission sponsored symposium on ecological farming. PROJECT MODIFICATIONS: Not relevant to this project.

2009/08/15 TO 2010/08/14 OUTPUTS: Studies were completed concerning the effect of brassicaceae seed meal particle size on the efficacy of these amendments for the control of soilborne fungal pathogen Rhizoctonia solani and the parasitic nematode Pratylenchus penetrans (lesion nematode). The relative contribution of chemical and biological mechanisms in seed meal induced suppression of the oomycete plant pathogen Pythium abapressorium was determined. Three new orchard plantings were established to evaluate the capacity of seed meal formulations and host tolerance to provide effective control of apple replant disease. The effect of rootstock, seed meal formulation, and application period (autumn prior to planting or spring of planting) were evaluated. Results of these trials were reported to growers at the annual meeting of the Washington State Horticultural Association. Results of these trials were also disseminated to the producer and scientific community through field days held at the Washington State University Sunrise Orchard, the site of one field trial. In addition, these trials were used as an educational tool as part of the summer field tour conducted by graduate students in the Department of Crop and Soil Sciences at Washington State University. This project resulted in the hosting and mentoring of numerous graduate students currently conducting studies at Washington State University, the University of Idaho, Sonoma State University, and the University of Cordoba (Spain). PARTICIPANTS: Mark Mazzola, the PD, managed the overall research program including the conduct of field trials. Ms. Mudithat Weerakoon, graduate student, has conducted research concerning the development of suppressiveness toward the oomycete plant pathogen Pythium abappressorium in response to Brassica juncea seed meal amendment. Ms. Xiaowen Zhao conducted studies that addressed the impact of B. juncea particle size on generation of allyl isothiocyanate and subsequent control of the fungal plant pathogen Rhizoctonia solani. Mr. David Granatstein has provided extension resources for the dissemination of findings from this program to growers at various meetings. This project has served as a vehicle to provide training to a number of graduate students at various institutions including Mr. Maxwell Handiseni (Univ. of Idaho), Mr. Aaron Agostini (Sonoma State Univ.) and Ms. Manuela Vincente Dominguez (Cordoba University). This research program has also resulted in contact with commercial operations that are attempting to develop effective formulations of brassicaceae seed meals for use in organic strawberry and vineyard production systems. TARGET AUDIENCES: Field days were conducted at the Washington State University Sunrise Orchard to demonstrate the efficacy of seed meal formulations for the control of apple replant disease. These events were attended by growers, industry representatives, and research scientists. Additional events were conducted at this orchard trial as part of formal Washington State University classes in which the justification for such research and the findings of these trials were presented to undergraduate and graduate students. Findings from these trials were also presented to growers at the annual meeting of the Washington State Horticultural Association and the Washington Tree Fruit Research Commission. PROJECT MODIFICATIONS: Not relevant to this project.

2008/08/15 TO 2009/08/14 OUTPUTS: Studies were conducted to assess the effect of brassicaceous seed meal particle size on the structure and function of soil microbial communities and the generation of the active chemistry allyl isothiocyanate in response to soil amendment with Brassica juncea seed meal. Studies were initiated to determine the relative contribution of chemistry and soil biology to the suppression of the oomycete apple root

pathogen Pythium spp. observed in response to brassicaceous seed meal amendments. Plantings were established at the Columbia View research and demonstration orchard and a commercial organic apple orchard on replant ground which will assess the efficacy of brassicaceous seed meal amendments for the control of apple replant disease. Initial brassicaeous seed meal soil amendments were applied at the Sunrise organic orchard and follow up treatments will be applied in the spring of 2010. This site will be planted with a susceptible and tolerant apple rootstock in May 2010 to evaluate the potential of seed meal formulations in concert with host tolerance for control of this disease complex. A field day describing this research project was conducted at the Sunrise orchard in July 2009. This project resulted in hosting or mentoring graduate students at Washington State University, the University of Idaho, and Sonoma State University. PARTICIPANTS: Mark Mazzola, the PI, managed the overall research program and conducted the field trials described. Ms. Muditha Weerakoon, graduate student, has conducted research on the effect of particle size on populations of Pythium spp. and disease control. Ms. Xiaowen Zhao conducted studies concerning the effect of particle size on populations of resident Streptomyces spp. and emissions of allyl isothiocyante from seed meal amended soils. Ms. Sheila Ivanov and Ms. Jing Yang provided technical support in the conduct of these studies. Dr. Gennaro Fazio, USDA-ARS, Geneva, New York, has provided apple rootstock genotypes that will continue to be used in these studies. Mr. David Granatstein has provided extension resources for the dissemination of this material to growers at various meetings. Training was provided to three graduate students and one postdoctoral research associate. TARGET AUDIENCES: Information was provided to grower groups through field days and presentations at grower annual meetings. PROJECT MODIFICATIONS: Not relevant to this project.

IMPACT

2008/08 TO 2012/08 The findings obtained in these studies will significantly improve the ability to predictably utilize Brassicaceae seed meal amendments for the control of apple replant disease, and other soil-borne diseases, in organic crop production systems. Our findings clearly established that disease control in response to these plant-based amendments is not exclusively a function of chemical mechanisms but that altered soil biology plays a significant role in disease control, with the active mechanism varying in a time dependent manner. It was also established that the use of an individual seed meal is unlikely to yield significant benefit as these materials exhibit differential effects on populations of diverse soil-borne pathogen populations. As a result, novel seed meal formulations were developed in this program that enabled effective control of fungal, oomycete and nematode pathogens/parasites. Optimal strategies for the application of these materials were developed. Factors that were demonstrated to be of importance included seed meal formulation, soil moisture, seed meal particle size, duration of plant back period, soil type, and the use of a virtually impermeable film after incorporation of the seed meal amendment. All of these factors were defined and an effective systems-based approach to the use and application of the materials was established. Field trials established that pre-plant application of the Brassicaceae seed meal system provided control of apple replant disease as effectively as the use of pre-plant soil fumigation. Furthermore, application of the seed meal system resulted in the establishment of a soil microbial community that exhibited significantly greater resilience against plant pathogen and parasite re-colonization relative to that observed in fumigated soils. Moreover, fruit yields obtained were consistently and significantly higher in seed meal treated soil relative to that attained in fumigated soil. These studies have made available a seed meal formulation and application protocol that can effectively control a diversity of soil-borne pathogens and parasites in organic crop production systems. **PUBLICATIONS (not previously reported):** 2008/08 TO 2012/08 1. Mazzola, M. and Manici, L. M. 2012. Apple Replant Disease: Role of microbial Ecology in Cause and Control. Annual Review of Phytopathology 50:45-65. 2. Raaijmakers, J. M., and Mazzola, M. 2012. Diversity and natural functions of antibiotics produced by beneficial and pathogenic soil bacteria. Annual Review of Phytopathology 50:403-424. 3. Weerakoon, D.M.N., Reardon, C. L., Paulitz, T. C., Izzo, A. D., and Mazzola, M. 2012. Long-term suppression of Pythium abappressorium induced by Brassica juncea seed meal amendment is biologically mediated. Soil Biology & Biochemistry 51:44-52. 4. Handiseni, M., Brown, J., Zemetra, R., and Mazzola, M. 2012. Use of Brassicaceous seed meals to improve seedling emergence of tomato and Pepper in Pythium ultimum infested soils. Archives of Phytopathology and Plant Protection 45:1204-1209. 5. Mazzola, M., Reardon, C. L., and Brown, J. 2012. Initial species composition and brassicaceae seed meal type influence extent of Pythium-induced plant growth suppression. Soil Biology & Biochemistry 48:20-27. 6. Lamprecht, S. C., Tewoldemedhin, Y. T., Hardy, M., Calitz, E. J., and Mazzola, M. 2011. Effect of cropping system on composition of Rhizoctonia populations recovered from canola and lupin in a winter rainfall region of South Africa. European Journal of Plant Pathology 13:305-316. 7. Spies, C.F.J., Mazzola, M., Botha, W. J., Langenhoven, S., Mostert, L., and McLeod, A. 2011. Pythium irregulare isolates from grapevines in South Africa represent one phylogenetic species that may include aneuploids or polyploids. Fungal Biology 115:1210-1224. 8. Spies, C. F. J., Mazzola, M., and McLeod, A. 2011.Characterization and detection of Pythium and Phytophthora species associated with grapevines in South

Africa. European Journal Plant Pathology 131:103-119. 9. Lamprecht, S. C., Tewoldemedhin, Y. T., Calitz, F. J. and Mazzola, M. 2011. Evaluation of strategies for the control of canola and lupin seedling diseases caused by Rhizoctonia anastomosis groups. European Journal of Plant Pathology 130: 427-439. 10. Spies, C. F., Mazzola, M., Botha, W. J., Van der Rijst, M., Mostert, L. and McLeod, A. 2011. Oogonial biometry and phylogenetic analyses of the Pythium vexans species group from woody agricultural hosts in South Africa reveal distinct groups within this taxon. Fungal Biology 115:157-168. 11. Tewoldemedhin, Y. T., Mazzola, M., Labuschagne, I. and McLeod, A. 2011. Towards understanding the etiology of apple replant disease in South Africa using a multiphasic approach. Soil Biology & Biochemistry. 43:1917-1927. 12. Tewoldemedhin, Y. T., Mazzola, M., Mostert, L., and McLeod, A. 2011.Cylindrocarpon species associated with apple tree roots in South Africa and their quantification using real-time PCR. European Journal of Plant Pathology 129:637-651. 13. Mazzola, M. 2011. Advances in Brassica seed meal formulation for apple replant disease control. pp 6.1-6.4, In, Proceedings Annual International Research Conference on Methyl Bromide Alternatives and Emissions Reductions. MBAO, Fresno, CA. 2011. 14. Mazzola, M. 2011. Active management of soil microbial communities to limit soilborne disease development in strawberry production systems. In, Annual Report to the California Strawberry Commision. pp137-147. 15. Mazzola, M. 2011. Potential of biofumigation for soilborne pest control in strawberry. pp 47.1-47.2, In, Proceedings Annual International Research Conference on Methyl Bromide Alternatives and Emissions Reductions. MBAO, Fresno, CA. 16. Tewoldemedhin, Y. T., Mazzola, M., Botha, W. J., Spies, C. F., and McLeod, A. 2011. Characterization of fungi (Fusarium and Rhizoctonia) and oomycetes (Phytophthora and Pythium) associated with apple orchards in South Africa. European Journal Plant Pathology 130:215-229. 17. Handiseni, M., Brown, J., Zemetra, R., and Mazzola, M. 2011. Herbicidal activity of Brassicaceae seed meal on wild oat (Avena fatua), Italian rye grass (Lolium multiflorum), redroot pigweed (Amaranthus retroflex) and prickly lettuce (Lactuca serriola). Weed Technology 25:127-134. 18. Mazzola, M. 2010. Management of resident soil microbial community structure and function to suppress soilborne disease development. pp 200-219, In, M. Reynolds (ed.) Climate Change and Crop Production. CABI, Wallingford, UK. 2010. 19. Mazzola, M. and Zhao, X. 2010. Brassica juncea seed meal particle size influences chemistry but not soil biology-based suppression of individual agents inciting apple replant disease. Plant and Soil 337:313-324. 20. Mazzola, M. and Brown, J. 2010. Efficacy of brassicaceous seed meal formulations for the control of apple replant disease in organic and conventional orchard production systems. Plant Disease 94:835-842. 21. Mazzola, M., de Bruijn, I., Cohen, M. F., and Raaijmakers, J.M. 2009. Protozoan-induced regulation of cycliclipopeptide biosynthesis is an effective predation defense mechanism for Pseudomonas fluorescens. Applied and Environmental Microbiology 75:6804-6811. 22. Mazzola, M. 2009. Active manipulation of native soil microbial community structure and function to suppress soilborne diseases. Pages 1-11. In, Proceedings, 19th Southern Africa Symposium on Soils and Soilborne Plant Diseases. Agricultural Research Council, Plant Protection Research Institute, Stellenbosch, South Africa. 23. Mazzola, M. 2009. Resident biology restricts Macrophomina phaseolina in brassicaceous seed meal amended soil. pp 100.1-100.3, In, Proceedings Annual International Research Conference on Methyl Bromide Alternatives and Emissions Reductions. MBAO, Fresno, CA. 24. Mazzola, M. 2009. Non-fumigant management of apple replant disease in organic and conventional systems. pp 47.1-47-4, In, Proceedings Annual International Research Conference on Methyl Bromide Alternatives and Emissions Reductions. MBAO, Fresno, CA. 25. Pusey, P. L., Stockwell, V.O., and Mazzola, M. 2009. Epiphytic bacteria and yeasts on apple blossoms and their potential as antagonists of Erwinia amylovora. Phytopathology 99:571-581. 26. Izzo, A. and Mazzola, M. 2009. Hybridization of an ITS-based macroarray with ITS community probes for characterization of complex communities of fungi and fungal-like protists. Mycological Research 113:802-812. 27. Mazzola, M., Brown, J., Zhao, X., Izzo, A., and Fazio, G. 2009. interaction of brassicaceous seed meal and apple rootstock on recovery of Pythium spp. and Pratylenchus penetrans from roots grown in replant soils. Plant Disease 93:51-57. 28. Wissuwa, M., Mazzola, M. and Picard, C. 2009. Novel approaches in plant breeding for rhizosphere-related traits. Plant and Soil 321:409-430. 29. Hoagland, L., Carpenter-Boggs, L., Granatstein, D., Mazzola, M., Smith, J., Peryea, F., and Reganold, J. P. 2008. Impact of floor management strategies on nitrogen fertility and biological soil quality in newly established organic apple orchards. Biology & Fertility of Soils 45:11-18. 30. Hoagland, L., Carpenter-Boggs, L., Reganold, J., and Mazzola, M. 2008. Role of native soil biology in brassicaceae seed meal induced weed suppression. Soil Biology & Biochemistry 40:1689-1697.

2010/08/15 TO 2011/08/14 Data obtained from field trials to date will significantly improve the ability to predictably utilize brassicaceae seed meal amendments for the control of apple replant disease in organic orchard production systems. In these field trials, the seed meal formulations developed were shown to provide control of root populations of the plant parasitic nematode Pratylenchus penetrans (lesion nematode) and root infection by Pythium spp. as effectively as pre-plant soil fumigation. Correspondingly, apple tree performance in response to seed meal amendment over two growing seasons at two of the orchard sites is comparable to that attained in response to soil fumigation and at the third site, tree growth in response to seed meal amendment was 100% greater than the response in fumigated soil. However, in soils possessing low overall microbial activity significant tree death was observed when soils were treated in the spring of planting rather than the fall prior to

planting. In addition, significant seed meal formulation by rootstock genotype responses have been observed. These findings will enable application of a prescription-based model for use in determining appropriate seed meal formulation based on soil type and apple rootstock when applying these materials for replant disease control. Long-term control of of Pythium root infection in response to pathogenic Pythium spp. was shown to be dependent upon transformations in orchard soil fungal communities. Such an approach is important in the irrigated orchard systems found throughout the west as various oomycetes, including Pythium and Phytophthora, are introduced into the orchard environment through irrigation water.

2009/08/15 TO 2010/08/14 Field trials established during the current fiscal year will significantly improve our ability to effectively utilize brassicaceae seed meals for the control of soilborne plant pathogens in organic agricultural production systems. Of utmost significance is the finding that seed meal (SM) formulations consisting of Brassica juncea/Brassica napus or B. juncea/Sinapis alba SM when utilized with an effective tarping system can provide an initial growth response in apple on replant sites that is equivalent to that obtained through soil fumigation. Initial relative tree growth response did not differ among seed meal formulations, however the level of weed control was superior with the B. juncea/S. alba formulation. Of particular note was the effect of seed meal application date on growth of apple. At two orchards possessing soils with organic matter content ranging from 3.2-4.3% spring applications of seed meal were highly effective and yield a growth increment that was equivalent to or greater than that attained through soil fumigation. In contrast, when similar studies were conducted in a soil possessing low organic matter content (1.2%) and correspondingly lower microbial activity, autumn seed meal application was effective in controlling replant disease but spring application resulted in high levels of tree mortality. Significant mortality was observed irrespective of apple rootstock and was marginally higher in the B. juncea/S. alba treatment compared to the B. juncea/B. napus treatment. The herbicidal nature of these seed meals is well documented, but differential plant back periods required in different soil types has not previously been established. Such information is critical to the effective use of seed meal amendments in a disease control or fertility management program. Seed meal particle size was found to have significant effects on disease control efficacy, but the response was pathogen specific and affected chemistry-based but not biology-based mechanisms. Emission of ally isothiocyanate (AITC) from B. juncea SM-amended soil was initiated earlier and reached higher maximal concentrations in soils amended with fine particle (\<1 mm dia) than coarse particle (2-4 mm dia) size. This corresponded with the level of R. solani suppression obtained with B. juncea SM through chemical mechanisms; fine particle size but not coarse particle size B. juncea SM suppressed apple root infection. Biological mechanisms associated with B. juncea SM-induced control of R. solani were not affected by seed meal particle size. Our findings demonstrate that particle size will affect the efficacy of B. juncea SM soil amendment for the control of R. solani AG-5, but will do so only through effects on chemistry-and not biologically-based mechanisms of pathogen suppression. Studies demonstrated that control of Pythium abappressorium through B. juncea SM amendment was also dependent upon chemical and biological mechanisms. The amendment was capable of inducing soil suppressiveness towards this pathogen of apple within two weeks of application. Preliminary evidence suggests that soil fungi are functional in the observed disease suppression.

2008/08/15 TO 2009/08/14 To date, data from field trials have demonstrated that the use of individual brassicaceous seed meal soil amendments, when utilized with the highly susceptible apple rootstock M26, will not be compatible for control of apple replant disease in organic orchard production systems. However, data from the trial conducted in a commercial organic apple orchard which employed a novel composite seed meal formulation with the same highly susceptible apple rootstock indicate that this treatment has significant potential. The composite seed meal amendment controlled all elements of the pathogen complex inciting replant disease at this study site including Pythium spp., Phytophthora cactorum, Cylindcarpon destructans, Rhizoctonia spp. and the lestion nematode Pratylenchus penetrans. To date, growth of trees (increase in trunk diameter) established in seed meal amended soils is equivalent to that attained for trees cultivated in soils receiving preplant treatment with the fumigant 1,3-dicloropropene-chloropicrin. Seed meal species and particle size had significant effects on components of the microbial community known to function in suppression of the fungal pathogen Rhizoctonia solani. Brassica napus and Brassica juncea seed meals consistently elevated resident Streptomyces spp. to densities that were significantly higher than that attained with Sinapis alba seed meal amendments. Fine particles of Brassica juncea seed meal generated significantly higher levels of the active chemistry allyl isothiocyante than did coarse particles of the same seed meal when added to a soil system. These findings are important as both chemistry and biology contribute to control of the pathogen complex that incites apple replant disease.

PUBLICATIONS

2010/08/15 TO 2011/08/14 1. Tewoldemedhin, Y. T., Mazzola, M., Mostert, L., and McLeod, A. 2011. Cylindrocarpon species associated with apple tree roots in South Africa and their quantification using real-time PCR. European Journal of Plant Pathology 129:637-651 2. Tewoldemedhin, Y. T., Mazzola, M., Botha, W. J., Spies, C. F., and McLeod, A. 2011. Characterization of fungi (Fusarium and Rhizocotonia) and oomycetes (Phytophthora and Pythium) associated with apple orchards in South Africa. European Journal of Plant Pathology 130:215-229. 3. Handiseni, M., Brown, J., Zemetra, R., and Mazzola, M. 2011. Herbicidal activity of Brassicaceae seed meal on wild oat (Avena fatua), Italian rye grass (Lolium multiflorum), redroot pigweed (Amaranthus retroflex) and prickly lettuce (Lactuca serriola). Weed Technology 25:127-134.

2009/08/15 TO 2010/08/14 1. Weerakoon, M., and Mazzola, M. 2010. Brassica juncea seed meal amendment induces long-term suppressiveness to Pythium abapressorium under enclosed and open soil incubation conditions. Phytopathology 100:S134. 2. Mazzola, M. 2010. Management of resident soil microbial community structure and function to suppress soilborne disease development, chapter 11 in M.P. Reynolds (ed.) Climate Change & Crop Production, CAB International Oxfordshire, UK, p. 200-218. 3. Mazzola, M. and Zhao, X. 2010. Brassica juncea seed meal particle size influences chemistry but not soil biology-based suppression of individual agents inciting apple replant disease. DOI 10.1007/s11104-010-0529-5

2008/08/15 TO 2009/08/14 1. Mazzola, M. 2009. Active manipulation of native soil microbial community structure and function to suppress soilborne diseases. Pages 1-11 in, Proc. 19th Annual Interdisciplinary Symposium on Soilborne Diseases. Stellenbosch, South Africa. 2. Mazzola, M., Brown, J. and Fazio, G. 2009. INTERACTION OF BRASSICACEOUS SEED MEAL AND ROOTSTOCK ON RECOVERY OF PRATYLENCHUS PENETRANS FROM ROOTS OF APPLE GROWN IN REPLANT ORCHARD SOILS. Abstract book Annual Meeting of the Society of Nematologists, Burlington, VT. 3. X. Zhao, Y. Tewoldemedhin, A. Mcleod, and M. Mazzola. 2009. Multiple personalities of Streptomyces spp. from the rhizosphere of apple cultivated in brassica seed meal amended soils. Phytopathology 99:S150. 4. Mazzola, M., Brown, J., Zhao, X., Izzo, A. D., and Fazio, G. 2009. Interaction of brassicaceous seed meal and apple rootstock on recovery of Pythium spp. and Pratylenchus penetrans from roots grown in replant soils. Plant Dis. 93:51-57.

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Nwtc\'s Organic Agriculture Program Features an Annual Professional Development Training Series and an Organic Farming Certificate Program

Accession No.	0213593
Subfile	CRIS
Project No.	WISW-2008-01278
Agency	NIFA WISW
Project Type	OTHER GRANTS
Project Status	TERMINATED
Contract / Grant No.	2008-51300-04307
Proposal No.	2008-01278
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Grant Amount	$434,925
Grant Year	2008
Investigator(s)	Jaworski, D. M.
Performing Institution	NORTHEAST WISCONSIN TECHNICAL COLLEGE, 2740 W MASON STREET, PO BOX 19042, GREEN BAY, WISCONSIN 54307

NON-TECHNICAL SUMMARY

The Northeast Wisconsin Technical College\'s (NWTC) Organic Agriculture Program is designed to improve resources available to professionals and farmers in northeast Wisconsin by offering educational and networking opportunities. The goals of the program are to: 1) Increase the quantity, productivity and profitability of organic farming in northeast Wisconsin; and 2) Establish NWTC as a regional resource center in organic farming. Grant objectives include: 1) Developing and implementing a professional development training workshop series in organic agriculture that will be offered annually; and 2) Creating and implementing an eight credit Organic Farming Certificate Program available on campus and via the internet at NWTC. NWTC\'s Organic Agriculture Program supports the Integrated Organic Program\'s sixth funding priority through the creation of a professional development training series targeting UW Extension and other agricultural professionals. Additionally, the proposed certificate program addresses OREI\'s first legislatively-defined goal of \"facilitating the development of organic agriculture production, breeding, and processing methods.\" An Advisory Panel will oversee the program\'s implementation. Panel members will include organic farmers and representatives from the Brown County Extension Office; Wisconsin Department of Agriculture, Trade and Consumer Protection; Wisconsin Technical College System; a manure application business; and the Midwest Organic Sustainable Education Service.

OBJECTIVES

The goals of the Northeast Wisconsin Technical College\'s Organic Agriculture program are to: 1) Increase the quantity, productivity and profitability of organic farming in northeast Wisconsin; and 2) Establish Northeast Wisconsin Technical College(NWTC) as a regional resource center in organic farming. Grant objectives include: 1) Developing and implementing a professional development training workshop series in organic agriculture that

will be offered annually; and 2) Creating and implementing an eight credit Organic Farming Certificate Program available on campus and via the internet at NWTC. Performance outcomes include: 1) DACUM(Developing A CurriculUM)process completed for professional development training and certificate program; 2) 60 percent of high school agriculture teachers participating in the workshop series will incorporate at least one or more elements of the UW-Madison Center for Integrated Agriculture System\'s Toward a Sustainable Agriculture curriculum into their current lesson plan as measured through a follow-up survey; 3) 40 percent of UW Extension personnel participating in the workshop series will include organic options in their discussion with farmers as measured through follow-up surveys; 4) 30 percent of instructors and/or consultants completing the workshop series will refer peers to the training as measured by a question on the registration form; and 5) 50 percent of farmers enrolled in and/or completing the Organic Farming Certificate Program will investigate and/or apply for organic farm certification as measured through follow-up surveys. The curriculum developed through this project will be available to and shared with any institution or organization interested at no cost. Entities will be able to take the curriculum and adapt it to meet their specific needs. Additionally, the certificate may lay the groundwork for an associate degree program in organic farming at NWTC. The College will be evaluating the success and demand for the certificate in year four. If developed, participants will be able to apply completed credits towards the associate degree.

APPROACH

NWTC\'s Organic Agriculture Program will feature an annual professional development workshop training series and an Organic Farming certificate program. To ensure a solid foundation is in place that addresses the needs of organic producers and processors, NWTC will be taking a two-phased approach to establishing the program: 1) Planning/Curriculum Development, and 2) Implementation. Year one of the project will be devoted to the curriculum development for the Organic Agriculture Program, including the workshop series and certificate program. Both components will be developed at an associate degree-level so participants may apply credits toward a certificate and/or degree program. In year two both the Professional Development for the Organic Educator Workshop Series and the Organic Farming Certificate Program will be launched. The Professional Development for the Organic Educator Workshop is a four-part series that will consist of a two-day training covering a variety of topics in organic agriculture. This initial workshop will be a requirement to participate in the three follow-up sessions that will be available both in person and online to accommodate participants\' busy schedules. The three one-day workshops will provide more in-depth information on the topic areas covered in the first training. Participants will be expected to participate in at least one of the follow-up workshops. The Organic Farming Certificate Program is intended for farmers considering and/or transitioning to organic farming, but will be open to others interested in the subject matter. This program will be designed to foster and promote information on the techniques and processes necessary to gain organic certification, which can only be granted by recognized organizations like National Organic Producers (NOP). Upon completion, graduates will have the knowledge they need to formally pursue certification. The Project Director will be responsible for collecting data on attendance, registration, and course/workshop evaluations. This data will be summarized bi-annually and shared with the Advisory Panel so the progress of the program can be evaluated based on the performance outcomes identified. If benchmarks are not being met, the Panel, Project Director and Co-Project Director will together determine what adjustments and/or steps need to be taken. Additionally based on the evaluation data, changes may be made to enhance or improve the existing curriculum.

PROGRESS

2008/07 TO 2012/06 OUTPUTS: 1) An eight-credit Organic Agricultural Practices Certificate was developed and offered. Participants can choose from the following certificate courses: Organic Food and Ag: Practices and Issues (2 credits); Organic Soils, Nutrients and Composting (1 credit); Organic Agronomic Crops (1 credit); Organic Ruminant Livestock (1 credit); Organic Produce (1 credit); Organic Specialty Animals (1 credit); Organic Ag and Food Marketing (1 credit); Organic Farm: Applied (1 credit); Organic Ag: Independent Study (1 credit); Managed Grazing (1 credit); Permaculture, Edible Landscapes (1 credit); Organic Poultry (1 credit); Small Farm Machinery and Tools (1 credit); and Food Nutrition and Preservation (1 credit). 2) Throughout the grant period, the Organic Program Coordinator facilitated/co-hosted seminar/workshop events with an organic agriculture or local food focus. The Organic Program Coordinator provided presentations on different aspects of organic farming and information about NWTC\'s Organic Agriculture Certificate Program at events throughout northeast Wisconsin. NWTC also hosted several workshops including one for the Wisconsin Association of Agriculture Educators, another for farmers focused on grant programs, and a third for entrepreneurs focused on food safety. PARTICIPANTS: Individuals: Valerie Dantoin, NWTC Faculty, in conjunction with the NWTC Organic Agriculture Advisory Committee, developed program curriculum and reviewed outreach strategies. Additionally, Ms. Dantoin

worked collaborative with a number of individuals to develop and organize trainings/workshops. These individuals include: Kevin Erb, Land Conservation Professional Development Coordinator (EPA Region 5); Kevin Kiehnau, Field Representative (Organic Valley Cooperative); Harriet Behar, NOP Coordinator (Midwest Organic Services); Fred Depies, (Trust Local Foods); Lynn Walters, University of Wisconsin - Green Bay Professor Emeriti (Healthy Local Foods Initiative); Teresa Engel (Wisconsin Department of Agriculture); Diane Mayerfield (USDA-SARE); Laura Paine (Wisconsin Department of Agriculture); Bridgett Neu (Wisconsin Association of Ag Educators); Joe Tomandl, GrassWorks Apprenticeship Coordinator; Rhonda Gildersleeve, University of Wisconsin Extension Grazing Specialist; and Bridget O\'Mera, GrassWorks Conference Planner. TARGET AUDIENCES: Participants in the presentations/events and courses included college students, re-trained unemployed workers, general public, farmers, high school agriculture teachers, Technical College Instructors, UW-Extension staff, and County Land Conservation Professionals PROJECT MODIFICATIONS: Nothing significant to report during this reporting period.

2010/07/01 TO 2011/06/30 OUTPUTS: 1. Two additional courses were added to the Organic Agricultural Practices Certificate: Organic Poultry and Permaculture, Edible Landscapes. These courses will be offered in 2012. 2. On-line versions of three courses were developed: Organic Produce (formerly Organic Hort: Fruits, Veg); Organic Ag and Food Marketing; and Organic Specialty Animals. 3. All ten of the organic certificate program courses were offered during the 2009-2010 school year. Only three of the ten did not run due to low enrollments. 4. NWTC offered an awareness seminar with Dr. Don Huber. 5. Two professional development workshops were offered, but had to be cancelled due to a lack of enrollment. 6. The Organic Program Coordinator provided presentations on different aspects of organic farming and information about NWTC\'s Organic Agriculture Certificate Program at 15 events throughout northeast Wisconsin. 7. NWTC hosted several workshops including one for the Wisconsin Association of Agriculture Educators, another for farmers focused on grant programs, and a third for entrepreneurs focused on food safety. 8. NWTC coordinated with the Wisconsin Department of Agriculture and Consumer Protection to develop and train grazing educators. 9. Offered Learning in Retirement Seminar on Issues and Practices in Organic Agriculture. PARTICIPANTS: Individuals: Valerie Dantoin, NWTC Faculty, in conjunction with the NWTC Organic Agriculture Advisory Committee, has developed program curriculum and reviewed outreach strategies. Additionally, Ms. Dantoin has worked collaborative with a number of individuals to develop and organize trainings/workshops. These individuals include: Kevin Erb, Land Conservation Professional Development Coordinator (EPA Region 5); Kevin Shelley; Soils Professor (University of WI - Madison); Kevin Kiehnau, Field Representative (Organic Valley Cooperative); Harriet Behar, NOP Coordinator (Midwest Organic Services); Fred Depies, (True Foods); Lynn Walters, University Professor (Healthy Local Foods Initiative); Paul Linzmeyer (NEW North); Teresa Engel (WI Department of Agriculture); and Diane Mayerfield (USDA-SARE) TARGET AUDIENCES: Participants in the presentations/events and courses included: college students, re-training unemployed workers, farmers, high school agricultural teachers, UW-Extension staff, and County Land Conservation Professionals PROJECT MODIFICATIONS: Because of lower than desired enrollments, the industry advisory committee recommended adding courses to appeal to a broader audience, the courses include: Edible Landscapes and Permaculture, Organic Ag Issues and Practices, Organic Poultry, and Produce, Cook and Preserve with Style. Also to address low enrollment in the Professional Development Workshop series, NWTC plans to work with the American Society of Agronomy to get the associate level courses certified for CEU\'s for land conservation professionals.

2009/07/01 TO 2010/06/30 OUTPUTS: 1. Two additional courses were added to the Organic Agricultural Practices Certificate: \"Managed Grazing\" and \"Independent Study.\" The \"Independent Study\" course was designed as an alternative to the \"On-Farm\" course for students who do not currently own a farm. 2. On-line versions of three courses were developed: \"Introduction to Organic Ag Systems;\" \"Organic Soils,Nutrients and Composting;\" and \"Organic Horticulture.\" 3. Eight of the nine organic certificate program courses were offered during the 2009-2010 school year. 4. NWTC offered an awareness seminar with Dr. Temple Grandin. 5. Two professional development workshops were offered but had to be cancelled due to a lack of enrollment. 6. The Organic Program Coordinator provided presentations on different aspects of organic farming and information about NWTC\'s Organic Agriculture Certificate Program at 15 events throughout northeast Wisconsin. PARTICIPANTS: Individuals: Valerie Dantoin, NWTC Faculty and Organic Program Coordinator, in conjunction with NWTC\'s 20-Member Organic Agriculture Advisory Committee, has developed program curriculum and reviewed outreach strategies. Additionally, Ms. Dantoin has worked collaboratively with a number of individuals to develop and organize trainings/workshops, review curriculum, and schedule events like \"Field Days.\" These individuals include: Kevin Erb, Land Conservation Professional Development Coordinator (EPA Region 5); Kevin Shelley, Soils Professor (University of WI - Madison); Kevin Kiehnau, Field Representative (Organic Valley Cooperative); Harriet Behar, NOP Coordinator (Midwest Organic Services); Fred Depies, Grazing Educator (Glacierland Resource Conservation District); Lynn Walters, University Professor (Healthy Local Foods Initiative);

Paul Linzmeyer (NEW North); Anne Pfieffer (WI Department of Agriculture); and Diane Mayerfield (USDA-SARE). TARGET AUDIENCES: Participants in the presentations/events and courses included college students, re-training unemployed workers, farmers, high school agricultural teachers, UW-Extension staff, and County Land Conservation Professionals. PROJECT MODIFICATIONS: As mentioned above, NWTC struggled with enrollment in its Professional Development Workshop series. As a result, the Organic Agriculture Advisory Committee and staff plan to continue to explore different strategies to increase enrollment and interest in the subject matter. Delivery mode, length of session, location, and timing are just a few of the factors that are being explored. Additionally, NWTC will be looking at developing some additional entry-level courses for farmers of 20 acres or fewer, as well as urban farmers, based on the recommendations of its Organic Agriculture Advisory Committee. Possible course offerings may include \"Intro to Urban Farming;\" \"Evolution of Food and Farming Systems;\" and/or \"Produce, Cook and Preserve with Style.\"

2008/07/01 TO 2009/06/30 OUTPUTS: 1.Organic curriculum outline was developed at a 2 day DACUM process on Oct 25-26, 2008. 15 organic agriculture experts brainstormed/organized content for organic ag courses. Results were distributed through NWTC\'s Organic Advisory Comm and e-mailed to other organic community leaders. Results were disseminated to staff at North Central region SARE offices and EPA region V prof development coordinators. DACUM output was presented to the WI Dept of Ag Organic Advisory Comm. Outline is also available on NWTC\'s internal website. 2.NWTC Advisory Committee and faculty member developed the Organic Agricultural Practices Certificate (http://www.nwtc.edu/academics/ProgTeamSites/OSAFE/Pages/Home.aspx) comprising 8 organic ag courses to prepare students for jobs in this field. A brochure was distributed at the MOSES Organic Conf in LaCrosse, WI in March 2009 attracting 1,500 attendees. The brochure was also distributed at other events, reaching. an estimated 4000 people. 3.8-course curriculum was completed using the Worldwide Instructional Design System and is disseminated through the WI Tech College System. The first 2 courses, Intro to Organic Ag Systems and Soils, Nutrients, and Composting were distributed to advisory committee members in Sept 2009. 4.An Agricultural Entrepreneurship workshop was taught in March 2009 with 8 students. 5.Two summer 2009 trainings for professional development were taught in collaboration with EPA Region V with 32 attendees, most USDA Natural Resources Conservation Svc employees. Training was very timely due to implementation of Organic Transition Plans as a cost share practice available for the first time through the Federal Farm bill. WI had the second highest number of sign ups in the nation for this practice. Training offered by NWTC for NRCS staff was perhaps the only one in the nation available before the signup period closed June 30, 2009. Several other state professional development coordinators contacted NWTC for assistance in creating their own training workshops. Similar workshops for University Extension and County Land Conservation Professionals will be taught Dec 15,, 2009. The grant originally provided for a 2-day professional development workshop; due to agency restrictions on travel and overnight stay, this format was not possible. 6.Tools for Teaching the Science & Art of Organic Agriculture was presented at the WI. Assn. Of Agricultural Educators annual conference on July 2, 2009 with 15 attendees. Workshop for High School Ag teachers is scheduled for Nov 18, 2009. Again, due to school budget cuts, one-day rather than two-day events are scheduled. 7.A 1-credit Applied on Farm Management course was offered in summer 2009 with 3 enrollees. The first course in the certificate series is being presented ahead of schedule in fall 2009. Four more courses are scheduled to run in January 2010. The last 2 courses will begin in summer 2010. 8.Currently working to deliver courses via distance learning options available in fall of 2010. 9.A resource center is available to the general public at NWTC. PARTICIPANTS: Individuals: Valerie Dantoin, NWTC Faculty, in conjunction with the NWTC Organic Agriculture Advisory Committee, has developed curriculum for Organic Agriculture Certificate and facilitated/delivered workshops and professional development events. Partner Organizations: n/a Collaborators and contacts: Vicki Csida and Valerie Bielinski, NWTC Instructional Designers, helped facilitate the DACUM process in conjunction with representatives from Eastern Kentucky University. Fifteen organic agriculture experts also brainstormed/organized content for organic ag curriculum. Training or professional development: An Agricultural Entrepreneurship workshop was taught in March 2009 with 8 students. Two summer 2009 trainings for professional development were taught in collaboration with EPA Region V with 32 attendees, most USDA Natural Resources Conservation Svc employees. Tools for Teaching the Science & Art of Organic Agriculture was presented at the WI Assn. Of Agricultural Educators annual conference on July 2, 2009 with 15 attendees. Workshop for High School Ag teachers is scheduled for Nov 18, 2009. TARGET AUDIENCES: Workshop and professional development event audiences have included USDA Natural Resources Conservation Svc employees; University Extension and County Land Conservation Professionals; and members of WI. Assn. Of Agricultural Educators. Target audience also includes farmers wishing to convert to organic farming. PROJECT MODIFICATIONS: The grant originally provided for a 2-day professional development workshop; due to agency restrictions on travel and overnight stay, this format was not possible. A one-day session will be offered. Workshop for High School Ag teachers is scheduled for Nov 18, 2009; again, due to school budget cuts, one-day rather than two-day events are scheduled.

IMPACT

2008/07 TO 2012/06 1) Between December 2009 and June 2012 there were a total of 267 enrollments in certificate course offerings. 2) NWTC has become a local and regional resource for answering farmers and Regional University Land Grant Extension staff\'s questions about organic agriculture. The College also provides a focal point for working farmers in this region to network. 3) The College recently received approval from the Wisconsin Technical College System office for its \"indication of interest\" to pursue investigation of an Associate of Applied Science degree in Sustainable Food & Agriculture Systems. 4) NWTC is in the process of contextualizing the organic curriculum for English Language Learners (ELL). 5) The Wisconsin State Technical College System is interested in exploring ways to expand the organic course offerings at NWTC to other technical colleges in the system. 6) An increase in the number of organic farms in the Northeast region of Wisconsin cannot be directly attributed to this program; however, there were two instances of landowners able to secure FSA loans as a direct result of their participation in organic coursework. 7) Organic Coordinator worked with about 38 individual landowners through the \"Applied on-farm\" course. Many have developed plans for creating new small farm ventures on their land as a direct result of this course. 8) Organic Coordinator mentored three people planning to become NRCS technical service providers so they have the knowledge to write Organic Farm Plans for eligible farmers who wish to transition to organic farming. **PUBLICATIONS (not previously reported):** 2008/07 TO 2012/06 No publications reported this period

2010/07/01 TO 2011/06/30 1. The courses in the Organic Certificate program had combined enrollments of 88. 2. Nineteen (19) students are enrolled in the Organic Agriculture Certificate Program and three have completed. 3. Over a dozen women have enrolled in the Applied On-Farm course. Many say it is just the tool they needed to have the confidence to keep or convert their farm to an organic system. 4. Over 100 people attended Dr. Huber\'s presentation. 5. NWTC is hosting a regional forum where the goal is to connect local foods to jobs and health. 6. Twenty people from the Wisconsin Agriculture Education Association attended on-farm training. 7. Forty people attended a train the trainer workshop focused on managed grazing. 8. Ten retired people attended the Issues and Practice in Organic Agriculture seminar. 9. One student received a USDA- FSA loan to purchase a 40-acre organic farm. 10. Two international students (one from Cameroon and one from El Salvador) specifically came to NWTC to complete the Organic Certificate. 11. Fifty people participated in the organic pasture walk, including Congressman Reid Ribble. 12. The on-line \"Soils\" course is required for the new Dairy Grazing Apprenticeship Program.

2009/07/01 TO 2010/06/30 1. The courses offered in the Organic Certificate had a combined enrollment of 61. 2. Fourteen students are enrolled in the Organic Agriculture Certificate. 3. Eighty people attended Dr. Grandin\'s seminar. 4. NWTC is seeing a strong interest in the audience of \"concerned consumers\" and is looking at developing some new outreach materials to encourage this population to participate in the courses and/or professional development workshops. 5. To address the low enrollment in NWTC\'s professional development workshops, the College plans to collaborate with professional associations, like the Wisconsin Agriculture Education Association, to provide professional development workshops at statewide/regional conferences. This method has proven to be effective in the past, so the College will continue to identify partners until stand alone workshops can be offered. Additionally, NWTC plans to explore offering professional development webinars.

2008/07/01 TO 2009/06/30 1.Wisconsin signups for the Federal Farm Bill EQIP conservation practice \"Organic Transition Plans\" were the second highest (behind California) in the U.S. The high response may be attributed to our training of conservation professionals and the awareness it created. Five farmers who have been working with NWTC faculty signed up for the Organic Transition Plan practice. 2.Participation on the State Organic Advisory Committee resulted directly in a modification of the letter submitted by Wisconsin\'s Secretary of Agriculture to the National Organic Program (NOP) regarding the rule on pastured livestock. 3.Other faculty in the Wisconsin Technical College system have curriculum available and have begun incorporating it into their courses. Other outcomes/Impacts will accrue as courses are delivered.

PUBLICATIONS

2010/07/01 TO 2011/06/30 Organic Ag can Help New Farmers Succeed Gives Existing Farmers a Second Chance 2011 was published in various Wisconsin farm papers Hungry for Change 2011 was published in a local food magazine.

2009/07/01 TO 2010/06/30 No publications reported this period

2008/07/01 TO 2009/06/30 DACUM results, October 2008 Organic Agricultural Practices Certificate Brochure - link available from NWTC; this field cannot accept the percent sign in the link. Organic Agriculture Certificate Flyer - link available from NWTC; this field cannot accept the percent sign in the link. Documentation of curriculum in the Worldwide Instructional Design System

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Designing Production Strategies for Stewardship and Profits on Fresh Market Organic Farms

Accession No.	0213730
Subfile	CRIS
Project No.	WNP07725
Agency	NIFA WN.P
Project Type	OTHER GRANTS
Project Status	TERMINATED
Contract / Grant No.	2008-51300-04460
Proposal No.	2008-01247
Start Date	01 AUG 2008
Term Date	31 JUL 2013
Fiscal Year	2009
Grant Amount	$0
Grant Year	2008
Investigator(s)	Cogger, C. G.; Ostrom, M.; Painter, K.; Kennedy, A.; Fortuna, A.; Alldredge, R.; Bary, A.; Miller, T.; Collins, D.; Goldberger, J.; Antonelli, A.; Cha, B.
Performing Institution	PUYALLUP RESEARCH AND EXTENSION CENTER, WASHINGTON STATE UNIVERSITY, 240 FRENCH ADMINISTRATION BLDG

NON-TECHNICAL SUMMARY

Small-scale farms throughout the country struggle to achieve profitability within the dominant food production and marketing system. An alternative direct marketing system shows promise of providing far higher economic returns for smaller growers. Increasing direct sales of local agricultural products can potentially improve the economic viability of small and mid-sized farms and enhance the economies of communities through the multiplier effect of consumer dollars. However, unleashing the potential of direct marketing opportunities and promoting small farm economic sustainability can only be achieved by addressing critical missing links or barriers in both production and marketing systems. Little is understood about the economic and agro-ecosystem characteristics of contrasting specialty crop production systems. The long-term goal of this project is to improve the agronomic and economic competitiveness of fresh market organic farms by developing integrated, systems-based solutions to their most significant soil and weed problems. We will investigate relationships between production management strategies, soil quality, weed pressure, and economic risks and returns in high-value, organic vegetable cropping systems; then incorporate our findings into practical farmer training programs and informational materials. The centerpiece of the project is a systems experiment comparing 12 organic management strategies for high-value, fresh market vegetable production, and their long-term effects on crop yield, soil quality, nitrogen management, and weed pressure. We will also replicate selected soil nutrient, physical, and biological measurements from the organic systems experiment on 6-8 partner organic farms. A multi-year economic analysis (costs, returns, risks) of the experimental cropping systems will be completed. Outreach will involve partnership with producers and stakeholders to design and offer courses, farm walks, field days, workshops, web materials, and publications, including programs for Hmong and Latino farmers. An Advisory Committee of farmer partners will provide guidance and evaluation. This project will make significant contributions to our understanding of how the soil ecosystem responds to different organically managed environments. It will provide insight into the value of alternative soil tests for organic farmers. We will also develop a better understanding of systems-based management strategies for improving farm ecosystem and economic performance. This new knowledge will help

us develop practical educational materials and programs that provide guidelines for farm decision-making. Through this project we will pilot and share new models for interdisciplinary, farmer participatory research and extension. Anticipated benefits include farmer adoption of strategies that improve long-term soil quality while maintaining or improving economic returns.

OBJECTIVES

The long-term goal of this project is to improve the agronomic and economic competitiveness of fresh market organic farms by developing integrated, systems-based solutions to their most significant soil and weed problems. We will investigate relationships between production management strategies, soil quality, weed pressure, and economic risks and returns in high-value, organic vegetable cropping systems; then incorporate our findings into practical farmer training programs and informational materials. This project places special emphasis on small and limited resource producers, a group that is largely underserved by traditional research and extension programs. For this audience, direct sales of specialty crops are an essential strategy for capturing higher returns per acre and generating improved family incomes. Specific objectives of this project are to: 1. Elucidate relationships between organic management systems, soil quality, weed pressure, and crop productivity to improve agroecosystem design and performance. 2. Analyze the potential economic costs, returns, and risks of organic vegetable production systems in the maritime Northwest. 3. Develop and offer an innovative, collaborative educational program on organic farming targeted at new, experienced, and transitioning organic farmers; immigrant farmers; students; and agricultural professionals. Outputs (activities) include a long-term organic production systems experiment focused on direct market vegetable systems, on-farm experiments and soil quality assessments, teaching extension classes, and mentoring of Latin American agricultural interns. Events include field days in English and Hmong, farm walks in English, Spanish and Hmong, presentations at workshops and symposia. Products include extension publications, refereed journal articles, information on cover crop, amendment, and tillage management in organic systems and long-term effects of organic systems on crop productivity and soil quality, curriculum for Cultivating Success classes and website (http://www.puyallup.wsu.edu/soilmgmt/SusAg.htm)

APPROACH

The centerpiece of this project is a long-term organic vegetable systems experiment established at Washington State University (WSU) Puyallup in 2003. The experiment compares 12 organic management systems, including 3 cover crop treatments, 2 tillage regimes, and 2 organic amendment types, arranged in a split-split plot design with four replications (48 plots). Cover crops are the main plots, tillage is the first split and amendments the second split. Cover crop treatments include 1) a fall-seeded cereal rye-hairy vetch mix; 2) relay-intercropped hairy vetch planted into the cash crop; and 3) a short-term pasture planted to a mixture of annual ryegrass, perennial ryegrass, and red clover. Organic amendments include a low-C treatment (broiler litter) and a high-C treatment (mixed on-farm compost). The tillage regimes are conventional tillage (plow, disc, rototill) and modified tillage (rotating spader). Microbial constituents and their functions will be assessed by traditional and molecular techniques. Decomposer community functions will be assessed by soil enzyme activity. The bacterial and fungal communities will be analyzed using phospholipid fatty acid profiles and substrate induced respiration. Nitrifier community structure will be measured using DGGE. We will isolate Collembola using Berlese-Tullgren funnels and identify them to the family level. Nematodes will be isolated by a sieving-Baermann funnel procedure, identified at the genus level, and evaluated through ecological indices such as the enrichment and structure indices. Soil physical measurements include compaction, bulk density, infiltration, water holding capacity, and aggregate stability. Chemical/biochemical measurements include total and POM C, nutrients, total N, and N mineralization. Yield of each cash crop will be measured each year, along with weed pressure, and cover crop yield, C, and N. Results will be analyzed using general linear model methodology, complemented with path analysis and structural equation modeling to test and modify models that specify causal relationships among variables. We will also replicate selected soil nutrient, physical, and biological measurements from the organic systems experiment and collect information on soil management practices on partner organic farms. The potential economic costs, returns, and risks of each organic production system in the experiment will be systematically evaluated. The evaluation will entail preparation of 240 budgets covering 2003-2010. These budgets will be tracked by plot and rotation, so that each budget series will reflect the results of annual production risk for each rotation-tillage-cover crop-amendment system. Income risk will be examined by comparing annual income variability and ability to cover variable costs for each crop or rotation. Outreach will include partnership with producers and stakeholders to design and offer courses, farm walks, field days, workshops, web materials, and publications, and will include programs for Hmong and Latino farmers. Evaluations of changes in knowledge and actions from this project will be done using follow-up surveys, phone interviews, and observations.

PROGRESS

2008/08 TO 2013/07 Target Audience: Major audience: Organic vegetable farmers, agency personnel associated with organic farming, students, other researchers Secondary audience: Other farmers interested in aspects of this project. Changes/Problems: Nothing Reported What opportunities for training and professional development has the project provided? We had five people who had the opportunity for training as interns in this program. These included two recent graduates from Peru who came to the US through the Multicultural Exchange in Sustainable Agriculture (MESA) program, one student from Evergreen State College, one from Pacific Lutheran University (PLU), and one from Washington State University. One of the MESA stewards worked with us for a year, learning organic farming techniques in the US, learning to collect soils data on our organic vegetable systems experiment, and visiting other organic farms through farm walks. The second MESA steward joined us for the last three months of her time in the US, and also participated in data collection and farm walks.Both of them translated and recorded a powerpoint presentation on soils, nutrient management, soil testing, and organic amendments into Spanish, and recorded it for Spanish-speaking audiences. The Evergreen intern also participated in data collection, farm activities, and farm walks and field days. The PLU student did research on microbial biomass measurement and collembolan populations in the systems experiment, in addition to other field data collection and farm walks. She was an ASA Golden Opportunity Scholar (one of few from a liberal arts college) and presented posters at ASA and at Soil Ecological Society meetings in Canada. The WSU student focused on Good Agricultural Practices research, and then began working in the food safety lab at WSU Pullman. He switched majors from Engineering to Food Science as a result of his work with us. Besides these interns, 1-3 students or recent graduates worked with us each summer, learning about soils, organic farming systems, and soils research. How have the results been disseminated to communities of interest? Results have been disseminated to farmers, agricultural professionals and agencies, agricultural students, and future farmers through a variety of means including annual field days at the organic vegetable systems experiment at WSU Puyallup, farm walks, Cultivating Success classes, short courses, presentations at the annual Washington Tilth Producers conference, Good Agricultural Practices workshops, presentations at other agricultural meetings, videos, web pages, traditional extension publications, and other printed and electronic materials. Some of these activities were done in conjunction with other grant funding (such as USDA immigrant farmer grants), which allowed us to extend our outreach. Field days at WSU Puyallup have focused on soil quality, cover cropping, pastured poultry, equipment demonstrations, and food safety on the farm, including worker hygiene, irrigation water, harvest tools, and soil amendments, with attendance ranging from 40 to 80 per field day. We also held a bi-lingual cover crops field day for Hmong farmers. Most of the farm walks occur on commercial organic farms and cover a wide range of soil quality, fertility, crop, and farm management issues. From 2009 through 2012, members of our team developed, coordinated, and evaluated 39 farm walks with the host farmers leading the walk in collaboration with WSU. Two farm walks were held at the WSU Puyallup organic vegetable systems experiment. One was a mock good agricultural practices (GAP) audit at the organic vegetable systems experiment at WSU Puyallup, and included crate washing, hand washing, irrigation, and composting. Cultivating Success is a series of classes for farmers and future farmers focused on basic soil and crop information, farming practices, and farm business planning. Not all participating farmers are organic, but many are, and all can benefit from the classes. Research results from our organic systems experiment are worked into the curricula of the classes and several of our team members teach one or more sections of the class in different locations. Bi-lingual Cultivating Success classes were done for Hmong, east African, and Latino immigrant farmer groups. Short courses included winter and summer cover crops schools, and pastured poultry. The winter and summer cover crops schools had an on-line component followed by a field day. Presentations at the annual Washington Tilth conference are typically attended by 80-100 farmers. They have included English and Spanish presentations on soil quality and food safety, farmer-researcher co-presentations on topics such as cover crops, and presentations on management zones for on-farm soil sampling and the roll of soil organisms in maintaining productive soils. Our work on Good Agricultural Practices was an outgrowth of food safety research done at the organic systems experiment and collaborations from that research. We have held 3-6 workshops each year since 2009, focused on basic GAPS, developing GAPS plans, and GAPS certification and Food Safety Moderization Act (FSMA). Dissemination also included other local and regional presentations and workshops, and videos. These include a series of video clips from a WSU Puyallup organic farming systems farm walk in 2009. Each short video clip features a WSU speaker highlighting elements of their research, including: drip irrigation for food safety, riparian buffers, and sources of food-borne pathogens on the farm. These videos were watched by 485 people in 2012. Videos also include a Spanish language video on harvest practices and food safety. We have two web pages on small farms (http://smallfarms.wsu.edu) and soil management (http://puyallup.wsu.edu/soilmgmt/). The small farms web page contains links to the videos and other educational materials. Five extension bulletins are in print or in press, including ones on management zone approaches to soil testing for small farms, soil fertility in organic systems, and three on cover crops. Other printed/electronic materials include practical nutrient and soil

management articles in Tilth Producers Quarterly, which is read by organic farmers. Dissemination to researchers includes presentations at national and international meetings (11 abstracts), and refereed journal articles in print(one on the early years of the systems project, one on farm-scale variability of soil quality indices, and one on cover crops and nitrogen management). Additional journal articles are in preparation, including crop yield and N availability in the systems experiment, organic matter and physical soil quality in the systems experiment, two on soil biology, and another publication on on-farm soil variability. We have also done outreach activities to reach members of communities who are not usually aware of these research activities. These include presentations at high schools during college and career days, field tours/labs for technical college students, and field labs for undergraduate students at non-land grant colleges and universities. We typically have done 1-2 high school events and 2-3 technical college/undergraduate field labs each year. Outcomes An unexpected outcome was expanding our focus beyond soil quality and productivity to Good Agricultural Practices (GAPS) for organic production. We used our organic vegetable systems experiment to leverage collaboration and funding for a study of the fate of natural pathogens and indicators in on farm composting, irrigation water, soil, and crops, and outreach in GAPS and FSMA (Food Safety Modernization Act) education. GAPS I (basic) and GAPS II (advanced) workshops topics included manures and composting, irrigation water, worker hygiene, and harvesting and equipment. Workshops included organic and conventional farmers. Evaluation of our GAPS workshops showed positive outcomes for both changes in knowledge and changes in action. In the first three years, 149 producers attended both workshops. GAPs recordkeeping changed for 53%, and implementation status changed for 58% since Session I. In a one-year follow-up, 76 participants completed an online survey. Reported new implementation was 34% for employee training, 36% for hygiene and facility monitoring, 27% for recordkeeping and 25% for harvest and storage sanitation practices. Ten participants had completed a GAPs assessment and 8 had completed third-party GAPs certification. We evaluated our farm walks to document knowledge and action changes. During each year from 2010 to 2012, farmers that attended farm walks managed an estimated 25,000 acres. Not all attendees are certified organic, but much of the focus is on organic practices systems. Based on the 2012 farm walk evaluations, 85% of farmer attendees reported they would apply something they learned. Across four farm walks with a focus on soil quality, 84% of attendees indicated they would implement changes in soil fertility management. At a pasture management farm walk, 67% of attendees indicated they would change livestock management. Respondents at specific farm walks indicated "great" knowledge increases in farm profitability (54%) and soil fertility (89%). Through a retrospective evaluation of all farm walk attendees through 2012 (n=228 respondents; 28% response rate) we were able to quantify specific actions taken as a result of knowledge or connections from attending a farm walk. For example, 8% started farming organically, 75% improved fertility management, 57% expanded cover cropping, 47% improved food safety, and 30% intensified pasture management. Of the farmers that responded to the retrospective survey, 52% indicated that they increased their annual income by implementing changes on their farm based on knowledge or connections made at farm walks; 75% of these indicated that the changes increased annual farm income by \$1,000 or more and 30% indicated annual farm income increases of \$5,000 or more. What do you plan to do during the next reporting period to accomplish the goals? Nothing Reported

2011/08/01 TO 2012/07/31 OUTPUTS: This project is focused on an organic vegetable crop systems experiment in Puyallup, WA, begun in 2003. The experiment compares 12 organic management systems, including 3 cover crop treatments, 2 tillage regimes, and 2 organic amendments, arranged in a split-split plot design with 4 replications. Cover crops include 1) fall-seeded cereal rye-hairy vetch mix; 2) relay-intercropped hairy vetch or red clover planted into the cash crop; and 3) short-term pasture planted to a mix of ryegrass and clover. Tillage treatments are conventional (plow, disc, rototill as needed for major tillage) and \"spader\", (rotary spader), and amendments are an N-rich, low C treatment (composted broiler litter) and a high C treatment (mixed on-farm compost). The rotational pasture has been on a 2-year pasture, 1-year cash crop rotation since 2008, with no added amendments. Poultry and sheep are seasonally raised on the pasture. Vegetable crops grown since 2008 are broccoli, winter squash, and lettuce. Winter wheat was grown in 2011 to provide a break from vegetables. No amendments were added to the wheat crop, and yield differences among treatments reflected soil management in previous years. Plots with previous on-farm compost had significantly greater grain yields (116 bu/ac) than plots with previous chicken manure applications (101 bu/ac), consistent with greater N mineralization potential (laboratory incubation) from plots with a history of on-farm compost. Grain yields were greater in spader-tilled plots (114 bu/ac) than in plots with conventional tillage (103 bu/ac). Penetrometer results show that plots with spader tillage were consistently less compact in the 6 to 12-inch depth than plots with conventional tillage. This could cause a better rooting environment than in the conventionally tilled plots. We investigated indicator and pathogen fate under on-farm composting conditions for both the broiler litter (aerated turned pile) and on-farm compost (aerated static pile). For the turned pile, fecal coliform indicators increased in mixed samples collected during turning compared with samples collected from the undisturbed pile before turning, probably a result of mixing in material from the colder bottom of the pile. Fecal coliform levels in declined as the number of turnings increased. Generic E coli declined to below detectable levels after 1 to 2 turns. Fecal coliforms were low during

composting in the first year of the aerated static pile, but increased to \>3 log10 MPN at when the pile was unpacked and mixed at the end of composting. In the second year fecal coliforms remained \> 3 log 10 on the pile surface throughout the composting process, and at unpacking and spreading. Pathogens (E Coli O157 and/or Salmonella) were detected after the aerated static pile and the turned pile met pathogen reduction time and temperature criteria in one of the two sampling years. Education programs included farm walks and field days, presentations at regional and national conferences, and workshops (two were bi-lingual) for direct market farmers. PARTICIPANTS: Nothing significant to report during this reporting period. TARGET AUDIENCES: Organic farmers, direct market vegetable farmers, agricultural and agency professionals PROJECT MODIFICATIONS: Nothing significant to report during this reporting period.

2010/08/01 TO 2011/07/31 OUTPUTS: This project is focused on an organic vegetable crop systems experiment in Puyallup, WA. The experiment compares 12 organic management systems, including 3 cover crop treatments, 2 tillage regimes, and 2 organic amendments, arranged in a split-split plot design with 4 replications. Cover crops include 1) fall-seeded cereal rye-hairy vetch mix; 2) relay-intercropped hairy vetch planted into the cash crop; and 3) short-term pasture planted to a mix of ryegrass and clover. Tillage treatments are conventional (plow, disc, rototill as needed for major tillage) and \"spader\", (rotary spader), and amendments are an N-rich, low C treatment (broiler litter) and a high C treatment (mixed on-farm compost). The rotational pasture was grown on alternating year cycles from 2003-2007, but beginning in 2008, it was switched to a 2-year pasture, 1-year cash crop cycle, with no added amendments. Poultry and sheep are seasonally raised on the pasture. Vegetable crops in 2009-2010 were broccoli, winter squash, and lettuce, and winter wheat was grown in 2011 to provide a break from vegetables. This report is focused on treatment effects on novel and traditional soil biological indicators, including nitrification potentials, ammonia monooxygenase enzyme (amoA) gene copy number, ammonia oxidizing archaea, soil enzymes, phospholipid fatty acid methyl esters (PLFA), soil organic carbon (SOM), particulate organic matter (POM) and POM carbon. Inorganic N in the soil correlated with nitrification potential but not amoA gene copy numbers in ammonia-oxidizing bacteria (AOB) or ammonia oxidizing archaea. Inorganic N supply and nitrification potentials were consistently higher in treatments that received additions of N via on-farm compost. Green manure additions resulted in temporary increases in nitrification potential and AOB amoA gene copy numbers. Ammonia oxidizing archaea, amoA gene copies were negatively correlated with nitrification and were insensitive to N additions of cover crops and amendments. The role of ammonia oxidizing archaea in N cycling is still unclear. Dehydrogenase activity was highest in pasture followed by Relay and post harvest. B-glucosidase activity was the lowest in Relay. Arylamidase and phosphatase activities did not change with cropping system or tillage, but had less activity with broiler litter when compared to on-farm compost amendment. SOM was least in pasture (least amendment application). Percent POM was low in the Post Harvest treatment and POM C was least with pasture. Broiler litter resulted in soils with the lowest carbon, nitrogen, POM C, dehydrogenase, B-glucosidase and arylamidase, while other characteristics were not different between the carbon amendments. Post harvest and relay separated from the pasture treatments for PLFA analyses of community structure. The changes occurring in soil properties may lead to early identification of differences among organic management practices and allow land managers to predict the benefits of various management practices. Outreach in 2010-11 included farm walks, field days focused on food safety and cover crops, and continued programs for Hmong farmers. PARTICIPANTS: GAPs training programs continued in collaboration with Dr.Karen Killinger and collaborators at WSU and at the Washington State Department of Health and Washington State Department of Agriculture. TARGET AUDIENCES: Our main target audience is direct market organic farmers, with other audiences including other organic farmers, other small-acreage direct market farmers, students, and agency personnel. Our main audience includes farmers from Hmong and Latino communities in Washington State. PROJECT MODIFICATIONS: Nothing significant to report during this reporting period.

2009/08/01 TO 2010/07/31 OUTPUTS: This project is focused on an intensive organic vegetable crop systems experiment in Puyallup, Washington. The experiment compares 12 organic management systems, including three cover crop treatments, two tillage regimes, and two organic amendment types, arranged in a split-split plot design with four replications (48 plots). Cover crop treatments include 1) a fall-seeded cereal rye-hairy vetch mix; 2) relay-intercropped hairy vetch planted into the cash crop; and 3) a short-term pasture planted to a mixture of annual ryegrass, perennial ryegrass, and red clover. Tillage treatments are conventional (plow, disc, rototill as needed for major tillage) and \"spader\", (rotary spader), and amendments are a nitrogen rich, low C treatment (broiler litter) and a high C treatment (mixed on-farm compost). The short-term pasture was grown on alternating year cycles from 2003-2007, but beginning in 2008-11, it was switched to a 2-year pasture, 1-year cash crop cycle, with no added amendments. Poultry were raised seasonally on the pasture in 2006, 2008, and 2009 sheep were added in 2008 and 2009. Current vegetable crops are broccoli, spinach, winter squash, and lettuce. Soil properties have been most sensitive to amendment over the course of this project, with greater soil enzyme activity (dehydrogenase, β-glucosidase, and arylamidase), total and POM C, total N, infiltration, pH, and lower

bulk density observed with the on-farm compost (higher carbon input). Nitrification potentials and ammonia oxidation bacteria copy number were first measured in 2009, and also showed higher levels with the on-farm compost, but only on the sampling date closest to the application. Nematode enrichment index and post-harvest soil nitrate tended to be greater with broiler litter. Among the cover crop treatments, the pasture had lower levels of C and N, slower infiltration, and higher bulk density and compaction than the annual cover crop treatments. Infiltration, bulk density, and compaction were only affected during the pasture years of the rotation, and lower C and N were the result of fewer amendment additions. Dehydrogenase activity, pH, and collembola were greater in the pasture treatment, with the collembola highly sensitive to tillage. Fewer differences were observed between spader and conventional tillage, with consistently lower compaction observed with spader tillage. Yield effects have been variable, with lower yields some years in the relay cover crop treatment, possibly a result of competition. When the pasture treatment is in vegetables, yields have been lower, as has post-harvest soil nitrate, as expected for a low-input system. Total and POM C and N and enzyme activities have increased over time, while pH has decreased. Bulk density decreased in the early years of the experiment. This experiment has provided opportunities for related research, including a study of pathogens and indicators in compost, soils, crops, and irrigation water, and an evaluation food quality in the different organic systems. Outreach in 2010 included cover crops schools, farms walks, a field day focused on food safety, and continued programs for immigrant farmers. PARTICIPANTS: Individuals. PIs and co-PIs: C. Cogger. Overall project management; lead on soil physical measurements; data analysis; lead on reports; outreach including workshops, field days, and immigrant farmer programs; assist with GAPS program. M. Ostrom. Outreach lead including immigrant farmer program, Cultivating Success, liaison with partner organizations. K. Painter. Economics lead. Developing economic database and analyses. A. Kennedy. Lead on soil enzymes, ammonia oxidizers, C and N, and PLFA; reports. A. Fortuna. Lead on nitrification potentials, ammonia oxidizers, DGGE, and incubations; reports. R. Alldredge. Statistical guidance, including development of structural equation models. A. Bary. Field work lead; soil sampling; data analysis; reports; outreach including field days, workshops, immigrant farmers and GAPS programs. D. Collins. Lead on mesofauna and substrate-induced respiration. Outreach lead including advisory panel, on-farm cooperators, and Washington Tilth. Field days, farm walks, workshops, immigrant farmer programs. J. Goldberger. Lead on preparation for evaluations. B. Cha. Liaison for Hmong and East African immigrant farmer programs. Partial financial support by grant: A. Bary. See above E. Myhre. Field work and logistics; data collection; sample handling and inventory; database management; field day preparation. A. Lawson. Graduate student focused on cover crop management and nutrient management. K. McCann. Undergraduate researcher focused on nematodes, collembolan and SIR; field work. New collaborators: C. Benedict. Extension Educator. Weed science (replacing Miller as lead); outreach including on-line training and field days focused on cover crops and weed management. K. Killinger. Food safety specialist. Food safety research and education; lead on GAPS education; liaison between food safety and organic production research and outreach. Training and professional development: Main activities included GAPS field day at WSU Puyallup systems site, GAPS workshops, cover crops schools and field days at WSU Puyallup, farm walks coordinated with Washington Tilth, Cultivating Success classes. TARGET AUDIENCES: Organic vegetable farmers, fresh market farmers, immigrant farmers, agricultural agency personnel PROJECT MODIFICATIONS: Food safety has become an important part of this project, using our site as a food safety laboratory and training center, and springboard for food safety education. Funding for the food safety work comes from other sources.

2008/08/01 TO 2009/07/31 OUTPUTS: This project is focused on an intensive organic vegetable crop systems experiment in Puyallup, Washington. The experiment compares 12 organic management systems, including three cover crop treatments, two tillage regimes, and two organic amendment types, arranged in a split-split plot design with four replications (48 plots). Cover crop treatments include: 1) a fall-seeded cereal rye-hairy vetch mix; 2) relay-intercropped hairy vetch planted into the cash crop; and 3) a short-term pasture (ley) planted to a mixture of annual ryegrass, perennial ryegrass, and red clover. Tillage treatments are \"conventional\" (plow, disc, rototill as needed for major tillage) and \"spader\", (rotary spader), and amendments are a nitrogen rich, low C treatment (broiler litter) and a high C treatment (mixed on-farm compost). The short-term pasture was grown on alternating year cycles from 2003-2007, but beginning in 2008-09, it was switched to a 2-year pasture, 2-year cash crop cycle. Poultry was raised seasonally on the pasture in 2006 and 2008, and sheep were added in 2008. Vegetable crops have been broccoli, spinach, winter squash, and snap bean, with lettuce replacing snap bean in 2008. Objectives are: 1) Elucidate relationships between organic management systems, soil quality, weed pressure, and crop productivity to improve agroecosystem design and performance; 2) Analyze the potential economic costs, returns, and risks of organic vegetable production systems in the maritime Northwest; and 3) Develop and offer an innovative educational program on organic farming targeted at new, experienced, and transitioning organic farmers; immigrant farmers; and students. This report focuses on the effects of the different organic management practices on microbial biomass, nematodes and collembolans in the first phase of the project. Microbial biomass was determined with substrate-induced respiration 3 times in 2006 and 2007, nematode community analysis was performed once in 2005 and 2006 and 4 times in 2007, and collembolan diversity was

determined 3 times in 2005, 2006, and 2007. Broiler litter caused a marked increase in the number of bacterial-feeding nematodes without significantly decreasing omnivorous/predacious nematodes and indices sensitive to their relative abundance (e.g. structure index). Using a slow-speed spader as an alternative to rototilling did not lead to predictable differences in microbial biomass, nematode community indices, or size of collembolan populations. Including a one-year pasture-phase in rotation caused major and significant changes to the micro and mesofauna. Bacterial-feeding nematodes declined by 66-76%, indices of ecosystem maturity and fungal dominance increased significantly, and collembolan populations increased by a factor 3.4-4.5. However, when placed back into cultivation none of these changes to the soil community persisted. Several pasture rotations will likely be necessary to evaluate long-term effects of the rotation. PARTICIPANTS: Nothing significant to report during this reporting period. TARGET AUDIENCES: organic farmers and other small-scale intensive vegetable growers PROJECT MODIFICATIONS: Nothing significant to report during this reporting period.

IMPACT

2008/08 TO 2013/07 What was accomplished under these goals? This project is focused on an organic vegetable crop systems experiment in Puyallup, WA, begun in 2003, with Integrated Organic Program funding beginning in 2008. The experiment was designed to compare 12 organic management systems, including 3 cover crop treatments, 2 tillage regimes, and 2 organic amendments, arranged in a split-split plot design with 4 replications. Cover crops include: 1) fall-seeded cereal rye-hairy vetch mix; 2) relay-intercropped hairy vetch or red clover planted into the cash crop; and 3) short-term pasture planted to a mix of ryegrass and clover. Tillage treatments are conventional (plow, disc, rototill as needed for major tillage) and "spader", (rotary spader), and amendments are an N-rich, low C treatment (composted broiler litter) and a high C treatment (mixed on-farm compost). The rotational pasture was changed to a low-input (no amendment) treatment in 2006, and has been on a 2-year pasture, 1-year cash crop rotation since 2008. Poultry and sheep are seasonally raised on the pasture. Vegetable crops grown in 2008-2010 and 2012 were broccoli, winter squash, and lettuce. Winter wheat was grown in 2011 to provide a break from vegetables. We did not observe consistent crop yield effects of any treatment or system across all crops, although we did see some significant treatment differences on yield duringsome years. We grew multiple crops each year beginning in 2006, rotating the crops across the beds, and in some cases double cropping on a single bed. This resultedin a total of 26 crops harvested from 2006-2012. Yields were significantly ($p\< 0.05$) greater in the spader plots compared with conventional tillage for 5 of the 26 crops, with no cases of higher yields in the conventionally-tilled plots. Yields were greater with broiler litter (low C) compared with mixed compost (high C) in two cases, and yields were greater with mixed compost in two cases. The greater yields with mixed compost occurred for wheat in 2011, when no amendments were added. This suggests the mixed compost had increased the ability of soil to supply N, consistent with what we observed in incubation studies. The post-harvest cover crop treatment had greater yields than relay in two of 26 cases, while the relay had greater yields than post-harvest in two cases. Higher yields following relay occurred in 2012, following wheat, when we had the most vigorous relay cover crop stand (red clover seeded into wheat). Since the rotational pasture had vegetables only two years, there were only 7 crop harvests. In two cases (both broccoli), yields were significantly lower in the pasture treatment, indicating that the low-input pasture did not supply adequate available N for a high demand crop such as broccoli. Physical soil quality and organic matter were most consistently affected by amendment, with the mixed compost (high C) treatment showing higher levels of total soil C and N, lower bulk density, and faster infiltration than the broiler litter (low C) amendment. Changes were greatest in the first years of the experiment, with differences maintained thereafter. We saw no significant differences in organic matter or physical soil quality between the post-harvest and relay cover crop systems. The rotational pasture had lower levels of C and N, slower infiltration, and higher bulk density and compaction than the annual cover crop treatments. Infiltration, bulk density, and compaction were only affected during the untilled pasture years of the rotation, and lower C and N were the result of fewer amendment additions. The only measured difference in physical soil quality observed between spader and conventional tillage was in soil compaction, with the spader-tilled soils consistently less compact than conventional. Spader tillage also produced a more uniform seedbed, although this is based on visual observations rather than measurements. Soil biological quality was affected by amendment and cover crop system. The cover crop affect appeared to be related to frequency of tillage in the different cover crop systems. Soil enzyme activity and nitrification potential were greater with the high C mixed compost amendment compared with the low C broiler litter, while nematode enrichment index was greater with broiler litter. The greater enrichment index likely indicated the response of the food web to the greater N availability in the broiler litter. The rotational pasture treatment had greater dehydrogenase activity and Collembola (during the untilled pasture phase), reflecting the sensitivity of Collembola to tillage. Activity of β-glucosidase was lowest with the relay cover crop, possibly because cover crop biomass input was lower with the relay cover crop. Cover crop incorporation resulted in temporary increases in nitrification potential and ammonia

oxidizing bacteria amoA gene copy numbers. Ammonia oxidizing archaea, amoA gene copies were negatively correlated with nitrification and were insensitive to N additions of cover crops and amendments. The role of ammonia oxidizing archaea in N cycling is still unclear. Weed seedbank data was collected in 2010-2012, and we observed no significant differences in total weed seed density across any of the treatments in 2010 and 2011, but in 2012 there was a significantly lower overall seed bank density in the pasture when compared with other systems. The pasture plots were in their second year of pasture in 2012, indicating degradation of the seed bank during the pasture phase. Species-specific analysis is still in progress. Economics Enterprise budgets were constructed for each treatment using standard economic procedures. A separate spreadsheet was created for each year that provides data for each treatment and crop as well as a summary of each year's economic outcome. At this point, results are preliminary, as some costs have not yet been incorporated into the analyses. These include drip irrigation and greenhouse expenses, including both supplies and the greenhouse structure. Detailed costs and returns budgets for each crop, treatment and year reveal impacts on profitability by treatment and crop. Examples from 2010 and 2009 follow. In 2010 for two crops of lettuce, planted in double rows, net returns over total production costs averaged nearly \$55,000 per acre per year, compared to \$5,000 per acre for broccoli and \$12,237 per acre for squash. Net returns for lettuce were also least variable, with a coefficient of variation (CV) across treatments of just 6%, compared to 50% for broccoli and 23% for winter squash. The most profitable treatment differed substantially by crop. While the relay cover cropping, spader tillage, and high C compost was the most profitable for broccoli, this treatment was one of the least profitable treatments for winter squash. The most profitable treatment for winter squash was the pasture treatment with the spader tillage, but this was the least profitable treatment for the other two crops. Lettuce in 2010 was most profitable with the post harvest cover crop, spader tillage, and high C compost. In 2009, results by crop were quite different, with the lettuce crop losing an average of \$3600 over all treatments, with a CV of 20%. Broccoli followed by spinach and radishes was most profitable, averaging \$15,700 across all treatments with a CV of 6%. Winter squash had net returns averaging \$13,800 and a CV of 7%, and was most profitable under post harvest cover crop, spader, and high C compost. The other crops were most profitable (least negative) with the post harvest cover crop, conventional tillage, and high C compost. Outreach and outputs arediscussed in the dissemination section below. **PUBLICATIONS (not previously reported):** 2008/08 TO 2013/07 1. Type: Conference Papers and Presentations Status: Published Year Published: 2012 Citation: Collins, D., C. Cogger, A. Bary. 2012. Soil testing: A guide for farms with diverse vegetable crops. Proceeding of the 6th National Small Farms Conference. Memphis, TN. 2. Type: Other Status: Published Year Published: 2013 Citation: Collins, D. C. Miles, C. Cogger, and R. Koenig. 2013. Soil fertility in organic systems - A guide for gardeners and small acreage farmers. Pacific Northwest Extension Publication PNW 646. 3. Type: Other Status: Published Year Published: 2012 Citation: Collins, D.P. 2012. Soil testing: A guide for farms with diverse vegetable crops. Washington State University Extension Fact Sheet. EM050E.

2011/08/01 TO 2012/07/31 A one-day short course on pastured poultry production was held at the WSU Puyallup Research and Extension Center. Thirty-eight participants attended the event; 71% were farmers, 23% were interested community members, 3% were agricultural professionals. Participants viewed a pastured poultry breed trial at WSU Puyallup where Cornish Cross and Slow Cornish Cross were being compared. Fencing and cages were also viewed and discussed. A retrospective (post class) evaluation was completed by 31 participants. All of the participants (100%) increased their knowledge somewhat in at least one topic, while 77% greatly increased their knowledge in at least one topic. Topics with the highest knowledge increases included: food safety in poultry processing, maintenance of poultry, animal management, and pasture management. The vast majority (86%) planned to make at least one change on their farm as a result of the shortcourse. Evaluation respondents indicated they would increase organic marketing strategies (including using lactic acid (4 people) and acquiring or renting processing equipment (2 people)), change their pasture strategies or mobile tractors (10 people), change feed regiments (12 people), alter breed selection (13 people), and change avian health practices (10 people). Participants indicated that they would like future workshops to focus on hands-on butchering, costs/how to be profitable, economics, lambs for meat, layer production, and pork production.

2010/08/01 TO 2011/07/31 Short term evaluations were done with participants of winter and summer cover crop schools. All participants of the winter school/field day were asked to take a pre-online course covering basic cover crop information. At the end of the in-person workshop, they were surveyed on a number of different topics. Data was then entered into a database and analyzed for trends. In addition to discovering that the workshop was effective at increasing knowledge (\>95%), we also learned that the use of online education can be effective for both farmers (ave: 3.59 out of 5) and non-farmers (ave: 4.25 out of 5). At the end of the summer workshop, participants were surveyed on a number of different topics. Thirty-one surveys were collected (91% participation rate). Ninety percent of participants indicated that they greatly increased their knowledge of summer cover crops during the workshop. Ninety-two percent indicated they somewhat or greatly increased their skills and ability to

incorporate summer cover crops. The vast majority (93%) indicated that they were very likely to use or encourage the use of cover crops as a result of the workshop. In our 2010 CRIS report we noted that a major impact was an unanticipated one - resulting in research on the fate of naturally occurring human pathogens in organic farming systems, and the use of our site in GAPS food safety training. Follow-up surveys of practice changes from the GAPS training showed that 32% of participants adopted food safety training, 25% adopted additional harvest and storage practices to reduce the risk from food-borne pathogens, and 11% received third-party GAPs certification.

2009/08/01 TO 2010/07/31 The most important impact over the last two years was an unanticipated one regarding food safety and Good Agricultural Practices (GAPs) education. Research at the WSU Puyallup organic systems experiment provided new information on pathogen and indicator presence in compost, soils, crops, and irrigation water, leading to a change in irrigation, management, and harvest practices in our experiment, and the development of our site as a model for GAPs practices a center for GAPs education. We are working with WSU food safety specialists delivering GAPs training to organic and other farmers, including immigrant farmers. The training is focused on amendments, irrigation water and systems, and field and harvest practices, and has included field days, a one-day basic session, and an advanced session focused on discussion of GAPs implementation. Our experimental site has been used for a mock food safety audit field day, and will host FDA food inspectors later this fall. We have already observed increased levels of knowledge and awareness of GAPS and increased trust by farmers in discussing and addressing food safety issues. On-the-ground changes in practices will be assessed in the future.

2008/08/01 TO 2009/07/31 We have demonstrated that different organic management systems affect soil quality in different ways in the short run and that long run changes are evolving. We expect that long-term assessment of soil quality in our experiment and on participating farms will encourage farmers of intensively managed high-value organic crops to adopt practices that provide more long term benefits to soil quality. The measurable effects of modified tillage using the spader are significant, and growers are impressed by the quality of seedbed that it can produce after a single pass. The spader appears to be most suitable for small farms and light to medium textured soils. We have provided information on cover cropping strategies through field days, workshops, and classes, and some farmers have adapted covering cropping to fit their farming systems. But we have a long way to go to get more widespread adoption in the intensive management systems typical of our region. We expect that forthcoming economic analyses will help farmers make decisions on adoption of practices.

PUBLICATIONS

2011/08/01 TO 2012/07/31 Lawson A., A.Fortuna, C.G.Cogger, A.I.Bary, T.L.Stubbs. 2012. Nitrogen contribution of rye-hairy vetch cover crop blends to organically grown sweet corn. Renewable Agriculture and Food Systems. doi:10.1017/S1742170512000014.

2010/08/01 TO 2011/07/31 1. Collins, D.P., C.G. Cogger, A.C. Kennedy, T. Forge, H.P. Collins, A.I. Bary, and R. Rossi. 2011. Farm-scale variation of soil quality indices and association with edaphic properties. Soil Sci. Soc. Am. J. 75:580-890. 2. Pritchett, K., A.C. Kennedy, and C.G. Cogger. 2011. Management effects on soil quality in organic vegetable systems in western Washington. Soil Sci. Soc. Am. J. 75:605-615. 3. Lawson, A., Fortuna, A., Cogger, C.G., & Bary, A.I. 2010. Cover crops to enhance nitrogen management in organic cropping systems. ASA annual meetings Long Beach, California. 4. Fortuna A. and C.G. Cogger. 2010. The effect of organic cropping systems, fertility source and time of season on nitrification. ASA, Long Beach, CA. 5. Fortuna A. and C.G. Cogger. 2010. The Biogeochemical cycling of nitrogen in annual and perennial agroecosystems, AGU, San Francisco, CA.

2009/08/01 TO 2010/07/31 No publications reported this period

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