ORG Project Details

Award Year 2007

5 Research Projects

PROJECT INDEX

Flea Beetle Control Treatment Demonstration in Western Washington State

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Subfile	CRIS
Project No.	WNN-0102
Agency	NIFA WN.N
Project Type	OTHER GRANTS
Project Status	TERMINATED
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Grant Amount	$74,394
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Investigator(s)	MacConnell, C. B.; Burrows, C. L.
Performing Institution	COOPERATIVE EXTENSION, WASHINGTON STATE UNIVERSITY EXTENSION, HULBERT 411

NON-TECHNICAL SUMMARY

Small, diversified organic farms in Western Washington State have been having increased difficulties in controlling the crucifer flea beetle on salad greens and brassica crops. While limited research on crucifer flea beetle control in organic systems has been done in California and northeastern parts of the United States and Eastern Canada; little research has been performed on organic control of the flea beetle in northwestern parts of the United States, including Washington State. This project will evaluate six methods of control for flea beetle on organic farms and demonstrate these methods to local growers during on-farm field days.

OBJECTIVES

Small, diversified farms have been increasing in number in western Washington State over the past decade. The proximity to significant urban markets and the favorable growing season in this region allows for increasing success of these farms to direct market to consumers through farmer\'s markets and consumer supported agriculture programs. Popular products for these farmers include salad greens (lettuces, mustard greens, arugula, spinach) and Brassica types (broccoli, cauliflower, cabbage, Brussels sprouts). With the increasing number of certified organic farms within proximity to one another, pests can easily move from one farm to another through the entire season. One such pest that is causing a problem in Whatcom County and King County, Washington is the crucifer flea beetle (Phyllotreta cruciferae (Goeze)). This flea beetle will damage salad greens and Brassicas by chewing 1mm to 5mm or larger holes in the leaves, making the greens non-saleable and decreasing the survivability of Brassica seedlings. This project will evaluate existing tools for flea beetle control in western Washington State and investigate new tools for these growers. This will be achieved by conducting research trials of at least two treatments of flea beetle control on each of 7 to 8 farms (4 in Whatcom County, and 3 to 4 in King County). The existing tools to be evaluated are those that have been tried with varying levels of success in other regions of North America, such as Northeastern United States and California. One local grower has tried a control method and gained anecdotal evidence to its success. This method will also be demonstrated and tested for efficacy. This research and extension (demonstration) project attempts to address the pest problem of the flea beetle on Brassica species and related plant types. By reducing the population of flea beetles on a crop, the amount of damage to the crop will be reduced, resulting in three potential outcomes: 1) the grower will produce a less damaged, more saleable product; 2) the grower will produce a product of saleable size in a shorter period of time; or 3) more plants will survive resulting in a larger volume of saleable product. The research efforts proposed are to be conducted in two counties in western Washington; King and Whatcom. This separation of multiple plot locales will increase the likelihood of interest, support, and relevance to a broad segment of small, fresh market producers in western Washington. The results will be shared with other Extension professionals and growers throughout the region through events such as the field days, presentations at the Washington Tilth Conference, and information on websites

APPROACH

Seven to eight farms in Whatcom and King Counties will be involved in the research and demonstration of treatments for flea beetle control. Treatments include six methods of flea beetle control during the first year of the study. Treatments showing promising results will be tested again in the second year, along with new treatments that may be developed or discovered during the first year. A minimum of two treatments will be tested at each farm in each year of the trial. The six treatments of flea beetle control to be tested are: 1. The use of a floating row cover: A row cover cloth will be placed over the crop immediately following seeding or transplanting. This method is meant as a physical barrier to the flea beetle. 2. Growing weed or cover crop populations among desirable crop: A cover crop will be started before the commercial crop and grown alongside the desired crop. This crop may be planted in one of two ways: 1) between the rows of the desired crop, or 2) as one of the rows, such as one in every four rows planted. Alternatively, weeds may be left allowed to grow between and among plants in a row to add plant diversity and confuse the pest. 3. Using straw mulch between and among rows of desirable crop: The straw mulch would be placed between the rows of a seed sown crop such as salad greens and would be placed between the rows and within the row of a transplanted crop such as broccoli. 4. Living barrier crop between rows: A tall crop, such as asparagus or tall peas, would be planted in between rows of the desired crucifer crop. This trial will be set up across at least 4 rows of a certain crop with living barriers separating rows. 5. Trap cropping with Chinese Southern Giant Mustard around edges of plot: A trap crop of \'Chinese Southern Giant Mustard\' will be planted around the edges of the target plot. This trap crop will be sown earlier to be at a more advanced developmental stage than the commercial crop making it more attractive to the flea beetle. The flea beetles will be vacuumed from the trap crop on a weekly basis to reduce flea beetle numbers. 6. Use of a flea beetle trolley to disturb and trap flea beetles: A simple machine designed to disrupt beetles from the crop and catch them on a sticky surface will be used. The trolley will be pushed along the crop during a period of flea beetle activity, between mid morning and mid afternoon. Once per week, the number of flea beetles caught on the trolley will be counted to monitor efficacy of the trolley. Each treatment will be tested in three replicated plots per farm. Three plots will also be used as control plots, with all the same except for no flea beetle control treatment used. Plots will be incorporated into a farmer\'s growing system, as a result irregular plot sizes may be used in some instances. Efficacy of each treatment will be measured in two ways: 1) by visual evaluation, and 2) by using yellow sticky cards to evaluate the number of beetles per treatment. Two field days per year will be held in each county (Whatcom and King) for growers to observe methods being tested and to learn the results of the trials.

PROGRESS

2007/09 TO 2010/09 OUTPUTS: Seven management methods for the crucifer flea beetle were tested in 2008 and 2009. In 2008, treatments were tested on 5 farms in Whatcom County and 3 farms in King County; in 2009, methods were tested at 5 farms in Whatcom County, 3 farms in Snohomish County, and WSU Mt. Vernon Research and Extension Center. Crops used for testing management methods were all crucifers: broccoli, arugula, mizuna, mustard greens, bok choi, and tatsoi. Treatments were: floating row cover (row cover put over crop immediately following planting or sowing), straw mulch between rows (1\" thick straw mulch was filled in alleyway), cover crop between rows (cover crop of buckwheat or a mix of bell beans, field peas common vetch, and cayuse oats), living barrier (cash crucifer crop planted between established asparagus or peas), fabric wall (row cover material attached to stakes to make a wall around cash crop), trap crop (Chinese Southern Giant Mustard, tatsoi, or mizuna planted either on border or every 4th row in broccoli planting), and a flea beetle trolley (4 wheeled trolley to disturb beetles in the crop and trap them on underside). At least two treatments were tested per farm and compared against a control plot near the treatment area, set up at the same time as the treatment plot. The experiment at the Mt. Vernon Research Center was set up as a Randomized Complete Block Design with five treatments tested. Plots were managed agronomically on-farm by participating growers. The Mt. Vernon plots were managed by the vegetable field crew. Efficacy of treatment was measured in two ways. Feeding damage was determined by examining leaves and subjectively measuring damage on a scale of 1-5. Two yellow sticky cards were placed in each plot and were used to monitor the number of beetles. Each was measured by the same person once per week for four weeks for each crop cycle. Analysis of Variance was used to evaluate differences in the number of beetles trapped or qualitative feeding rating at each trial location. Differences among the means were analyzed with the Tukey Method. Two field events were held in Whatcom County and two were held in King County in 2008 and in Whatcom County and Snohomish County in 2009 to disseminate the information to growers. A total of 35 farmers attended the Whatcom County events, 55 attended the King County events and 3 farmers attended the Snohomish County event. A handout describing the project and interim results was distributed at each event and the project and results were described. Farmers interested in the project but unable to attend the field days were sent the handout electronically. Information from this project was disseminated at the Tilth Producers in Washington Annual Conference in Fort Worden in November 2010, with over 40 farmers attending this talk. A web page is available on the WSU Whatcom County Extension website (whatcom.wsu.edu/ipm/fleabeetle) explaining the pest identification, life cycle, and cultural control methods that were tested along with results. PARTICIPANTS: Craig MacConnell (Project Investigator) Mr. MacConnell participated as an advisor to the project. Colleen Burrows (co-PI) Ms. Burrows was the project manager. She set up farm locations and field trials and directed the project assistant in tasks such as data collection. She analyzed data, led field days, and produced reports. Daniel Coyne (Project Assistant) Mr. Coyne helped to set-up the field trials and collected the data. Mellissa Volk Mrs. Volk helped to set-up the field trials and collected the data. Collaborators: Andrew Corbin Mr. Corbin helped coordinate farm trials in Snohomish County. Farmer Collaborators: Alm Hill Farms, Whatcom County Hopewell Farm, Whatcom County Rabbit Fields Farm, Whatcom County Holistic Homestead Farm, Whatcom County Terra Verde Farm, Whatcom County Full Circle Farm, King County Rent\'s Due Farm, Snohomish County Garden Treasures Farm, Snohomish County TARGET AUDIENCES: The target audience of this project is small, diversified organic farms in Western Washington. These farmers participated in the research and attended field days to receive information. PROJECT MODIFICATIONS: Not relevant to this project.

2008/09/15 TO 2009/09/14 OUTPUTS: Six treatments for the crucifer flea beetle were tested on five farms in Whatcom County, three farms in Snohomish County, and at the WSU Mt. Vernon Research Center. Treatments were: floating row cover, straw mulch between rows, cover crop between rows, living barrier (asparagus or peas) between rows, fabric wall, and trap crop. At least two treatments were tested per farm and compared against a control plot near the treatment area, set up at the same time as the treatment plot. The experiment at the Mt. Vernon Research Center was set up as a Randomized Complete Block Design with five treatments tested. Efficacy of treatment was measured in two ways. Feeding damage was determined by examining leaves and subjectively measuring damage on a scale of 1-5. Two yellow sticky cards were placed in each plot and were used to monitor the number of beetles. Each was measured by the same person once per week for four weeks. Two field events were held in Whatcom County and two were held in King County to disseminate the information to growers. A total of 14 farmers attended the Whatcom County events. One Snohomish County event was attended by 3 local farmers. A handout describing the project and interim results was distributed at each event and the project and results were described. Farmers interested in the project but unable to attend the field days were sent the handout electronically. Results will be analyzed statistically in the winter of 2009-2010 and these results will be posted on the WSU Whatcom and Snohomish County Extension websites for greater access. PARTICIPANTS: Individuals: Craig MacConnell (Project Investigator) Mr. MacConnell participated as an advisor to the project. Colleen Burrows (Senior Research Associate) Ms. Burrows was the project manager. She set up farm locations and field trials and directed the project assistant in tasks such as data collection. She analyzed data, led field days, and produced reports. Daniel Coyne (Project Assistant) Mr. Coyne helped to set-up the field trials and collected the data. Mellissa Volk Mrs. Volk helped to set-up the field trials and collected the data. Collaborators: Andrew Corbin Mr. Corbin helped coordinate farm trials in Snohomish County. Farmer Collaborators: Alm Hill Farms, Whatcom County Hopewell Farm, Whatcom County Rabbit Fields Farm, Whatcom County Holistic Homestead Farm, Whatcom County Terra Verde Farm, Whatcom County Full Circle Farm, King County Rent\'s Due Farm, Snohomish County Garden Treasures Farm, Snohomish County TARGET AUDIENCES: The target audience of this project is small, diversified organic farms in Western Washington. These farmers participated in the research and attended field days to receive information. PROJECT MODIFICATIONS: Not relevant to this project.

2007/09/15 TO 2008/09/14 OUTPUTS: Seven treatments for the crucifer flea beetle were tested on 5 farms in Whatcom County and 3 farms in King County. Treatments were: floating row cover, straw mulch between rows, cover crop between rows, living barrier (asparagus), between rows, fabric wall, and a flea beetle trolley. At least two treatments were tested per farm and compared against a control plot near the treatment area, set up at the same time as the treatment plot. Efficacy of treatment was measured in two ways. Feeding damage was determined by examining leaves and subjectively measuring damage on a scale of 1-5. Nine yellow sticky cards were placed in each plot and were used to get a picture of the number of beetles in each plot. Each was measured by the same person once per week for four weeks. One farm site in Whatcom County was the Hovander Homestead Park, owned by Whatcom County Parks. This site was planted and maintained by WSU Whatcom County Extension employees and 5 treatments were used at this site. A descriptive poster was posted at this site to educate farmers and the general public about this research. Hovander Homestead Park is visited by hundreds of people daily. Two field events were held in Whatcom County and two were held in King County to disseminate the information to growers. A total of 16 farmers attended the Whatcom County events. One King County event was attended by 3 Hmong farmers and was videotaped to be shown to others. The other King County event was a part of a larger farm walk, where approximately 60 people attended. A handout describing the project and interim results was distributed at each event and the project and results were described. At one of the Whatcom County events, a new treatment (the fabric wall) was suggested by a farmer and tried later in the season with good results. A similar handout was provided at the Washington Tilth Conference in November. Results will be analyzed statistically in the winter of 2008-2009 and these results will be posted on the WSU Whatcom and King County Extension websites for greater access. PARTICIPANTS: Individuals: Craig MacConnell. WSU Whatcom County Extension (Project Investigator) participated as an advisor to the project. Colleen Burrows, WSU Whatcom County Extension,(Senior Research Associate) set up farm locations and field trials and directed the project assistant in tasks such as data collection. She analyzed data, led field days, and produced reports. Warren Hellman (Project Assistant)helped to set-up the field trials and collected the data. Collaborators: Todd Murray, WSU King County Extension, helped coordinate farm trials in King County. Farmer Collaborators:Alm Hill Farms, Whatcom County;Hopewell Farm, Whatcom County;Rabbit Fields Farm, Whatcom County;Holistic Homestead Farm, Whatcom County;Hovander Homestead Park, Whatcom County;21 Acres, King County;Song Ger Cha, King County;South 47 Farm, King County TARGET AUDIENCES: The target audience of this project is small, diversified organic farms in Western Washington. These farmers participated in the research and attended field days to receive information. One on-farm trial site was owned by a Hmong family. One of the field days was catered to this minority population which included a translator. PROJECT MODIFICATIONS: Not relevant to this project.

IMPACT

2007/09 TO 2010/09 Results from the research performed on flea beetle treatments indicated some treatments more effective than others in controlling the flea beetle on crucifer crops, and efficacy and integration into farm system differed in time of year, type of crop, farm size, and farming type. Row cover was very effective in most cases, except where beetles were trapped under the row cover or the sides were not adequately pinned down. Other treatments with beetle damage less than the control were the living wall of asparagus or trellised peas, the fabric wall, and the trap crop. Treatments not effective in our trials were straw mulch and the cover crop in the alleyways. The Flea Beetle Trolley as designed was not effective and cumbersome to use. Most treatments worked best early in the season before the flea beetles became established in the crop. Growers who attended the field days learned how different methods of flea beetle control need to be worked into a specific system of farming. Not all treatments will work with all farmers. Some of the treatments require planning where and how crops will be grown. Others require managing a crop differently so that it can be harvested earlier or later. The farmers who attended the field days started to appreciate the holistic approach to pest management that this takes and started to develop thoughts of how aspects might fit into their own systems. One farmer has begun using the row cover walls on her farm for salad greens. Several growers have committed to using living walls for growing some crops. Growers of different sizes and crop planning skills expressed interest in different management techniques. **PUBLICATIONS (not previously reported):** 2007/09 TO 2010/09 No publications reported this period

2008/09/15 TO 2009/09/14 Results from the research performed on flea beetle treatments indicated that some treatments were more effective than others in controlling the flea beetle on brassica crops. The row cover was very effective in most cases. Other treatments showing promise were the living wall of asparagus or trellised peas, the fabric wall, and the trap crop. Treatments that did not show as much promise were the straw mulch and the cover crop. These were slightly different results than in 2008; some methods for using treatments were worked out in this situation. Efficacy of treatments varied depending on time of the growing season when they were applied. Most treatments worked best early in the season before the flea beetles became established in the crop. Growers who attended the field days learned how different methods of flea beetle control need to be worked into a specific system of farming. Not all treatments will work with all farmers. Some of the treatments require planning where and how crops will be grown. Others require managing a crop differently so that it can be harvested earlier or later. The farmers who attended the field days started to appreciate the holistic approach to pest management that this takes and started to develop thoughts of how aspects might fit into their own systems.

2007/09/15 TO 2008/09/14 Results from the research performed on flea beetle treatments indicated that some treatments were more effective than others in controlling the flea beetle on brassica crops. The row cover was very effective in most cases. Other promising treatments were the living wall (asparagus), the fabric wall, and the cover crop between rows. Treatments that did not show as much promise were the straw mulch and the trap crop. The flea beetle trolley ran into some engineering difficulties; it will be re-designed and tested in 2009. One aspect of small organic farming translated into the difficulty of coordinating the cover crops or trap crops. Timing planting of cover crops and trap crops is very difficult in a small organic farm system. The cover crops and trap crops must be established before the main crop is at a stage that is desired by the flea beetle. This is often not achievable considering tilling and ground preparation timing. A perennial cover crop will be integrated into the design in 2009 to avoid the intricacies of the timing of annual cover crops. Farmers present at the field days were eager to try some of the new methods on their farms. Three new farmers volunteered to work with the project in 2009 as they were interested in learning the efficacy of treatments on their farm.

PUBLICATIONS

2008/09/15 TO 2009/09/14 No publications reported this period

2007/09/15 TO 2008/09/14 No publications reported this period

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Grafting to Improve Organic Vegetable Production in Field and High Tunnel Systems

Accession No.	0210246
Subfile	CRIS
Project No.	OHO01001-SS
Agency	NIFA OHO
Project Type	OTHER GRANTS
Project Status	TERMINATED
Contract / Grant No.	2007-51106-03794
Proposal No.	2007-01380
Start Date	01 AUG 2007
Term Date	31 JAN 2012
Fiscal Year	2009
Grant Amount	$858,507
Grant Year	2007
Investigator(s)	Francis, D. M.; Kleinhenz, M.; Miller, S. A.; McSpaden-Gardner, B.; Markhart, A.; Louws, F. J.; Peet, M.; Estes, E.; Liedl, B.; Sanchez, E.
Performing Institution	HORTICULTURE AND CROP SCIENCE, OHIO STATE UNIVERSITY, 1680 MADISON AVENUE

NON-TECHNICAL SUMMARY

Unfavorable weather, low nutrient levels and disease restrict season-long production of high quality, high value organic vegetables. Variety development to alleviate production limitations is time-consuming and expensive. The use of grafting and high tunnels can remove barriers to the success of organic vegetable farms, but information and outreach resources are limiting. Grafting efficiently combines rootstock and scion traits. Grafting is used to grow fruit and hydroponic greenhouse vegetables worldwide and field-grown vegetables in Asia. However, grafting is new in U.S. organic vegetable production. The purpose of these studies is to test numerous grafted tomato plants in multiple settings (field, high tunnel, greenhouse, growth chamber; farm, station), identify which perform best and why, and teach farmers and others how to make and use grafted plants. High tunnels can provide numerous benefits to farmers. Used throughout Europe and Asia, they are increasingly common on U.S. organic farms, especially for tomato production. Yet, data indicate that soilborne disease and/or nutrient deficiencies may buildup in high tunnels. Unchecked, these problems may devastate vegetables produced in high tunnels. The purpose is to test whether grafting can provide a solution to biotic and abiotic crop stress that limit field and high tunnel production.

OBJECTIVES

Unfavorable weather, low soil nutrient levels and disease limit season-long production of high quality, high value organic vegetables in many areas. However, the use of grafting and high tunnels can limit these barriers to the success of organic vegetable farms. Variety development is time-consuming, expensive, and technically-demanding. Grafting, in contrast, quickly and directly combines the traits of rootstocks and scions. In fact, grafting is used to grow fruit and hydroponic greenhouse vegetables worldwide and field-grown vegetables in Asia. However, it is new in U.S. organic vegetable production. Grafted plants often out-perform their non-grafted counterparts in our organic on-farm and on-station plots. Grafted plants (roots and tops) are larger, show less disease, and often dramatically out-yield non-grafted control plants. The superior performance of grafted plants may result from their ability to scavenge nutrients and/or resist disease. We plan to test numerous rootstock-scion combinations in multiple settings (open field, high tunnel; farm, station), identify which combinations work best and why and teach farmers and others how to make and use grafted plants. High tunnels are inexpensive, plastic-covered structures used in Europe, Asia and, increasingly, the U.S., to protect horticultural crops and widen production and marketing windows. High tunnels are much cheaper and simpler to manage than greenhouses but create a protective micro-climate around high value crops, benefitting farmers in numerous ways. Yet, our data and organic high tunnel users that we and others work with indicate that soilborne disease and/or nutrient deficiencies may buildup in high tunnels. Unchecked, soilborne disease and/or nutrient deficiencies may devastate organic farms, particularly those with high tunnels. However, grafting is an exciting potential remedy to various types of crop stress. We aim to facilitate the successful use of grafting in soil-based organic field and high tunnel vegetable production. Certain rootstock-scion combinations may out-perform their non-grafted counterparts in terms of plant vigor, disease resistance, and fruit yield and quality. Therefore, our specific objectives are: 1 - Develop tomato rootstocks that improve fruit yield and quality; 2 - Explain rootstock, scion, soil and production system effects on plant responses to biological and non-biological stress; and 3 - Increase knowledge about grafting and facilitate its successful use on organic farms. What we learn in this project can be applied to many horticultural crops and growing areas, so numerous growers will benefit.

APPROACH

For Objective 1 we will evaluate experimental and commercial rootstocks in a randomized design with un-grafted and self-grafted checks. Rootstocks will be grafted to two scions and the entire experiment replicated in MN, OH, and NC. High tunnel evaluation will be conducted on a single scion in the first year in Ohio. Second and third year trials will also test a more limited number of rootstocks over a larger number of locations through our network of grower cooperators. Ohio will provide seed for cooperators in MN, NC, WV and PA in years 2 and 3, and grafted plants to OH growers in years 2 and 3. Evaluation will include: yield and quality data (including sensory quality), plant vigor and disease resistance, tolerance to cold stress, hybrid vigor, and economic feasibility. For Objective 2 we will determine if scion performance is determined by improved nutrient transport or host defense signals that are passed from roots through the graft. We will establish greenhouse experiments in NC and OH using soils from six different organic farms. We will choose the two most and two least productive rootstock-scion combinations identified under Objective 1, with 20 plants per treatment. Measurements of soil quality, root disease severity, root biomass, nutrient uptake/sap nutrient levels, shoot biomass, fruit yield, and quality will be made using similar approaches as for Objective 1. We will collect data on pathogen infection levels of the roots and for plant defense responses. Symptoms of root disease are not always visible and we will therefore assess infection of roots using quantitative PCR. To assess induced defenses we will use a functional bioassay using Pseudomonas syringae as a challenge pathogen and real-time PCR to monitor the expression of specific host genes associated with induced plant defenses. To determine the relationships between soil and fruit quality we will measure the chemical characteristics of soils collected from plots in order to build a data set to test for correlations. Soil analysis will include particle size distribution, organic matter, complete elements, and standard tests (e.g. pH, exchangeable P, K, Ca, Mg). The resulting data will be combined with our quality data to test whether rootstocks improve nutrient uptake in organic production environments. For Objective 3 we will expand on-farm evaluations and demonstrations of grafted plants by including sites in OH, WV, MN, and NC and PN. Information regarding the selection of parents and crossing for rootstocks, seed saving and grafting methods will be formatted for dissemination via the web. We will present practical training workshops on grafting, participatory breeding, seed saving and sterilization, greenhouse sanitation and high tunnel use. We anticipate that training sessions will be held in conjunction with annual field days in OH and NC to take advantage of high tunnels, field plots, greenhouse facilities, and classrooms at both locations. Workshops will emphasize grower-oriented topics within participatory breeding (for rootstock development), high tunnel use, and methods for seed saving, grafting, seed sterilization and greenhouse sanitation.

PROGRESS

2007/08 TO 2012/01 OUTPUTS: Grafted vegetables are integral to production systems ranging from hydroponic greenhouses to subsistence agriculture. This diversity of use suggests a role for grafting in high value cropping systems such as organic production. Our specific objectives, using tomato production as a model, are to 1) test the feasibility of using rootstocks (RS) in soil-based organic vegetable production systems; 2) quantify the effects of grafting and RS on yield and quality; 3) test the hypothesis that genetic distance between parents would predict RS performance; and 4) provide growers with research based information relative to grafting. We tested commercial and experimental RS in OH, NC and MN under organic management in open-field and high tunnel conditions over three years. We also tested RS in organic high-tunnel production under two irrigation regimes. During the course of these studies, grafts to the scion \"Celebrity\", \"NC84173\", Ohio FG99-218 (a high lycopene line), and various \"heirloom\" varieties were evaluated. Grafted plants showed an increased yield (relative to un-grafted controls) of up to 25% under standard irrigation and 40% under deficit irrigation. However, only a few of over 36 RS proved to be statistically better than the un-grafted or self-grafted controls; several performed worse. When we consider the relationship between genetic distance (GD) of parents used to create hybrid RS, there is a positive correlation with respect to yield (greater GD is correlated with greater yield) but a negative correlation with quality traits such as sugar and titrateable acids. These results demonstrate a potential role for grafted plants to improve production in both open field and high tunnel systems. There is also evidence from our studies that grafting can directly lead to problems. Grafting of some genotypes, affects the percent success of grafts. Low percent success and brittle grafts, often referred to as \"incompatible\", appear to have a genetic basis that is independent of major resistance genes. Although use of cyanaocrylate adhesives during the grafting process can improve the percentage of success, such adhesives are unlikely to be compatible with organic certification. Graft transmission of bacterial and viral pathogens is possible, and propagators must take precautions to limit the spread of pathogens. Grafting also adds cost and may not always produce an economic benefit. Growers may therefore need to consider specific circumstances, such as the presence of soil-borne disease, before adopting grafted vegetables. Outreach goals of the project were met through workshops, webinars, videos, and web-based outreach. Project goals, activities and outcomes were also summarized during grower association conferences in NC, IL, MN, MI and OH where surveys were conducted. Our outreach efforts focus on outlining the pros and cons of grafted plant production and use and on teaching producers how to graft. The importance of sanitation during the grafting process to minimize the opportunity for diseases to spread was emphasized. PARTICIPANTS: Supplemental outreach and research are funded through the North Carolina Specialty Crops Program, S-SARE Research & Extension Grant (Peet & Louws), S-SARE Graduate Student Research Grant, the Ohio Agricultural Research and Development Center (OARDC), Research Enhancement Competitive Grants Program (Francis, Kleinhenz, Miller, and McSpadden Gardener) and competitive grower-funded Ohio Vegetable and Small Fruit Research and Development Program (Kleinhenz, Francis, Miller and McSpadden Gardener) . The North Carolina trial was conducted as an on-farm project with Hilltop Farms, a certified Organic Produce farm in Willow Springs, NC. TARGET AUDIENCES: Organic vegetable producers, vegetable growers, nurseries, and vegetable propagators. PROJECT MODIFICATIONS: On September 16, 2010, a tornado destroyed greenhouse and laboratory facilities on the Ohio State University, OARDC. Destruction of facilities and parental RS material has delayed the release of germplasm and RS varieties developed during this research.

2009/08/01 TO 2010/07/31 OUTPUTS: Grafted vegetables are integral to diverse production systems ranging from the highly technical hydroponic greenhouse environment to subsistence agriculture. This diversity of use suggests a role for grafting in high value cropping systems such as organic production. Our specific objectives, using tomato production as a model, are to 1) test the feasibility of using rootstocks (RS) in soil-based organic production systems; 2) quantify the effects of grafting and RS on yield and quality; 3) test the hypothesis that genetic distance between parents would predict RS performance; and 4) provide growers with research based information relative to grafting. For a third year we tested commercial and experimental RS in OH, NC and MN under organic management in open-field and high tunnel conditions. Grafts to the scion, Celebrity, were evaluated for yield and quality. Only a few RS proved to be statistically better than the un-grafted or self-grafted controls; several performed worse. No significant RS effects were detected (positive or negative) for fruit quality characteristics including sugar and vitamin C content. Despite differences between locations, several RS emerged as high performers across locations and years. Results from three years of trials suggest that grafting to RS will often, but not always, improve production. Several experimental RS and controls were also tested in on-farm trials. At some locations, plants grown on RS showed delayed maturity and resulting yields were numerically lower than ungrafted or self-grafted controls. Grafting of some genotypes, e.g. Hawaii 7998 (used as a source of resistance to bacterial wilt) and derived hybrids, affects the percent success of grafts. Low percent success and brittle grafts, often referred to as incompatible, appear to have a genetic basis that is independent of major resistance genes. Use of cyanaocrylate adhesives during the grafting process can improve the percentage of success. Such adhesives are unlikely to be compatible with organic certification. Use of RS in organic high-tunnel production under two irrigation regimes was tested using an heirloom variety, Cherokee Purple. Grafted plants showed an increased yield (relative to un-grafted controls) of 28% under standard irrigation and 41% under deficit irrigation. These results demonstrate a role for grafted plants to improve production in both open field and high tunnel systems. To meet outreach goals, a project web-page (http://www.oardc.ohio-state.edu/graftingtomato/) was improved and maintained. Project goals, activities and outcomes were also summarized during grower association conferences in NC, IL, MN, MI and OH; webinars with national reac; field days, tours and numerous informal stakeholder consultations. Our outreach efforts focus on outlining the pros and cons of grafted plant production and use and on teaching producers how to graft. The importance of sanitation during the grafting process to minimize the opportunity for diseases to spread is emphasized frequently. PARTICIPANTS: Francis, D. M..; Kleinhenz, M.; Miller, S. A.; McSpadden Gardner, B.; Markhart, A.; Louws, F. J.; Peet, M.; Estes, E.; Liedl, B.; Sanchez, E. Supplemental outreach and research are funded through the North Carolina Specialty Crops Program, S-SARE Research & Extension Grant (Peet & Louws), S-SARE Graduate Student Research Grant, the Ohio Agricultural Research and Development Center (OARDC) Research Enhancement Competitive Grants Program (Francis, Kleinhenz, Miller, and McSpadden Gardener) and competitive grower-funded Ohio Vegetable and Small Fruit Research and Development Program (Kleinhenz, Francis, Miller and McSpadden Gardener) . The North Carolina trial was conducted as an on-farm project with Hilltop Farms, a certified Organic Produce farm in Willow Springs, NC. TARGET AUDIENCES: Vegetable growers, Nurseries, and Organic vegetable producers. PROJECT MODIFICATIONS: On September 16, 2010, a tornado destroyed greenhouse and laboratory facilities on the Ohio State University, OARDC, campus. Destruction of facilities delayed data collection relative to fruit quality and subsequent data analysis. In addition, RS parent material was destroyed.

2008/08/01 TO 2009/07/31 OUTPUTS: Grafted vegetables have been used in production systems ranging from hydroponic greenhouses to subsistence agriculture. This diversity of use suggests a role for grafting in high value cropping systems such as organic tomato production. Our specific objectives were to 1) test the feasibility of using rootstocks (RS) in soil-based organic production systems; 2) quantify the effects of grafting and RS on yield and quality; 3) test the hypothesis that genetic distance between parents would predict RS performance; and 4) provide growers with research based information relative to grafting. For the second year we tested 25 commercial and experimental RS in OH, NC and MN under organic management in open-field conditions. Significant differences were observed between RS for seed germination and percent success of grafts. Use of cyanaocrylate adhesives during the grafting process improved the percentage of success. Such adhesives are unlikely to be compatible with organic certification. Tests for the fixed effect of RS were significant for total yield and marketable yield and in the analysis performed across two years. Only a few experimental RS proved to be statistically better than the un-grafted or self-grafted controls; several performed worse. Year-to-year correlations within a location were significant and positive (r2=0.14); location-to-location correlations within a year were also significant and positive (r2=0.21). No significant RS effects were detected (positive or negative) for fruit quality characteristics including sugar and vitamin C content. Despite differences between locations, several RS emerged as high performers across locations and years. Sufficient rainfall occurred to generate foliar disease pressure. The primary foliar disease in NC was Early Blight with Septoria leaf spot also present. Late blight occurred at the OH location toward the end of the season. Rootstock significantly impacted disease incidence values. Southern Stem Blight (SSB) occurred but disease pressure was relatively low and no significant differences were noted among treatments this year. However, all three non-grafted treatments and 2 of three self-grafted treatments had a high incidence of SSB. As noted in 2008, many of the RS selections had no SSB. These results suggest that RS can reduce scion disease. Use of RS in organic high-tunnel production under two irrigation regimes was tested using \"Cherokee Purple\". Grafted plants showed an increased yield (relative to un-grafted controls) of 28% under standard irrigation and 41% under deficit irrigation. These results demonstrate a role for grafted plants to improve production in both open field and high tunnel systems. To meet outreach goals, a project web-page (http://www.oardc.ohio-state.edu/graftingtomato/) was improved and maintained. PI\'s Francis and Miller are also participating in eOrganic. Our outreach efforts focus on teaching producers how to graft and stress the importance of sanitation during the grafting process to minimize the opportunity for diseases to spread. PARTICIPANTS: Investigator: Francis, D. M..; Kleinhenz, M.; Miller, S. A.; McSpaden-Gardner, B.; Markhart, A.; Louws, F. J.; Peet, M.; Estes, E.; Liedl, B.; Sanchez, E. Supplemental outreach and research are funded through the North Carolina Specialty Crops Program, S-SARE Research & Extension Grant (Peet & Louws), S-SARE Graduate Student Research Grant, and the Ohio Agricultural Research and Development Center (OARDC) Research Enhancement Competitive Grants Program (Francis, Kleinhenz, Miller, and McSpadden-Gardener). The North Carolina trial was conducted as an on-farm project with Hilltop Farms, a certified Organic Produce farm in Willow Springs, NC. TARGET AUDIENCES: Vegetable growers, Nurseries, and Organic producers. PROJECT MODIFICATIONS: Nothing significant to report during this reporting period.

2007/08/01 TO 2008/07/31 OUTPUTS: Grafted tomatoes have been used in production systems ranging from high input hydroponic greenhouses to subsistence agriculture. We tested 35 commercial and experimental RS in Ohio, North Carolina and Minnesota. The specific objectives this year were to 1) test the feasibility of using RS in soil-based organic production systems; 2) quantify the effects of grafting and RS on yield and quality; 3) test the hypothesis that genetic distance between parents would predict RS vigor and performance; and 4) provide growers with research based information relative to grafting. Significant differences were observed between RS for seed germination and percent success of grafts. In the field, location and replicate within location were highly significant for both total yield and marketable yield. The RS by location interaction was also significant for both total and marketable yield. Tests for the fixed effect of RS were significant P = 0.0307 for total yield but marginally non-significant for marketable yield (P = 0.0833). Significant rootstock by location interactions for total and marketable yields suggested rank shifts in the performance of varieties. Variance components were partitioned in order to estimate the importance of RS genotype relative to environment as a contributing factor to total yield and marketable yield. Heritability, was estimated from variance components on a RS-mean basis and was moderate. Despite significant genetic effects for total yield, only a few RS proved better than the un-grafted or self-grafted control and several performed worse. In NC where Southern Blight was present, there were clear advantageous to using RS and several experimental RS appear tolerant to the disease. The significant RS by location interaction makes it difficult to select a RS that performed the \"best\" across environements. Despite differences between locations, several RS emerged as high performers across locations. We sought to test the hypothesis that genetic distance between parents would predict performance of the hybrid RS relative to seed, seedling growth, rootstock growth, scion growth and scion yield. Genetic distance (GD) between parents of the experimental RS was estimated based on DNA-based genetic markers. Negative correlations were detected between GD and both seed size and germination. RS developed from crosses with high GD had slow initial growth, but surpassed mid-parent values, and had vigorous later growth. Improved RS growth translated into improved scion growth, and suggested positive heterotic effects. These effects did not translate into significantly improved yields. The results suggested several points where selection might be implemented in a RS breeding program. To meet outreach goals, a project web-page (http://www.oardc.ohio-state.edu/graftingtomato/) was developed. In addition we are exploring Web 2.0 (interactive web) approaches to facilitate to facilitate project communication and development of extension materials. To this end, a wiki was set up using \"WETPAINT\" as a private (pass-word protected)/educational (no advertisements). PI\'s Francis and Miller are also participating in eOrganic. PARTICIPANTS: Supplemental outreach and research are funded through the North Carolina Specialty Crops Program, S-SARE Research & Extension Grant (Peet & Louws), S-SARE Graduate Student Research Grant, and the Ohio Agricultural Research and Development Center (OARDC) Research Enhancement Competitive Grants Program (Francis, Kleinhenz, Miller, and McSpadden-Gardener). The North Carolina trial was conducted as an on-farm project with Hilltop Farms, a certified Organic Produce farm in Willow Springs, NC. TARGET AUDIENCES: Vegetable growers, Nurseries, and Organic producers. PROJECT MODIFICATIONS: Nothing significant to report during this reporting period.

2007/08/01 TO 2008/07/31 OUTPUTS: Grafted tomatoes have been used in production systems ranging from high input hydroponic greenhouses to subsistence agriculture. We tested 35 commercial and experimental RS in Ohio, North Carolina and Minnesota. The specific objectives this year were to 1) test the feasibility of using RS in soil-based organic production systems; 2) quantify the effects of grafting and RS on yield and quality; 3) test the hypothesis that genetic distance between parents would predict RS vigor and performance; and 4) provide growers with research based information relative to grafting. Significant differences were observed between RS for seed germination and percent success of grafts. In the field, location and replicate within location were highly significant for both total yield and marketable yield. The RS by location interaction was also significant for both total and marketable yield. Tests for the fixed effect of RS were significant P = 0.0307 for total yield but marginally non-significant for marketable yield (P = 0.0833). Significant rootstock by location interactions for total and marketable yields suggested rank shifts in the performance of varieties. Variance components were partitioned in order to estimate the importance of RS genotype relative to environment as a contributing factor to total yield and marketable yield. Heritability, was estimated from variance components on a RS-mean basis and was moderate. Despite significant genetic effects for total yield, only a few RS proved better than the un-grafted or self-grafted control and several performed worse. In NC where Southern Blight was present, there were clear advantageous to using RS and several experimental RS appear tolerant to the disease. The significant RS by location interaction makes it difficult to select a RS that performed the \"best\" across environements. Despite differences between locations, several RS emerged as high performers across locations. We sought to test the hypothesis that genetic distance between parents would predict performance of the hybrid RS relative to seed, seedling growth, rootstock growth, scion growth and scion yield. Genetic distance (GD) between parents of the experimental RS was estimated based on DNA-based genetic markers. Negative correlations were detected between GD and both seed size and germination. RS developed from crosses with high GD had slow initial growth, but surpassed mid-parent values, and had vigorous later growth. Improved RS growth translated into improved scion growth, and suggested positive heterotic effects. These effects did not translate into significantly improved yields. The results suggested several points where selection might be implemented in a RS breeding program. To meet outreach goals, a project web-page (http://www.oardc.ohio-state.edu/graftingtomato/) was developed. In addition we are exploring Web 2.0 (interactive web) approaches to facilitate to facilitate project communication and development of extension materials. To this end, a wiki was set up using \"WETPAINT\" as a private (pass-word protected)/educational (no advertisements). PI\'s Francis and Miller are also participating in eOrganic. PARTICIPANTS: Supplemental outreach and research are funded through the North Carolina Specialty Crops Program, S-SARE Research & Extension Grant (Peet & Louws), S-SARE Graduate Student

Research Grant, and the Ohio Agricultural Research and Development Center (OARDC) Research Enhancement Competitive Grants Program (Francis, Kleinhenz, Miller, and McSpadden-Gardener). The North Carolina trial was conducted as an on-farm project with Hilltop Farms, a certified Organic Produce farm in Willow Springs, NC. TARGET AUDIENCES: Vegetable growers, Nurseries, and Organic producers. PROJECT MODIFICATIONS: Nothing significant to report during this reporting period.

IMPACT

2007/08 TO 2012/01 Research based information on grafting methods and the performance of grafted plants was developed through this project. This information will help growers assess the value of grafting as both a production tool and potential source of revenue. Since the inception of this project several domestic propagators have initiated grafting, with both commercial growers and the home garden market targeted. To meet Extension goals, we have engaged in direct outreach through extension and trade publications, workshops, field days, presentations and consultations. Over 50 presentations and workshops were made, with more than half invited, which reached over 2,372 direct contacts. Videos content, webinars and web pages reached over 87,000 viewers. http://www.youtube.com/watchv=5Fd6tBQTTAg : 10,663 (verified 01/30/2012) http://www.youtube.com/watchv=tHnOYcI6B44 : 38,046 (verified 01/30/2012) http://www.youtube.com/watchv=gfZZeBEvlFU : 30,977 (verified 01/30/2012) http://www.youtube.com/watchv=AWWPtCqZ IA : 8,051 (verified 01/30/2012) **PUBLICATIONS (not previously reported):** 2007/08 TO 2012/01 1. Louws, F.J., C.L. Rivard, and C. Kubota. 2010. Grafting herbaceous vegetable plants to manage biotic pests. Scientia Horticulturae. 127: 127 through 146 2. Rivard, C.L., S. O Connell, M.M. Peet, and F.J. Louws. 2010. Grafting tomato with inter\--- specific rootstock to manage diseases caused by Sclerotium rolfsii and southern root knot nematode. Plant Disease. 94: (1015 through 1024) 3. Rivard, C.L. and F.J. Louws. 2008. Grafting to manage soilborne diseases in heirloom tomato production. Hortscience 43:2104 through 2111. 4. Rivard, C.L. R.M. Welker, S. 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and M. Anderson. 2009. Grafting: an innovative management tool for maintaining tomato production in continuously cropped high tunnels and greenhouses. Ohio Ecological Food and Farm Association Newsletter, Winter-Spring 2009. 2 pp. (Popular article) 21. Milkovich, M. and M. Kleinhenz. 2009. Vegetable grafting survey. Vegetable Growers News, e-VGN 11: November 2009. (Popular article) 22. Clement, B. 2009. Grafting tomatoes on disease resistant rootstocks for small-scale organic production. Tomato Magazine 13 (6): 10 through 11. (Popular article)

2009/08/01 TO 2010/07/31 Research based information on grafting methods and the performance of grafted plants was developed through this project. This information will help growers assess the value of grafting as both a production tool and potential source of revenue. To meet extension goals, we have engaged in direct outreach through extension and trade publications, workshops, field days, presentations and consultations. A project web-page (http://www.oardc.ohio-state.edu/graftingtomato/), webinars, and videos have amplified our outreach. Our world-wide web presence is tracked through WebLog Expert and receives an average of eight visitors per day. Videos demonstrating the grafting process associated with this project were viewed over 38,000 times:
http://www.youtube.com/watchv=5Fd6tBQTTAg : 1,769 (verified 01/22/2011)
http://www.youtube.com/watchv=tHnOYcI6B44 : 19,000 (verified 01/22/2011)
http://www.youtube.com/watchv=gfZZeBEvlFU : 15,791 (verified 01/22/2011)
http://www.youtube.com/watchv=AWWPtCqZ IA : 2,207 (verified 01/22/2011) Personnel affiliated with the project shared information relative to grafting techniques, grafting sanitation, and the performance of grafted tomatoes at over 30 events including in-person and webinar presentations, workshops, and field days. We directly reached over 540 industry (e.g., growers) and research-extension personnel through these events. Workshops are evaluated using pre-assessment and post-assessment tools, and these document a 74% increase in knowledge of vegetable grafting and a 46% increase in the confidence of participants in their ability to graft.

2008/08/01 TO 2009/07/31 Research based information on grafting methods and the performance of grafted was developed through this project, and this information will help growers assess the value of grafting. To meet outreach goals, a project web-page (http://www.oardc.ohio-state.edu/graftingtomato/) has been established. Our world-wide web presence is tracked through WebLog Expert. For the period January 1, 2008 through August 2009 we hosted 3,211 visitors from 2,060 unique IP addresses, with an average of eight visitors per day. Our English language video \"Grafting of tomato plants\" has been viewed over 2,400 times with an average monthly viewing of 400; the Spanish language video has been viewed over 2,000 times with an average monthly viewing of over 330. Direct contact with our target audience has been through grower/industry association meetings, conferences and conventions, field days and tours, and workshops. Personnel affiliated with the project shared information relative to grafting techniques, grafting sanitation, and the performance of grafted tomatoes at over 30 events including presentations, workshops, and field days. We reached over 540 growers, Extension agents, and University personnel through these events. Workshops are evaluated using pre-assessment and post-assessment tools, and these document a 74% increase in knowledge of vegetable grafting and a 46% increase in the confidence of participants in their ability to graft.

2007/08/01 TO 2008/07/31 We shared information relative to grafting techniques, grafting sanitation, and the performance of grafted tomatoes with over 900 growers, Extension agents, and University personnel through 29 Extension presentations and demonstrations. Research based information on grafting methods and the performance of grafted plants is being developed through this project, and will help growers assess the economic value of grafting. To meet outreach goals, a project web-page (http://www.oardc.ohio-state.edu/graftingtomato/) has been established.

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A Systems Approach to Optimize Organic Crop Production: Enhancing Soil Functionality and Plant Health to Suppress Plant Diseases and Pests

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Performing Institution	SCHOOL OF BIOLOGY & ECOLOGY, UNIVERSITY OF MAINE, ORONO, MAINE 04469

NON-TECHNICAL SUMMARY

Organic crop production needs to be safe, effective, profitable and durable (sustainable) to be embraced by growers. This research includes some of the most promising strategies for a successful organic program, and is designed to provide critical information needed to accelerate adoption of sustainable pest management strategies that are safe and profitable. The purpose of this project is to understand the ecological processes occurring as a result of the proposed practices and their interacting components (when used in combination) for the development of effective pest management strategies. These strategies will improve yields, conserve the environment, enhance the farmers\' knowledge of the agro-ecosystem, help them become stewards of the land on which they live, and provide safe and nutritious food to their fellow citizens.

OBJECTIVES

The objectives of the proposed work are: (1) to improve crop production through a combination of sustainable practices promoting soil regeneration, reduction of disease pressure, and enhancement of plant growth; (2) to better understand the individual and collective contributions and ecological processes occurring as a result of these sustainable practices; and (3) to evaluate the profitability of these systems.

APPROACH

The anticipated impacts attained by addressing the above goals are as follows: 1) Soil fertility and quality will be enhanced by the addition of organic matter as compost and cover crop residue, which will bring about an increase in soil biodiversity, improved water infiltration, improved water-holding capacity. 2) Suppression of soilborne and, perhaps, foliar diseases will be achieved through competition, antibiosis, parasitism/predation, and induced systemic resistance brought about by increased soil biodiversity, introduction of biocontrol organisms, and composts. 3) Rapeseed cover crop-mediated biofumigation is expected to nullify the need for Metam-sodium as it suppresses soil-borne diseases. In addition, biofumigation, increases yields (by contributing biomass as a green manure), enhances soil microbial biomass, increases the bacteria:fungal ratios by enhancing the levels of aerobic bacteria (including Pseudomonas sp.), and nitrogen-fixing bacteria. 4) Suppression of the Colorado potato beetle and other insect pests will be through increasing plant resistance to herbivory by optimizing nutrient balance in affected plants, and increased beneficial insect populations, thus diminishing the need for synthetic insecticides. 5) Enhanced crop yields will be brought about by improved soil fertility and quality, and suppression of soil-borne diseases and insect pests, thus reducing the need for synthetic fertilizers.

PROGRESS

2007/07 TO 2012/06 OUTPUTS: The overall goal was to improve crop production through integration of sustainable practices promoting soil regeneration, reduction of disease pressure, and enhancement of plant growth. Soil properties, soilborne disease levels, potato yields, and soil microbial communities were assessed on an organic farm and a conventional farm following various soil amendments. Specific management factors assessed included a conifer-based compost amendment, one of three different biocontrol organisms (Trichoderma virens, Bacillus subtilis, and Rhizoctonia solani isolate Rhs1A1), and a rapeseed green manure rotation crop preceding potato, and treatments were assessed in all factorial combinations. Compost amendment and rapeseed rotation had the greatest impacts on soil microbial communities, with both treatments increasing total populations of culturable bacteria at both sites over the course of the study, as well as causing shifts in soil microbial community characteristics as determined by sole carbon-source substrate utilization and fatty acid methyl ester (FAME) profiles. Compost amendment resulted in increased utilization of complex substrates and increased levels of Gram-positive bacteria and fungi, and compost effects were more pronounced at the conventional site. Rapeseed rotation often resulted in somewhat different effects at the two sites. Consistent overall effects were observed with the biocontrol amendments Rhs1A1 and T. virens, including increased microbial activity and bacterial populations. Combined effects of multiple treatments were greater than those of individual treatments and were generally additive. Each treatment had significant and specific effects on soil microbial communities, and combined treatment effects tended to be complementary, suggesting the potential for combining multiple compatible management practices and their associated changes in soil microbial communities. Rapeseed rotation had the greatest effects on disease suppression, reducing all observed soilborne diseases (stem canker, black scurf, common scab, and silver scurf) by 10 to 52% in at least one year at both sites. Compost amendment had variable effects on tuber diseases, but consistently increased yield (by 9 to 15%) in all years at the conventional site and in two of three years at the organic site. Biocontrol effects on disease varied, though Rhs1A1 decreased both incidence and severity of black scurf at the conventional site in two out of three years, and T. virens reduced multiple diseases at the organic site in at least one year. The above treatments alone, and in combination were effective at reducing disease and increasing yield under both conventional and organic production practices. A method involving removal of organic matter inhibitors from soil DNA samples and qPCR for the detection of R. solani AG-3 was developed to detect and quantify pathogen populations in cultivated potato soils, under commercial field conditions over the course of three years. The amount of R. solani ranged from 400 to 243,100 copies of the AG-3 ITS 1 and 2 rDNA gene per gram of soil, demonstrating a large variability in population density both spatially and temporally. PARTICIPANTS: Dr. Edward Bernard, supported by this project as a doctoral candidate, completed the experiments of this project in this past year and received his Ph. D. degree. TARGET AUDIENCES: Nothing significant to report during this reporting period. PROJECT MODIFICATIONS: Nothing significant to report during this reporting period.

2010/07/01 TO 2011/06/30 OUTPUTS: The field portion of this project was conducted from 2007-2009 to assess the impact of various soil amendments on potato disease suppression and soil microbial community characteristics. This portion of the project was designed to investigate the association between specific pathogen levels for Rhizoctonia solani in soil from the different treatments and black scurf (caused by R. solani). In order to achieve this goal, DNA was extracted from soil samples which had been collected in the summer and fall of each year of the field study. Quantitative polymerase chain reaction (qPCR) was then used to detect the amount of R. solani DNA in composite soil samples representing each treatment. Results of qPCR showed that R. solani was detected in almost all soil DNA samples from each season of each year. Levels of R. solani DNA were comparable among soils receiving different soil amendments. While there were many significant differences in the levels of R. solani DNA detected among treatments, these effects were often not observed in more than one year or more than one season. Correlation analysis revealed that there was no overall correlation between the levels of R. solani DNA detected in the summer and fall samplings (of the same treatment). However, there was an overall correlation between the levels of R. solani DNA in soils collected from the summer sampling and severity and incidence of black scurf on tubers, demonstrating that levels of R. solani DNA in the soil in the midst of the growing season are roughly indicative of the disease observed in the fall (at harvest). Of the treatments used in the study, compost amendment resulted in slight increases in the severity (less than 0.5% increase in average overall surface area coverage) of black scurf disease in two of the three years. PARTICIPANTS: Nothing significant to report during this reporting period. TARGET AUDIENCES: Nothing significant to report during this reporting period. PROJECT MODIFICATIONS: A final no-cost extension was awarded to allow us completion of the experiments related to the association between the amount of soil-borne pathogen population, as determined by qPCR, and disease incidence and severity.

2009/07/01 TO 2010/06/30 OUTPUTS: All of the experiments outlined in the grant proposal for the third year of the project were completed at the organic site Wood Prairie Farm (Bridgewater, Maine) and the various labs on the University of Maine campus. The data was presented at an organic grower trade show in Augusta, Maine, the more technical Northeast Potato Technology Forum, and at national meetings such as National Society of Agronomy, and Entomological Society of America. PARTICIPANTS: Stellos Tavantzis, Project Director, a plant pathology professor at UMaine, was administrator and overall coordinator of the d project. He conducted all communications regarding field operations, was involved in all field operations, and coordinated interactions with the Grower Advisory Committee, and data presentations within the group. Robert Larkin, co-PD, a senior scientist at New England Plant, Soil and Water Research Laboratory, and faculty associate in the Department of Plant, Soil and Environmental Sciences at UMaine, supervised most field operations including experimental design, planting, disease assessment, plant and soil sample collection and analysis. Andrei Alyokhin, co-PD, an applied entomology associate professor at UMaine, was in charge of sampling and analyzing insect populations and assessing insect damage on crops. Susan Erich, co-PI, a soil chemistry professor at UMaine, was in charge of all aspects of soil analyses related to fertility and physical properties. John Jemison, co-PI, an Extension Professor for the UMaine Cooperative Extension, is in charge of outreach efforts as they relate to dissemination of our data to conventional and organic growers using his Cooperative Extension network and experience. He attended data presentation meetings but was not involved in data dissemination since we only had one year of data. Eric Sideman, collaborator, Director of Technical Services/Crop Specialist of the Maine Organic Farmers and Gardeners Association (MOFGA) was the coordinator of the Grower Advisory Committee, and facilitated our presentations to organic growers at the 67th Augusta Trades Show. Edward Bernard, a Ph. D. candidate supported by the project, assisted in all field operations, conducted all soil microbiological analyses (fatty acids, BIOLOG, etc.), data analyses, and data presentation. Serena Gross, and Andrew Lannan M. S. graduate students, supported by the project, assisted in all field operations, was involved in insect sampling, assessing insect damage, soil analysis, data analysis, and other ad hoc tasks. Several undergraduate students were hired to help with field operations and laboratory work (soil and microbial analyses, and soil DNA extractions). TARGET AUDIENCES: As indicated above, presentations have been made at trade, professional and scientific meetings. PROJECT MODIFICATIONS: Soil DNA extractions and QPCR experiments were postponed due to lack of additional personnel but are currently being conducted by existing personnel.

2008/07/01 TO 2009/06/30 OUTPUTS: The experiments described (in the grant proposal) for the second year of the grant were completed at the organic Wood Prairie Farm (Bridgewater, Maine). The data was analyzed and reported at forums such as an organic grower trade show (in Augusta, Maine), a more technical professional meeting (Bangor, Maine), and national meetings (please see below). We have not been involved in field days or training events to date, although we plan to do so, when we reach our final conclusions upon completion of the project. PARTICIPANTS: Stellos Tavantzis, Project Director, a plant pathology professor at UMaine, was administrator and overall coordinator of the d project. He conducted all communications regarding field operations, was involved in all field operations, and coordinated interactions with the Grower Advisory Committee, and data presentations within the group. Robert Larkin, co-PD, a senior scientist at New England Plant, Soil and Water Research Laboratory, and faculty associate in the Department of Plant, Soil and Environmental Sciences at UMaine, supervised most field operations including experimental design, planting, disease assessment, plant and soil sample collection and analysis. Andrei Alyokhin, co-PD, an applied entomology associate professor at UMaine, was in charge of sampling and analyzing insect populations and assessing insect damage on crops. Susan Erich, co-PI, a soil chemistry professor at UMaine, was in charge of all aspects of soil analyses related to fertility and physical properties. John Jemison, co-PI, an Extension Professor for the UMaine Cooperative Extension, is in charge of outreach efforts as they relate to dissemination of our data to conventional and organic growers using his Cooperative Extension network and experience. He attended data presentation meetings but was not involved in data dissemination since we only had one year of data. Eric Sideman, collaborator, Director of Technical Services/Crop Specialist of the Maine Organic Farmers and Gardeners Association (MOFGA) was the coordinator of the Grower Advisory Committee, and facilitated our presentations to organic growers at the 67th Augusta Trades Show. Edward Bernard, a Ph. D. candidate supported by the project, assisted in all field operations, conducted all soil microbiological analyses (fatty acids, BIOLOG, etc.), data analyses, and data presentation. Serena Gross, and Andrew Lannan M. S. graduate students, supported by the project, assisted in all field operations, was involved in insect sampling, assessing insect damage, soil analysis, data analysis, and other ad hoc tasks. Kylie Palmer, Kristopher Cook, both undergraduate students, were hired to help with field operations and laboratory work (soil and microbial analyses). Peter Gerritsen, son of Wood Prairie Farm owner Jim Gerritsen, was employed part-time during the summer to help with field operations and sample collections. TARGET AUDIENCES: First- and second-year data was presented at trade, professional and scientific meetings (see presentations above). PROJECT MODIFICATIONS: As described in the grant proposal, the rapeseed cover crop was included in this second year of the project.

2007/07/01 TO 2008/06/30 OUTPUTS: All of the experiments described in the respective grant proposal for the first year of the grant were completed, the data analyzed and reported at forums such as organic grower trade shows, more technical technology meetings, and national meetings (please see below). More than ten reports were presented in these meetings. We have also given a presentation of our findings to national representatives of the Organic Seed Alliance. Since the data were based on single-year observations, we were not involved in field days or training evens. However, the owner of Wood Prairie Farm on which we are conducting our study, is an international leader in organic farming, our findings are disseminated in an unofficial manner to other organic farmers. PARTICIPANTS: Stellos Tavantzis, Project Director, a plant pathology professor at UMaine, was administrator and overall coordinator of the d project. He conducted all communications regarding field operations, was involved in all field operations, and coordinated interactions with the Grower Advisory Committee, and data presentations within the group. Robert Larkin, co-PD, a senior scientist at New England Plant, Soil and Water Research Laboratory, and faculty associate in the Department of Plant, Soil and Environmental Sciences at UMaine, supervised most field operations including experimental design, planting, disease assessment, plant and soil sample collection and analysis. Andrei Alyokhin, co-PD, an applied entomology associate professor at UMaine, was in charge of sampling and analyzing insect populations and assessing insect damage on crops. Susan Erich, co-PI, a soil chemistry professor at UMaine, was in charge of all aspects of soil analyses related to fertility and physical properties. John Jemison, co-PI, an Extension Professor for the UMaine Cooperative Extension, is in charge of outreach efforts as they relate to dissemination of our data to conventional and organic growers using his Cooperative Extension network and experience. He attended data presentation meetings but was not involved in data dissemination since we only had one year of data. Eric Sideman, collaborator, Director of Technical Services/Crop Specialist of the Maine Organic Farmers and Gardeners Association (MOFGA) was the coordinator of the Grower Advisory Committee, and facilitated our presentations to organic growers at the 67th Augusta Trades Show. Edward Bernard, a Ph. D. candidate supported by the project, assisted in all field operations, conducted all soil microbiological analyses (fatty acids, BIOLOG, etc.), data analyses, and data presentation. Serena Gross, a M. S. graduate student, supported by the project, assisted in all field operations, was involved in insect sampling, assessing insect damage, analyses of the resulting data and other ad hoc tasks such as soil analysis. Jennifer Brown and Benjamin Richard, both undergraduate students, were hired to help with field operations and laboratory work (soil and microbial analyses). Peter Gerritsen, son of Wood Prairie Farm owner Jim Gerritsen, was employed part-time during the summer to help with field operations and sample collections. TARGET AUDIENCES: First-year data was presented as preliminary results at trade, professional and scientific meetings (see resentations above). PROJECT MODIFICATIONS: Nothing significant to report during this reporting period.

IMPACT

2007/07 TO 2012/06 As a result of this project, agricultural scientists and growers (in Maine and elsewhere) have access to improved knowledge on important parameters related to holistic, sustainable approaches to crop production, especially in regards to appreciation of the complexity of the agro-ecosystem as well as the expected range and degree of benefits resulting from particular soil amendments or combinations thereof. More organic growers are expected to use biocontrol and mutualistic microorganisms to improve plant disease management, enhance crop yields, and increase soil fertility, and this will lead to an improved abundance of healthier, locally grown, food for consumers, and higher incomes, through higher product value, for Maine growers. Finally, implementation of the strategies described in this project is expected to result in a reduced rate of environmental pollution through a decreased use of synthetic agrichemicals. The data of this project have been reported at several forums such as organic grower trade shows, regional technology meetings, and national scientific meetings. We have also given a presentation of our findings to national representatives of the Organic Seed

Alliance. Finally, the owner (Mr. Jim Gerritsen) of Wood Prairie Farm on which we conducted part of our study, is an international leader in organic farming, so our findings are disseminated to other organic farmers in many parts of the country and the world. **PUBLICATIONS (not previously reported):** 2007/07 TO 2012/06 1. Edward Bernard, Robert P. Larkin, Stellos Tavantzis, M. Susan Erich, Andrei Alyokhin, and Serena D. Gross. 2012. Evaluation of Several Different Management Practices on Soil-borne Diseases and Tuber Yield in Organic and Conventional Potato Production Systems. Applied Soil Ecology (In Review). 2. Edward Bernard, Stellos Tavantzis, Kristopher Cooper, Andrei Alyohkin. 2012. Monitoring Rhizoctonia solani AG-3 Levels in Response to Disease-Suppressive Management Practices. Plant Disease (In Review). 3. Bernard, E., Larkin, R. P., Tavantzis, S. M., Erich, M. S., Alyokhin, A., Sewell, G., Lannan, A., and S. D. Gross. 2012. Compost, rapeseed rotation, and biocontrol agents significantly impact soil microbial communities in organic and conventional potato production systems. Applied Soil Ecology 52:29-41. 4. Edward Bernard, Robert P. Larkin, A. Alyokhin, M.S. Erich and Stellos Tavantzis. 2012. From Soil to Symptoms: Investigating the Link Between Pathogen Population and Disease. Northeast Potato Technology Forum, 2012 Proceedings (p. 9).

2010/07/01 TO 2011/06/30 This is an ongoing three-year field study with a vast database, which is currently analyzed, with more data, related to soil-borne pathogen population assessment (by qPCR) as it relates to disease incidence and severity, still being generated. Resources (provided through this grant) have enabled us to conduct one of the most thorough field/laboratory studies reported to date. A refereed article is currently in press in a major soil ecology journal. When all aspects of this complex project are carefully considered, final conclusions and recommendations to the agricultural and ecological communities will be made.

2009/07/01 TO 2010/06/30 This is an ongoing three-year field study with a vast database, which is currently analyzed, with more data, related to soil-borne pathogen population assessment (by QPCR) as it relates to disease severity and yields, still being generated. Resources (provided through this grant) have enabled us to conduct one of the most thorough field/laboratory studies reported to date. When all aspects of this complex project are carefully considered, final conclusions and recommendations to the agricultural and ecological communities will be made.

2008/07/01 TO 2009/06/30 We have had two significantly different (weather-wise) growing seasons in the first two years of the study. A third season (currently ongoing) would be necessary for us to start making relatively reliable observations and conclusions.

2007/07/01 TO 2008/06/30 This was the first year of the study, and all findings are considered preliminary, and unsuitable for suggesting changes in knowledge or action.

PUBLICATIONS

2010/07/01 TO 2011/06/30 Edward Bernard, Robert P. Larkin, Stellos Tavantzis, M. Susan Erich, Andrei Alyokhin, Gary Sewell, Andrew Lannan, and Serena D. Gross. 2011. Compost, Rapeseed Rotation, and Biocontrol Agents Significantly Impact Soil Microbial Communities in Organic and Conventional Potato Production Systems. Applied Soil Ecology. In press.

2009/07/01 TO 2010/06/30 1. Serena D. Gross, Andrei Alyokhin, Robert Larkin, M. Susan Erich, Edward Bernard and Stellos M. Tavantzis. 2010. Response of Insect Herbivores to Disease-Suppressive Soil Amendments in Potato. Agriculture, Ecosystems, and Environment (submitted). 2. M. Susan Erich, Stellos Tavantzis, Robert Larkin, Andrei Alyokhin, Andrew Lannan, Serena D. Gross, and Edward Bernard. 2010. Effects of Organic Disease Suppression Strategies on Soil Properties in Organic and Conventionally Managed Potatoes. Agriculture, Ecosystems, and Environment (submitted).

2008/07/01 TO 2009/06/30 1. Tavantzis, S., Larkin, R.P., Erich, S., Bernard, E., Gross, S., and Alyokhin, A. 2009. A Systems Approach for Enhancing Soil Quality and Plant Health under Organic and Conventional Conditions (Abstract). Northeast Potato Technology Forum. Bangor, Maine. 2. Larkin, R.P., Tavantzis, S., Erich, S., Bernard, E., Gross, S., and Alyokhin, A. 2009. A Systems Approach for Enhancing Soil Quality and Plant Health under Organic and Conventional Conditions: Effects on Soilborne Diseases and Tuber Yield (Abstract). Northeast Potato Technology Forum. Bangor, Maine. 3. Gross, S., A. Alyokhin, R. Larkin, S. Erich and S. Tavantzis. 2009.

Reduced pest insect densities following compost application in organic and conventional systems (Abstract). Northeast Potato Technology Forum. Bangor, Maine. 4. Bernard, E., Larkin, R.P., Erich, S., Alyokhin, A., Gross, S., Tavantzis, S. 2009. A Systems Approach for Enhancing Soil Quality and Plant Health under Organic and Conventional Conditions: Effects on Soil Microbial Communities (Abstract). Northeast Potato Technology Forum. Bangor, Maine.

2007/07/01 TO 2008/06/30 1. Bernard, E., Larkin, R.P., Tavantzis, S., Erich, S., Alyokhin, A., Gross, S. 2008. Compost and Biological Amendments in Potato Systems: Effects on Soil Microbial Communities. Northeast Potato Technology Forum, Fredericton, New Brunswick, Canada (Abstract). 2. Tavantzis, S., Larkin, R.P., Alyokhin, A., Erich, S., Bernard, E., Gross, S. 2008. Compost and Biological Amendments in Potato Systems: Effects on Soilborne Diseases and Yield. Northeast Potato Technology Forum, Fredericton, New Brunswick, Canada (Abstract). 3. Erich, S., Tavantzis, S., Larkin, R.P., Alyokhin, A., Gross, S. 2008. Compost effects on soil properties and fertility. 67th Annual Maine Agricultural Trades Show, Augusta, ME. 4. Larkin, R.P., Alyokhin, A., Erich, S., Bernard, E., Gross, S.Tavantzis, S. 2008. Compost and biological amendment effects on soilborne diseases and yield in potato. . 67th Annual Maine Agricultural Trades Show, Augusta, ME. 5. Erich, M. Susan, S. Tavantzis, R. Larkin, S. Gross and A. Alyokhin. 2008. Effect of Compost Amendment on Soil Properties in Low and High Organic Matter Soils. Joint Annual Meeting of GSA, SSSA, ASA, CSSA, GCAGS, HGS in Houston, TX. Joint Annual Meeting Program, p. 349. 6. Larkin, R.P., Tavantzis, S., Bernard, E., Alyokhin, A., Erich, S., Gross, S. 2008. Compost and Biological Amendment Effects on Soilborne Disease and Soil Microbial Communities. Annual Meeting of the American Phytopathological Society. Phytopathology 98:586 (Abstract). 7. Larkin, R. P., A. Alyokhin, M. S. Erich, E. Bernard, S. Gross, and S. Tavantzis. 2008. A Systems Approach for Enhancing Soil Functionality and Plant Health to Suppress Plant Diseases and Pests. IOP Project Directors Meeting and SARE Conference, Kansas City. 8. Erich, S., Tavantzis, S., Larkin, R.P., Alyokhin, A., Gross, S. 2008. Compost and Biological Amendments in Potato Systems: Effects on Soil Properties and Fertility. Northeast Potato Technology Forum, Fredericton, New Brunswick, Canada (Abstract). 9. Gross, S., A. Alyokhin, R. Larkin, S. Erich and S. Tavantzis. 2008. Reduced pest insect densities following compost application in organic and conventional systems. Northeast Potato Technology Forum, Fredericton, New Brunswick, Canada (Abstract). 10. Alyokhin, A., Gross, S., R. Larkin, S. Erich and S. Tavantzis. 2008. Compost effects on insect pests of potato. 67th Annual Maine Agricultural Trades Show, Augusta, ME.

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Crop Diversification Complexity and Pest and Beneficial Organism Communities in Humid Tropical and Sub-tropical Climatic Regimes

Accession No.	0210705
Subfile	CRIS
Project No.	FLA-HOS-004655
Agency	NIFA FLA
Project Type	OTHER GRANTS
Project Status	TERMINATED
Contract / Grant No.	2007-51106-03803
Proposal No.	2007-03671
Start Date	15 JUN 2007
Term Date	14 JUN 2010
Fiscal Year	2009
Grant Amount	$414,591
Grant Year	2007
Investigator(s)	Chase, C. A.; Swisher, M. E.; McSorley, R.; Liburd, O. E.; Datnoff, L. E.; Treadwell, D. D.; Unruh Snyder, L.; Weiss, S. A.; Arancibia, R. A.; Robles, C.
Performing Institution	HORTICULTURAL SCIENCE, UNIVERSITY OF FLORIDA, BOX 100494, JHMHC

NON-TECHNICAL SUMMARY

Because tropical and subtropical climates do not have the benefit of a true winter weeds, pests, and pathogens can occur throughout the year and many persist year round. Therefore, alternative ways of breaking pest cycles and preventing species from achieving pest status are critically needed. The purpose of this study is to compare the impact of simple, intermediate, and complex systems that utilize crop rotation, off-season cover crops, in-season living mulches, and intercropping with the longterm goal of reducing pest pressure in organic vegetable cropping systems for regions with humid tropical and subtropical climates.

OBJECTIVES

The objectives of the project are to: (1) evaluate the impact of selected crop rotations, cover crops, and intercrop systems on growth and yield of organically produced vegetables; (2) evaluate the effects of the selected systems on the population dynamics of insect pests, beneficial insects, weeds, plant pathogenic nematodes, and to conduct simulation modeling of the dynamics of selected populations to explore how the experimental treatments may be affecting demographic parameters of the populations; (3) assess soil and crop nutrient status in order to minimize the occurrence of crop macronutrient deficiencies and to correlate pest density and diversity with changes in crop and soil nutrient status; (4) disseminate the research findings to local service providers, especially extension personnel, who work with organic farmers and farmers interested in transition to organic production, and to organic and transitional farmers; and (5) enhance the ability of our graduates to manage organic farms and serve as advisors for organic and transitional producers.

APPROACH

The effects of crop diversification complexity on pest populations and community dynamics will be evaluated in organic vegetable cropping systems under humid sub-tropical conditions in north central Florida and humid tropical conditions on St. Croix in the Virgin Islands. Mild or no winter results in the year round persistence of many pests, so alternative ways of breaking pest cycles and preventing species from achieving pest status are critically needed. Summer cover crops in monoculture or mixtures will be grown in sequence with several vegetable crops in monoculture or intercropped in a biannual rotation system. The impact of increasing plant biodiversity on growth and yield of organically produced vegetables, on the population dynamics of key insect pests and beneficial insects, weeds, plant pathogenic nematodes, and soil borne plant pathogens will be assessed. Multiple cultural management strategies will be used to address pest and pest-related problems using an integrated or systems approach and correlations between crop nutritional status and pest incidence will be evaluated. A strong training component for professionals who are service providers for organic and transitional farmers is included. The project will also be used to enhance the ability of our graduates to manage organic farms and serve as advisors for organic and transitional producers.

PROGRESS

2007/06 TO 2010/06 OUTPUTS: A workshop was held on October 7, 2008 at the University of Florida to disseminate results from our research to extension service providers. It was attended by 30 participants. Participants were divided into smaller groups to interact with individual researchers using a roundtable format that allowed participants to ask questions of the researchers and to discuss the results that were presented. This format was again used on October 8 and 9, 2009, at a 2-day train-the-trainer workshop held at the University of the Virgin Islands Agricultural Experiment Station and included a tour of the Virgin Islands Sustainable Farm Institute. The workshop was attended by 25 agriculture sector service professionals, agricultural extension personnel, and local farmer group representatives. The purpose was to educate and provide an opportunity for interactive dialogue on production issues facing tropical sustainable agricultural production in the U.S. Virgin Islands and to specifically focus on the utility of cover crops and rotations for pest incidence and soil management in organic crop production systems. Trainees included agricultural professionals from St. Croix, St. Thomas, St. John, and Puerto Rico representing the Virgin Islands Department of Agriculture, the University of the Virgin Islands Cooperative Extension Service and Agricultural Experiment Station, USDA Resource Conservation and Development Program, VI Farmer\'s Cooperative, St. Thomas Farmer\'s Cooperative, University of Puerto Rico-Mayaguez, and several prominent farmers from both St. Croix and St. Thomas. Two organic farms and members of the Virgin Islands Farmer\'s Cooperative have adopted production practices resulting from this grant. These practices include; incorporation of cover crops to improve soil quality, implementation of organic pest management strategies, and the utilization of vegetable cultivars that were tested during the research trial. Three PhD students and 1 MS student have been trained or funded by this project. Of these 1 PhD student and the MS student have completed their degrees. The 2 other doctoral students have completed their research and should complete their degrees in 2011. Three undergraduate students were trained in research and extension and presented a poster about their experience at the American Society for Horticultural Science Conference in Orlando in July 2008. One refereed journal article has been published and several more are in review or in preparation. Results have also been disseminated at state, regional, and national conferences. PARTICIPANTS: Dr. Xin Zhao supervised the selection and training of the undergraduate students and coordinated with Dr. Unruh Snyder who is no longer with the University of Florida. Workshops were designed by Marilyn Swisher of the University of Florida. Juan Carlos Rodriguez of the Florida Organic Growers and Consumers, Inc served as a facilitator at the workshops in Florida and the Virgin Islands. TARGET AUDIENCES: Target audiences were agriculture professionals and key growers from Florida, St. Thomas, St. Croix, St. John, and Puerto Rico. PROJECT MODIFICATIONS: Nothing significant to report during this reporting period.

2007/06/15 TO 2008/06/14 OUTPUTS: The second year of research in Florida and St. Croix was initiated in summer and fall 2007, respectively. Final field data collection is scheduled for summer 2008. The experiments were designed to compare different summer cover crop-fall vegetable-spring vegetable cropping systems for their effects on pest and beneficial organisms and to assess the effects of the cropping systems on soil nutrient status. Data analysis for the St. Croix location is on-going. Results are reported for the north central Florida location. Graminaceous cover crops of sorghum sudangrass and pearl millet and leguminous cover crops of sunn hemp and velvet bean were grown in summer as monocultures or as grass-legume mixtures of pearl millet-sunn hemp and sorghum sudangrass-velvetbean. Insects: The effect of the cover crops on the populations of aphids and whiteflies and natural enemies in organic summer squash was evaluated. Weeds: The effect of the summer cover crop monocultures and mixtures on weed infestation during the cover cropping period and in subsequent fall and spring cash crops was assessed. Results are reported for the first year of the study. Nematodes: One full season of nematode sampling has been completed in two vegetable production systems (cover crop-squash-pepper and cover crop-broccoli-sweet corn). Effects of summer cover crops on nematode population levels have been evaluated following cover crop, winter vegetable, and spring vegetable crops. Results were similar in each of the two vegetable production systems. Root-knot and stubby-root nematodes were unaffected by the cover crops. Lesion and ring nematodes built up on cropping systems with sorghum-sudangrass (SS), whether SS was planted alone or mixed with velvetbean. In most cases, increased levels of lesion and ring nematodes as a result of treatments with SS persisted through the fall and spring vegetable crops. Soil nitrogen: The cropping systems also were compared to determine their effects on soil nitrogen. Yields: The effect of the cropping systems on marketable vegetable yields was also compared. Results for year 1 are reported. Internships: Three interns were trained in research and extension techniques in spring 2008. PARTICIPANTS: One Masters student and one PhD student are funded by this project. In addition, three undergraduate students were provided with paid internships in which they were trained to conduct a field experiment with cover crops and a workshop was arranged to provide them with training in developing extension materials. Dr. Xin Zhao (Horticultural Sciences Department, University of Florida) has joined the project team and is assisting with the training of the undergraduate interns. TARGET AUDIENCES: The St. Croix experiment is located at the Virgin Islands Sustainable Farm Institute. The research area is used as a teaching tool for resident interns as well as visiting tour groups. Plans are in progress for the formal outreach part of the project - training of service providers and organic growers. PROJECT MODIFICATIONS: Nothing significant to report during this reporting period.

IMPACT

2007/06 TO 2010/06 Crop rotation, cover crops, living mulches, and intercropping used together to create more complex cropping systems were evaluated in Florida and the Virgin Islands over a two-year period. Velvet bean did not germinate well at both locations and succumbed to disease in Florida. In subsequent studies a a root-knot nematode resistant cowpea cultivar will be utilized instead. Although the cover crops suppressed weeds during the summer fallow; this suppression did not persist during the subsequent cash crops. This is probably because the weed seed bank was unchanged over the two-year study period. It is anticipated than when systems are examined over longer durations, complex systems will contribute to weed seed bank depletion and weed recruitment during the cash crops will decline. In the short term, retention of the cover crop residue as mulch on the soil surface or the utilization of other organic mulches or synthetic mulch can assist with weed management during the cash crops. Squash treated with cover crops sorghum sudangrass and pearl millet harbored significantly more parasitoids, and had significantly lower aphid populations compared with the control. Squash in sorghum sudangrass treatments had significantly more whitefly coccinellids, and had significantly fewer whitefly eggs, immatures and adults compared with the control. Summer cover crops of sorghum sudangrass or pearl millet increased root-knot nematode (Meloidogyne incognita) population levels in some instances while sunn hemp suppressed it in the broccoli-sweet corn experiment. The multiplication rate of root-knot nematodes was lowest when broccoli was planted in the cropping system. Systems with sorghum-sudangrass (alone or in mixture) increased population densities of ring (Mesocriconema spp.) and lesion Pratylenchus spp.) nematodes, and occasionally increased stubby-root nematodes (Paratrichodorus spp.). Cover crops that increased nematode numbers when planted alone usually gave the same result when planted in mixtures with another cover crop. Other cropping systems failed to suppress plant-parasitic nematodes but maintained low densities similar to weedy fallow. In St. Croix, it was determined that neither system complexity nor cover crop treatment had a beneficial effect upon maintaining high pre-experimental levels of soil nutrients (N, P, K) soil organic matter over the course of this experiment under intensive conventional soil tillage regimes in a three crop per year rotation for two consecutive years. However, it was determined that under tropical organic crop production standards, yields of tomato, totsoi, and cucumber could either equal or exceed yields of conventionally grown comparable vegetables for the State of Florida. Both spiral and reniform nematode levels decreased over time across all cover crop treatments to low or nonexistent levels. Results were disseminated during a to a diverse group of agricultural professionals from the Virgin Islands and Puerto Rico. The trainees have since returned to their respective locations to further disseminate knowledge and insights gathered as a result of this research initiative to their respective farmer constituents. **PUBLICATIONS (not previously reported):** 2007/06 TO 2010/06 1. Bhan, M. 2010. Cropping System Complexity for Suppressing Pests in Organic Vegetable Production. University of Florida PhD Dissertation. 2. Bhan, M. and C. A. Chase. 2009. Weed community changes with cover crops and crop rotation in organic vegetable production. WSSA Abstracts, #476, 1 page. 3. Bhan, M. and C. A. Chase. 2009. First year assessment of weed seedbanks in organic vegetable production systems in north central Florida. Proc. Florida Weed Science Society, pp. 7-8. 4. Bhan, M.,R. McSorley, and C. A. Chase. 2010. Effect of cropping system complexity on plant-parasitic nematodes associated with organically grown vegetables in Florida. Nematropica 40:53-70. 5. McNeill, C.A., O. E. Liburd and C. A. Chase. 2011. Effect of Cover Crops on Aphids, Whiteflies and their Associated Natural Enemies in Organic Squash. Journal of Sustainable Agriculture (In review). 6. Scott, C.A. 2008. Leguminous and Graminaceous Cover Crops for the Control of Insect Pests in Organic Squash. University of Florida MS Thesis. 7. Weiss, S.A., D.D. Treadwell, C.A. Chase and R. Ben Avraham. 2009. Sustainable Management of Soil Nitrogen and Organic Matter in Low-External-Input Organic Crop Production in the Caribbean. http://a-c-s.confex.com/crops/2009am/webprogram/Paper54491.html. (abstract) 8. Weiss, S.A., D.D. Treadwell, C.A. Chase, and R. Ben Avraham. 2009. Effect of cover crop biomass and green manure systems on vegetable yield in low-external-input (LEI) organic crop production in the Caribbean. Caribbean Food Crops Society 45th annual meeting, Basseterre, St. Kitts, July 2009. (Poster)

2007/06/15 TO 2008/06/14 Insects: The grass monocultures, particularly sorghum sudangrass, have the best potential for suppressing aphid and whitefly populations in organic summer squash. Sorghum sudangrass-velvet bean also demonstrated potential to reduce pest numbers by enhancing parasitoids and predator populations. Weeds: During the summer fallow period, grass cover crops suppressed weed density and biomass more effectively than the legume cover crops. The pearl millet monoculture and biculture gave the best weed suppression. Weed densities were assessed within the planting rows in squash at 4 weeks after planting (WAP), broccoli at 3 WAP, sweet corn and bell pepper at 2 WAP. In squash, grass weed densities were the same or higher with cover crops than with the weedy control. Only the bicultures had lower densities of broadleaf weeds than the weedy control. In broccoli, grass and broadleaf weed densities were equal to or greater than in the weedy control. In spring-grown sweet corn and bell pepper neither the grass, broadleaf, nor sedge weed densities with cover crop treatments were significantly lower than those with the weedy control. Nematodes: While lesion and ring nematodes are not expected to be damaging to vegetable crops at the population levels observed, the crop rotation principles demonstrated are important for organic growers. The results indicate that the summer cover crops chosen can affect nematode numbers through the next two successive vegetable crops. Thus a good (or poor) cover crop choice can influence nematode populations in the site for the entire year. Soil Nitrogen: Dry weights for sorghum sudangrass and pearl millet monocultures ranged between 4067 to 5403 kg/ha and were similar to sorghum sudangrass-velvet bean and pearl millet-sunn hemp bicultures. Both years monoculture velvet bean biomass was low (715 and 118 kg/ha for 2006 and 2007 respectively) due to poor stand establishment. Cover crop (CC) total nitrogen (N) in monoculture sunn hemp was higher compared to remaining CC treatments both years (95 and 93 kg/ha in 2006 and 2007, respectively) but those differences were not consistently observed in soil nitrate content. Immediately prior to CC incorporation, soil nitrate to a 20-cm depth ranged from 3.9-4.0 mg/kg in 2006 and 4.3-5.5 mg/kg in 2007, with no differences among treatments. Soil nitrate following fall vegetable crop harvest was similar among all treatments in 2006, but variable in fall 2007 likely due to rotation effects. Overall, CC have the potential to offset vegetable crop N requirements, but actual CC N contribution was limited by subtropical conditions and inherent soil properties. Yields: Only the pearl millet monoculture produced higher squash and sweet corn marketable yields than the weedy control. There was no difference among cover crop treatments in marketable yield of broccoli and bell pepper. Internships: Students gained practical research and extension training experiences that will help to prepare them for careers or graduate school. Students prepared an abstract and a poster summarizing their experiences for the American Society for Horticultural Sciences meeting.

PUBLICATIONS

2007/06/15 TO 2008/06/14 1. Bhan, M., C.A. Chase, R. McSorley, O.E. Liburd, D.D. Treadwell, and W.P. Cropper, Jr. 2008. Cropping system biodiversity for managing weeds in organic vegetable production. Proceedings Southern Weed Science Society 61:130. 2. Bhan, M., C.A. Chase, and R. McSorley. 2008. Effect of cropping system complexity on plant-parasitic nematodes associated with organically-grown vegetables in Florida. HortScience 43(4):1186. 3. Canger, V., K. Goodell, M. Riehm, X. Zhao, C. Chase, and L. Snyder. 2008. Undergraduate opportunities in organic and sustainable horticultural research, education, and extension. HortScience 43(4):1216. 4. Scott, C.A. and O.E. Liburd. 2007. Tracking insect populations within organic vegetable systems to determine how residual populations from cover crops affect vegetable production. Entomological Society of America. (Abstract)http://esa.confex.com/esa/2007/techprogram/paper 31991.htm. 5. Treadwell, D., M. Alligood, C. Chase, and M. Bhan. 2008. Soil nitrogen responses to increasing crop diversity and rotation in organic vegetable production systems. HortScience 43(4):1107.

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Integrated Organic Production of Summer Vegetable Crops Under Small Farm Environment in Southeastern U.s.

Accession No.	0210701
Subfile	CRIS
Project No.	ALAX-011-107
Agency	NIFA ALAX
Project Type	OTHER GRANTS
Project Status	TERMINATED
Contract / Grant No.	2007-51106-18226
Proposal No.	2007-01412
Start Date	15 JUL 2007
Term Date	14 JUL 2009
Fiscal Year	2008
Grant Amount	$152,010
Grant Year	2007
Investigator(s)	Mankolo, R. N.; Nyochembeng, L. M.; Mentreddy, S. R.; Ward, R. C.; Bukenya, J. O.
Performing Institution	Natural Resources & Environmental Sciences, ALABAMA A&M UNIVERSITY, 4900 MERIDIAN STREET

NON-TECHNICAL SUMMARY

This project will examine the effects of cover crops on organic vegetable production, soil health, and in the mitigation of common pests and diseases of tomato, southern peas and sweet corn. Furthermore, the biological economic (cost-benefit) outcome of the system in relation to crop yield, pest management and soil quality will be determined.

OBJECTIVES

The objectives are to 1)evaluate cover crop species (summer and winter) and their effects on soil health particularly microbial species population, weeds and diseases in organic tomato, southern peas, and sweet corn production, and 2)determine the economic (cost-benefit) outcomes of the system in relation to crop yields, pest management, and soil quality.

APPROACH

Establish cover crops in summer and winter at the Winfred Thomas Agricultural Research Station (WTARS) in North Alabama and their impact on summer vegetable crop (tomato, southern peas, and sweet corn). Both economic benefit and biological effect of cover crops in terms of reduction in weed infestation, disease and insect control, changes in soil chemical, microbial activity, and crop yield will be assessed. This integrated organic vegetable production system will be developed through testing, implementation and adopting of cultural, biological and other environmentally compatible farm practices.

PROGRESS

2007/07 TO 2009/07 OUTPUTS: NON-TECHNICAL SUMMARY: The practice of organic farming has been gaining popularity among vegetable producers, especially near urban markets where there has been a growing demand for organically grown fresh produce and processed food products, and because of their premium price in the market. The one year project was to initiate research to develop best management practices and economic budgets for mitigating insect pests, diseases and weeds and for improving soil health and vegetable crop productivity in the southeastern U.S. OBJECTIVES: This project was initiated in August 2007 as a multi-disciplinary team research effort from Alabama A&M University. The funding enabled our research team to establish four cover crop plots including a fallow control at the Winfred Thomas Agricultural Research Station (WTARS), and to evaluate the effect of the cover crops on soil health, pest and diseases on vegetable through two main objectives: (1) to evaluate cover crops species on soil quality particularly on microbial population, weeds and diseases on organic vegetable production (2) and, to evaluate the economic (cost-benefit) outcomes of this system. APPROACH: The site for the study was an acre lot within a five-acre block set aside for fifteen years for organic production. In summer 2007, the field was planted with a mixture of Iron clay peas and sudan-sorghum hybrid seeds. In preparation for cover crops planting, Iron clay peas and sudan-sorghum hybrid mixture was mowed and laid on the soil surface. In fall 2007, four cover crops (crimson clover (CC), rye, hairy vetch (HV), and Austrian winter peas (AWP) and were planted and arranged in a randomized complete block with three replications. In May 2008 cover crops were harvested and incorporated into soil as green manure. The plots were planted with tomato and pepper seedling, and cowpea seeds into the mulch under a no-till system. All plants were fertilized with pelletized poultry litter (PL), and with Multibloom and Pinnacle through drip irrigation. Weed control in the plots was done using cotton gin trash, and occasionally by manual weeding. Insect pests and tomato hornworm were controlled with Neem oil and Bacillus thuringiensis sprays. To evaluate cover crops species and their effects on soil quality particularly microbial population, soils were sampled in March 2008 and 2009, approximately 2 weeks after the cover crops were incorporated, and before PL application. Each year a composite sample was taken from each treatment at two depths. Soils were analyzed for C and N by dry combustion using an Elementar CNS analyzer. The enzymatic activity was assayed on duplicate less than 2mm filed-moist samples at their optimal at their optimal pH values. Disease assessment was done at 9 weeks after planting and at harvest using a scale of 0 to5 where 0 is no disease and 5 is 81 to 100 percent symptomatic foliage or fruit or dead plant. Cover crop and weed biomass were taken prior to cover crop mowing, and fruit yield at harvest. All data were subjected to the analysis of variance using GLM procedure of SAS and treatment means were separated using Tukey\'s test at 5 percent probability. 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.

2007/07/15 TO 2008/07/14 This report covers the first four months of year 1 of our Integrated Organic Program research project funded in August 2007. This initial funding (bridge grant) enabled our research team to establish four cover crops including a fallow control at the Winfred Thomas Agricultural Research Station (WTARS) in North Alabama, and to evaluate their effect on soil health, pest and diseases in southern peas and tomato. The field site for the study is a one acre lot within a five-acre block set aside for organic certification. Historically, this field has not been cultivated for the last fifteen years and has not been sprayed with any pesticides. In summer 2007, the field was tilled and planted with a mixture of Iron clay peas and a sudan x sorghum hybrid seeds. In preparation for planting the selected cover crops, iron clay peas and sudan x sorghum hybrid mixture was mowed and the residue left on the soil surface. In fall 2007, the field was planted with four cover crop species (crimson clover, rye, hairy vetch, Austrian winter peas) and a fallow control plot. All treatments were arranged in randomized complete block design with three replications. Soil samples were collected from0-5, 5-10, and 10-20cm depths, before cover crop planting and three weeks after cover crop establishment to be analyzed for pH, C, N, P, micronutrients, and microbial population. The results from pH analyses showed no statistical differences between cover species. The pH values varied from 6.19 to 6.73 at 0-5cm depth, 5.60 to 6.60 at 5-10cm depth and t5.32 to 5.51 at 10-20 cm depth. These results were expected since this is a baseline data and the cover crops have been in the field for only three weeks. Currently, an analysis of C, N, P, micronutrients, and microbial population is being performed. Further analysis will include: the impact of this cultural practice on pests and diseases in southern peas and tomato, and economic outcome of the system in relation to crop yield, pest management, and soil quality in 2008.

IMPACT

2007/07 TO 2009/07 IIMPACT: The parameters analyzed responded as expected for this type of treatment system. The yield of tomato, cowpea and pepper obtained under this system were above the average yields of conventional production in the state of Alabama. The higher tomato yields were found in rye and HV as compared to fallow plots from the first year trial. Inconsistent yield data was obtained in year 2 due to very high rain fall and persistent cloudiness that resulted in crop failure over fifty percent of the trial. However, CC outperformed both HV and fallow treatments on pepper production. Pepper yield on rye was better than on AWP plots. Cowpea yielded high under fallow and AWP. Disease and weed. Incidence of bacterial leaf and early blight were observed in tomato, although there was no significant difference between cover crop treatments. Fruit rot was significantly lower in HV and AWP plots compared to the fallow plots. There was a significant difference in weed biomass between the cover crop and the fallow plot, whereas no difference was observed between cover crops biomass. The high weed suppression observed under cover crops seems to be resulting from the cover crops mulch. The most destructive pests observed on tomato were armyworms, and hornworms. Late season tomatoes were heavily damaged by leaf-footed bug resulting in fruit scarring. Soil quality. Initial soil analyses show that soil chemical properties did not vary consistently among cover crops. While no significant difference was observed for selected soil nutrients under cover crops, total P and acid phosphatase were significantly affected by cover crops the first year. The highest P availability was found under CC, which was statistically higher than HV, AWP, rye, and fallow. The concentration of SOC and N were significantly impacted by the cover crop and the no-till system. The enzyme activities are often used as indices of microbial activities that provide a useful tool to monitor long-term soil quality potentials. The enzyme activities were used in this study to evaluate the microbial activity. For the preliminary study only two enzyme assays (acid phosphatase and glucosidase) were used based on their importance in nutrient cycling and organic matter decomposition. The results from this study show no significant differences among the studied enzymes except for acid phosphatase which was significantly different the first year of the study at 0-5 cm depth. However, HV and the AWP cover crops showed higher enzyme activities in year 2 and in both depths. Higher enzymes activities were found in the surface horizon than in subsurface horizon which can be attributed to low microbial activities with depth, related to decrease in OM. A field day was held at the WTARS (August 2009), involving a wide array of small organic, conventional, transitioning farmers and vegetable gardeners. The results obtained from this project could help to develop practical strategies for soil and pest management in organic farming and to identify the cover crop most adapted to the Southeastern U.S region. There is an ongoing research with different mulches for weed control with cover crop treatment as the base line. **PUBLICATIONS (not previously reported):** 2007/07 TO 2009/07 1. PUBLICATIONS AND PRESENTATIONS TO DATE 1PUBLICATIONS AND PRESENTATIONS TO DATE 1. Nyochembeng,L.M., R.N. Mankolo, S.R. Mentreddy and G. Mayalagu. 2009. Effect of fall cover crops on tomato and pepper diseases and fruit yield under organic production in North Alabama. Phytopathology 99:S95. 2. 2. Nyochembeng,L.M., R.N. Mankolo, S.R. Mentreddy and G. Mayalagu. 2009. Effect of fall cover crops on tomato and pepper diseases and fruit yield under organic production in North Alabama. Annual Conference of the American Phytopathological Aug. 2-5, 2009. Society, Portland, OR. 3. Mankolo R.N, L.M. Nyochembeng, S.R. Mentreddy, R. Ward and G. Mayalagu. 2009. Cover crop effect on nutrient availability and vegetable production under organic and conventional production systems. ASA-CSSA-SSSA Annual Meetings, Nov. 2-7, 2009, Pittsburgh, PA, (Agronomy Abstr)

2007/07/15 TO 2008/07/14 One PhD student is breing trained on how organic practices affect soil microbial community dynamics and distribution of trace elements in soil. The overall immpact of the cover crop will be determined at the completion of field experiments in the 2008 growing season.

PUBLICATIONS

2007/07/15 TO 2008/07/14 No publications reported this period

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