

ORG Project Details

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Integrating No-tillage with Farmscaping and Crop Rotations to Improve Pest Management and Soil Quality in Organic Vegetable Production

Accession No.	0196910
Subfile	CRIS\
Project No.	VA-428109
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Project Type	OTHER GRANTS
Project Status	TERMINATED
Contract / Grant No.	2003-51106-02083
Proposal No.	2003-04625
Start Date	01 SEP 2003
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Grant Amount	\$346,420
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Investigator(s)	Morse, R. D.; Warren, H. L.; Schonbeck, M.; Diaz, J. C.; Ruberson, J.; Phatak, S.
Performing Institution	HORTICULTURE, VIRGINIA POLYTECHNIC INSTITUTE, BLACKSBURG, VIRGINIA 24061

NON-TECHNICAL SUMMARY

Conventional tillage and cultivation practices used by most organic growers reduce soil quality and productivity. Likewise, high incidence of pests, especially weeds, limit crop yield and increase production costs. This project examines the potential of using diverse crop rotations and no-tillage systems to achieve cost-effective management of weeds and other pests and improved soil quality and productivity in organic farms.

OBJECTIVES

Research - The overall objective is to identify and develop critical elements of no-tillage systems, integrated with farmscaping and crop rotations, for production of organic vegetables that will (1) improve soil quality; (2) suppress weed growth below yield-limiting levels with minimum hand and/or mechanical cultivation; (3) reduce incidence and severity of phytopathogens and harmful insects below yield-limiting levels with minimum application of organic pesticides; and (4) maintain or increase crop yield. Specific research objectives are to assess short-term (annual) and multi-year effects of no-tillage systems on: (1) incidence (species) and severity (quantity) of weeds, phytopathogens and harmful insects; (2) soil quality indicators (mainly active soil organic matter); (3) yield and quality of cover crops and vegetable crops; and (4) production costs (economic analysis). Outreach/education - Outreach/educational programs are a major thrust of our proposal. Different combinations of agricultural outreach professionals and farmer-cooperators will be utilized to (1) identify and refine project objectives over time, (b) disseminate research findings to grower stakeholders throughout Virginia, Georgia and neighboring states using multiple outreach methods, and (c) educate and involve state and local agricultural professionals to ensure that the knowledge, impacts and expertise derived from this project will be utilized to enhance the environment and improve profitability for the organic growers.

APPROACH

At two research sites and five on-farm demonstration sites in Virginia and Georgia, we will compare high-residue no-till (NT) production systems against the conventional tillage system, in which crop residues are incorporated into the soil as green manure. For centuries, vegetable growers have applied organic mulch to improve pest management, build soil quality and increase marketable yield. High-residue cover crop mulch associated with NT systems has all the advantages of applied mulch, plus it is more economical and more effective in increasing soil quality. The central hypothesis of this project is that integrating high-residue NT systems with farmscaping and crop rotation best management practices (BMPs) will enhance soil quality and improve management of pests (weeds, insects and diseases) more effectively and economically than conventional tillage. The approach is holistic, combining the expertise of the Project Directors (PDs) and collaborators in NT/residue-management, pest management, soil quality, and economic analysis. We will use rotations of both cover crops and vegetable crops to improve plant and microbial diversity. All field plots will be farmscaped with beneficial-organism-habitat plantings as an IPM strategy for insect management. Appropriate organic fertilizers and pesticides will be applied as needed to improve plant stand and crop vigor in the NT system. Production costs will be determined for each tillage system and subjected to economic analysis. Outreach programs involving Cooperative Extension Service specialists and other agricultural professional and two established organic grower organizations will be functioning throughout this project and beyond to (1) disseminate the research findings and promote organic farming, (2) identify and implement refinements in the BMPs and experimental procedures, and (3) demonstrate site-specific applications of the high-residue NT systems.

PROGRESS

2003/09 TO 2007/08 This project completed research and outreach activities that were designed to identify and refine conservation agriculture (CA) and farmscaping (FC) techniques for production of organic vegetables in Virginia (VA) and Georgia (GA). Research: Over a 4-year period, three vegetables (summer squash/04; bell pepper/05; and broccoli/06 & 07) were organically grown at research farms in Blacksburg, VA, and Tifton, GA using integrated CA/FC techniques. Each year, 1) three different high-biomass annual cover crop monocultures or bicultures were evaluated; 2) flail mowers effectively killed the cover crops, leaving a uniform, evenly distributed organic mulch; 3) before establishing the vegetable crop, plots were subdivided by tillage-cover crop mulch was either incorporated (CT) or left as a surface mulch (NT); 4) squash seeds were planted by hand and bell pepper and broccoli transplants were set with a NT transplanter, with minimal disturbance of surface mulch; 5) following vegetable harvest, all plots were flail mowed, shallow tilled and seeded again with cover crops, thus maintaining permanent soil coverage; 6) a section of each replication was established and maintained with a mixture of flowering forages and herbs (farmscape planting). Outreach: Various outreach activities were completed during this project. 1) Five on-farm demonstration trials were conducted in which the six above-outlined CA/FC techniques were repeated on a reduced scale. 2) A total of six field days were held at the research farms and outreach sites, involving a wide array of certified and transitioning organic farmers and CES and NRCS field professionals. 3) To compliment this CSREES project, we received a 2-year USDA/SARE/PDP (Professional Development Program) grant (Title: Sustainable Organic No-Till Systems: A training Program for CES and NRCS Field Professionals-4/06 through 3/08) that enabled us to train 40 agricultural professionals and numerous organic/sustainable growers. 4) A total of 16 Information Sheets (2-10 pages) were published on various aspects of CA/FC techniques. These info sheets were used as handouts at field days and grower meeting and were combined with various other relevant publications into a manual for the PDP participants. 5) A 50-page SAN manuscript is being prepared for publication in 2008.

2005/10/01 TO 2006/09/30 In 2006, organic broccoli was grown in Georgia (transplanted on 8 March) and Virginia (transplanted on 16 August) to assess the effects of summer cover crops and tillage (conventional, CT, and no-till, NT) on head yield and pest management. Marketable broccoli yield in Georgia was unaffected by cover crop and tillage, averaging 4.8 t/ha across all treatments. In Virginia, yield was unaffected by cover crop, averaging 6.0 t/ha; however, CT outyielded NT by 16%. Abnormally low temperatures (-5 C) occurred on the 26 and 27 October, resulting in mortality of approximately 60-80 percent of the leaf area. Based on 2004-2005 fall broccoli crops, this killing frost reduced yield potential by 50 percent. Since broccoli head maturity is typically delayed in NT plots, the yield difference observed in 2006 is attributed to the untimely early frost which occurred 10 days before broccoli harvest. In both Georgia and Virginia, insect pest problems were kept in check by positioning farmscape plantings adjacent to all plots. Diseases were minimal in all plots and weeds were removed as needed by hand or cultivation. Outreach: Severe weed populations in all spring-planted on-farm trials reduced broccoli yield in all treatment plots. Yield-limiting weed pressure was attributed to 1) low levels of frost-killed

biomass, resulting in a uniform heavy growth of spring and early summer weeds; and 2) the absence of adequate cultivation. Conclusions: Spring-planted broccoli is not recommended for organic NT systems in Virginia or Georgia because 1) the majority of frost-killed cover crop residues is lost before transplanting, resulting in severe weed problems; and 2) uneven, slow plant growth occurs from relatively cold soil temperatures under NT mulch. In contrast, late summer-planted broccoli thrives in organic NT systems when planted early enough to avoid debilitating cold temperatures. Summer cover crops planted in late May-June produce high-biomass thick mulch that suppresses weed growth and conserves soil moisture. Cool growing temperatures in early fall (late October-November) are optimum for broccoli head development, resulting in high-quality large heads.

2004/10/01 TO 2005/09/30 In 2005, sweet pepper was grown organically in Virginia and Georgia to evaluate the effects of cover crops, tillage (conventional - CT, and no-till - NT), and farmscaping on crop yields, pest management and soil quality. Virginia: High marketable pepper quality and yield were obtained, averaging 31.4 t/ha; yield was not affected by tillage or cover crop treatments. High organic pepper yield was obtained because growth-limiting factors were minimized by achieving (1) ample fertility derived from low C:N high-biomass (6-7 t/ha) cover crops, plus sidedressing with organic fertilizer; (2) insect management using farmscape plantings and application of Bt sprays; (3) low incidence of diseased fruit (10-15 percent) using a combination of vigorous plants grown on raised beds, trellising to keep fruit elevated off the ground, and reduced incidence of European corn borer; and (4) weed suppression using timely cultivation and hand weeding in both CT and NT plots. Georgia: Marketable pepper yield was low (9.8 t/ha in CT and 2.9 t/ha in NT). Low yield is attributed primarily to high incidence of fruit rot, resulting from (1) heavy rainfall, (2) high weed pressure (especially in NT), and (3) untrellised plants allowing fruit to be in contact with the soil. Outreach: Mixed results occurred in on-farm trials in both states. Extreme weather extremes and high weed pressure resulted in crop failure in both CT and NT plots at three out of five on-farm sites. However, vegetable yield was the same or higher in NT than in CT lots at both on-farm sites in which good weed management was achieved. Conclusions: good-excellent marketable organic vegetable crops were achieved when (1) cover crops were properly grown and managed, (2) timely farmscape plantings and other recommended pest-management and other BMPs were followed, and (3) weeds were properly managed and nutrients were not limiting.

2003/10/01 TO 2004/09/30 In 2004, summer squash was grown in Virginia and Georgia to evaluate the effects of cover crops, tillage and farmscaping on organic crop yield, pest management and soil quality. Virginia-Squash yields were excellent, averaging 34 t/ha; yields were not affected by cover crop or tillage treatments. High organic squash yields were achieved because growth-limiting factors were minimized by integrating farmscaping with low C:N, high-residue (9-10 t/ha), grass-legume cover crops in no-till (NT) systems. Weeds were held in check by the mulch in NT plots and cultivating once in conventional tillage (CT). The NT/farmscaped systems held insect populations at low levels and diseases were not a problem. Georgia-Marketable squash yield was low in all treatments, resulting from severe insect damage in all plots and weed pressure, especially in CT. Outreach-Mixed results occurred in on-farm trials in both states. Good organic NT squash yields were achieved when weeds were controlled; while poor yields occurred when weeds were not managed properly. Conclusion-Good-excellent marketable organic squash yields were achieved when (1) cover crops were properly established and produced high biomass levels (6-10t/ha), (2) timely and appropriate farmscape plantings were established adjacent to the squash fields, and (3) nutrients, especially nitrogen, were not limiting.

2002/10/01 TO 2003/09/30 Cover crops were established on replicated plots in organic transition fields in Virginia (Kentland Agriculture Research Farm, Blacksburg) and Georgia (Coastal Plain Experiment Station, Tifton). Summer squash will be grown during the summer of 2004 as part of a 3-year organic no-till crop rotation study.

IMPACT

2003/09 TO 2007/08 Research: In general, research outcomes (results) were consistent over the 4-year duration of this project. 1) Establishment and early vegetative growth of vegetable crops were greater in conventional tillage (CT) than no-tillage (NT) plots. However, at final harvest, plant size and marketable yield were generally statistically similar, except yield of bell pepper/05 in GA and broccoli/06 in VA was less in NT than CT. 2) Marketable vegetable yield was not affected by cover crop species. 3) Weed biomass tended to be lowest in NT plots, probably resulting from weed suppression by the cover crop surface mulch; However, in VA, manual cultivation before full canopy development controlled weeds relatively well in CT plots. 4) Marketable crop yield was highest in VA for all vegetables grown. Low marketable yield in GA was highly correlated with severe

incidence of insects (squash/04) and weeds (bell pepper/05 and broccoli/06 & 07). High marketable yield in VA was attributed to low incidence of weeds and pests (insects and diseases), which probably resulted from intensive-biodiverse farmscape plantings; year-round weed management; and precision post-plant application of nitrogen fertilizers. Outreach: In contrast to research finding, inconsistent results occurred in on-farm demonstration plots in both VA and GA. Weather extremes and high incidence of weeds resulted in crop failures in over fifty percent of the on-farm trials. Of great significance, however, good-excellent marketable yields were achieved in on-farm sites when 1) cover crops were properly established (good, even stands) and managed; 2) timely biodiverse farmscape plantings and other recommended pest-management BMPs were used; and 3) nutrients (especially nitrogen) and water were appropriately applied and weeds were properly managed. Impacts: Based on annual increase in interest and participation of organic growers and agricultural professionals, integration of conservation agriculture (CA) and farmscaping (FC) is an ideal, but challenging system for production of organic cash crops such as vegetables. This approach is ideal because, when achieved, it can simultaneously 1) produce highly profitable crop yields (P), using substantial quantities of on-farm (renewable) resources (e.g., compost, manure and legume-based cover crops) to provide organic nutrients and biologically-based pest management; and 2) sustain or even improve soil quality (crop production capacity, PC). This excellent P/PC- balanced system is only achievable when emphasis is properly given to site-specific holistic management practices identified in this and related projects. Over time, as organic growers obtain sufficient experience and affordable equipment is made available, we fully expect that many certified organic and transitioning growers will adopt CA/FC cover cropping systems because of current emphasis on (and associated benefits of) conservation farming, building soil quality, and environmentally sound production practices.

****PUBLICATIONS (not previously reported):**** 2003/09 TO 2007/08 1. Benson, B.G. 2006. Integration of high biomass/no-till farmscaping systems in organic production systems (M.S. Thesis). Department of Horticulture, Virginia Tech, Blacksburg. 2. Diaz-Perez, J.C., S.C. Phatak, J. Ruberson, and R.D. Morse. 2006. Organic tomato transplant production in compost-amended substrate. Fourth International Symp.\-- Seed, Transplant and Stand Establishment of Horticultural Crops. International Soc. Hort. Sci. (ISHS), San Antonio, TX, 3-6 December. 3. Diaz-Perez, J.C., S.C. Phatak, J. Ruberson, D. Giddings, and R. D. Morse. 2005. Effects of cover crop and tillage on organically-grown summer squash production. HortScience 40(4) Abstract. 4. Diaz-Perez, J.C., S.C. Phatak, J. Ruberson, J. Silvoy, and R.D. Morse. 2006. Effect of winter cover crops and no-till on the yield of organically-grown bell peppers (*Capsicum annum L.*). International Hort. Congress, Seoul, Korea, 13-19 August, Abstract. 5. Diaz-Perez, J.C., J. Silvoy, S.C. Phatak, J. Ruberson, and R. D. Morse. 2007. Effect of winter cover crops and no-till on the yield of organically-grown bell pepper (*Capsicum annum L.*). Acta Horticulturae (in press). 6. Schellenberg, D.L. 2007. Nitrogen management and weed suppression in organic transition (M.S. Thesis). Department of Horticulture, Virginia Tech, Blacksburg.

2005/10/01 TO 2006/09/30 Based on increased interest and attendance at grower meetings and field days, there is a growing consensus among organic farmers that high-biomass, cover-cropping systems hold great potential to simultaneously achieve high crop yields and improve long-term productivity and sustainability. Over time, as organic growers obtain sufficient knowledge and equipment, we fully expect that they will adopt NT cover-cropping systems because of current emphasis on soil conservation, building soil quality, and environmentally sound production practices.

2004/10/01 TO 2005/09/30 Based on grower interest and attendance at four successful field days held in 2005, organic farmers believe that high-biomass/cover-cropping NT systems hold great potential to improve their productivity and sustainability. Over time, as organic growers obtain sufficient knowledge and equipment, we fully expect that they will adopt NT systems because of current emphasis on soil conservation, building soil quality, and environmentally sound production practices.

2003/10/01 TO 2004/09/30 Based on grower interest and attendance at our 2004 field days, organic farmers believe organic no-till systems have great potential to improve their productivity and sustainability. We expect vegetable growers will adopt organic no-till systems because of current emphasis on soil conservation, soil quality and environmentally sound production practices. We expect the research and outreach components of our project will positively impact production practices of Virginia and Georgia growers and in time influence growers in neighboring states and the nation. Ultimately, we anticipate that organic no-till systems will be widely adopted because of increased profits, resulting from reduced production costs (less pesticide, labor, nutrient and irrigation costs) and equivalent or higher marketable yields, compared to conventional tillage.

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research and outreach components of our project will positively impact production practices of Virginia and Georgia growers and in time influence growers in neighboring states and the nation. Ultimately, we anticipate that organic no-till systems will be widely adopted because of increased profits, resulting from reduced production costs (less pesticide, labor, nutrient and irrigation costs) and equivalent or higher marketable yields, compared to conventional tillage.

PUBLICATIONS

2005/10/01 TO 2006/09/30 1. Morse, R.D. and N.G. Creamer. 2006. Developing no-tillage systems without chemicals: the best of both worlds? p. 83-91. In P. Kristiansen, A. Taji, and J. Reganold (eds.). Organic Agriculture: A Global Perspective. CSIRO Publishing, Collinwood, Australia. 2. Diaz-Perez, J.C., S.C. Phatak, J.R. Ruberson, J. Silvoy, and R.D. Morse. 2006. Mulches increase yield in no-till organic broccoli (*Brassica oleracea* var. *italica*). Abstract-annual meetings of the Interamerican Society for Tropical Horticulture (ISTH). 3. Ruberson, J.R., J.C. Diaz-Perez, S.C. Phatak, and R.D. Morse. 2006. Tillage and cover crops in organic vegetables: impact on pests and their biological control in broccoli. Abstract-annual meetings of the Entomological Society of America (ESA).

2004/10/01 TO 2005/09/30 No publications reported this period

2003/10/01 TO 2004/09/30 No publications reported this period

2002/10/01 TO 2003/09/30 No publications reported this period

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Organic Weed Management: Balancing Pest Management and Soil Quality in a Transitional System

Accession No.	0197337
Subfile	CRIS\
Project No.	PEN03987
Agency	NIFA PEN
Project Type	OTHER GRANTS
Project Status	TERMINATED
Contract / Grant No.	2003-51106-02085
Proposal No.	2003-04619
Start Date	15 SEP 2003
Term Date	14 SEP 2008
Fiscal Year	2008
Grant Amount	\$498,335
Grant Year	2003
Investigator(s)	Barbercheck, M. E.; Mortensen, D. A.; Karsten, H.; Sanchez, E. S.; Duiker, S. W.; Hyde, J. A.; Kiernan, N. E.
Performing Institution	ENTOMOLOGY, PENNSYLVANIA STATE UNIVERSITY, 208 MUELLER LABORATORY

NON-TECHNICAL SUMMARY

Weed management in reduced pesticide and organic cropping systems is a priority for a large number of growers nationally and is consistently listed near the top of organic and reduced-input growers' pest management concerns. This project examines reduction of the weed seedbank as a key component in successful transition to organic production. The effects of various weed suppression tactics will be measured on other pests, soil quality indicators, and economic indicators.

OBJECTIVES

The overarching goal is to identify weed management approaches that balance the goals of pest management, soil fertility, crop productivity and soil quality. The project will be approached through specific research, education and outreach, and strategic objectives. The research objectives are to: 1) compare weed management approaches based on weed seedbank depletion through stimulation and suppression of weed seed germination and 2) compare the effects of these management practices on soil quality indicators, pest and beneficial organisms, crop productivity and economic indicators.

APPROACH

Experimental management system treatments for transition to organic production will emphasize depletion of the seedbank through tillage-enhanced germination, suppression of weed seed germination through reduction of soil disturbance and use of cover crops. Main plot treatments will be factorial and represent different degrees of soil disturbance (full or minimum tillage) and residue level (cover crop or no cover crop). If needed vinegar will be used as an organic herbicide to prevent weed seed production. Measured characteristics will be weed seed

density and weed populations, foliar and soil arthropods, insect pathogens, soil physical and fertility characteristics, and economic analyses.

PROGRESS

2003/09 TO 2008/09 OUTPUTS: Populations of arthropods, weeds, soil quality characteristics, and economic performance in organically-managed corn in minimum and conventional tillage systems were measured. We examined the interaction between soil disturbance and initial cover crop type and management on epigeal arthropods during the three-year transition to organic production in a feed grain rotation in central Pennsylvania. Four systems comprised of a factorial combination of two levels of primary tillage (conventional vs. reduced) and two types of initial cover crop (perennial sod/legume vs. annual cereal grain/legume). Over a three-year transition period, the cropping sequence consisted of an initial cover crop, followed by soybean, and finally, maize. Arthropod community composition was primarily defined by initial cover crop in the first year in sequence, by the interaction between cover crop and tillage intensity in the second year in sequence, and by tillage intensity in the final year. The orders associated with these patterns included Araneae, Opiliones, Collembola, Homoptera, Hemiptera, Coleoptera, and Diptera. All systems were effective at suppressing annual weeds. Systems involving more soil disturbance brought about the most rapid decline in the weed infestation. Reduced tillage resulted in more seeds at or near the soil surface and an increase in the prevalence of winter annual and perennial weeds. Perennial weeds (esp. Canada thistle, *Cirsium arvense*) increased in the minimum tillage plots. In the third year in transition, common lambsquarters, foxtail and velvetleaf sown at low, medium or high densities in the first year of the experiment were positively associated with minimum tillage and most of the measured soil quality characteristics (moisture holding characteristics, aggregate stability, labile soil carbon, and populations of microarthropods) were favored in systems that minimized tillage. By the third year, effects of initial cover crop and initial weed seed density on final weed population densities are lost. Corn yield was positively associated with full tillage. Over the 3-year transition period, detection of the entomopathogenic fungus *M. anisopliae* declined. There was a non-significant trend for detection of *M. anisopliae* to be greater in full-till (moldboard plow) systems compared with minimum till (chisel plow) systems. Partial budget analyses showed that reduced tillage systems led to lower profitability than conventionally-tilled systems. PARTICIPANTS: Primary Investigators: Mary E. Barbercheck, David A. Mortensen, Sjoerd W. Duiker, Heather Karsten, Jeffrey A. Hyde, and Nancy E. Kiernan. Andrew Hulting (Oregon State University). Graduate Student: Randa Jabbour. Technicians: Christina Mullen, David Sandy, and Scott Smiles. Wage Labor: Vaughn Hauk, Alyssa Gendron, Melissa Terhorst, Aaron Tamminga, Joe Kennis, and Lori Clayton. TARGET AUDIENCES: Farmers, Extension Educators, Agricultural Professionals, Scientists, Undergraduate and Graduate Students PROJECT MODIFICATIONS: Nothing significant to report during this reporting period.

2007/01/01 TO 2007/12/31 OUTPUTS: Populations of weeds, soil quality characteristics, and economic performance in organically-managed corn in minimum and conventional tillage systems were measured. All systems were effective at suppressing annual weeds. Systems involving more soil disturbance brought about the most rapid decline in the weed infestation. Reduced tillage resulted in more seeds at or near the soil surface and an increase in the prevalence of winter annual and perennial weeds. Perennial weeds (esp. Canada thistle, *Cirsium arvense*) increased in the minimum tillage plots. Canada thistle initially had patchy population distributions at the site, and became dominant in the minimum tillage plots as the crop sequence progressed from cover crops, to soybean and finally, maize. Abundance of weed seed predators (e.g., ground (carabid) beetles) was significantly higher in corn grown in this study than in adjacent conventionally grown corn. In the third year in transition, common lambsquarters, foxtail and velvetleaf sown at low, medium or high densities in the first year of the experiment were positively associated with minimum tillage and most of the measured soil quality characteristics (moisture holding characteristics, aggregate stability, labile soil carbon, and populations of microarthropods) were favored in systems that minimized tillage. By the third year, effects of initial cover crop and initial weed seed density on final weed population densities are lost. Corn yield was positively associated with full tillage. We detected three genera of entomopathogenic fungi in the experimental plots: *Metarhizium anisopliae*, *Beauveria bassiana*, and 2 species of *Isaria*. Over the 3-year transition period, detection of *M. anisopliae* declined. There was a non-significant trend for detection of *M. anisopliae* to be greater in full-till (moldboard plow) systems compared with minimum till (chisel plow) systems. We hypothesize that greater spread and mixing of the soil in full till treatments resulted in greater detection of *M. anisopliae* compared with minimum till treatments. Other biological and physical differences in soil conditions in the two tillage treatments may have also resulted in differential survival of the fungus or its hosts. Partial budget analyses showed that reduced tillage systems led to lower profitability than conventionally-tilled systems. PARTICIPANTS: Primary Investigators: Mary E. Barbercheck, David A. Mortensen, Sjoerd W. Duiker, Heather Karsten, Jeffrey A. Hyde, Nancy E. Kiernan, Andrew Hulting (Oregon State University); Graduate Student: Randa Jabbour; Technicians: Christina Mullen,

David Sandy, Scott Smiles; and Wage Labor: Vaughn Hauk Alyssa Gendron Melissa Terhorst Jessi DeLong.
TARGET AUDIENCES: Farmers, Extension Educators, Agricultural Professionals, Scientists, Undergraduate and Graduate Students.

2006/01/01 TO 2006/12/31 Populations of weeds and soil quality characteristics in organically-managed corn and soybeans in minimum and conventional tillage systems were measured. Perennial weeds (esp. Canada thistle, *Cirsium arvense*) has increased in the minimum tillage plots, and soil quality has declined in conventional tillage plots. Canada thistle initially had patchy population distributions at the site, and became dominant in the minimum tillage plots as the crop sequence progressed from cover crops, to soybean and finally, maize. Moisture holding characteristics, aggregate stability, labile soil carbon, and populations of microarthropod, entomopathogenic nematode and entomopathogenic fungi were favored in systems that minimized tillage.

2005/01/01 TO 2005/12/31 Populations of weeds and soil quality characteristics in soybeans following cover crop treatments were measured in organically-managed soybeans. In plots planted to a rye cover crop, foxtail establishment was higher than both velvetleaf and common lambsquarters. Velvetleaf and common lambsquarters establishment was low in the rye treatment. Conversely, foxtail establishment in a red clover/timothy treatment was very limited. Common lambsquarters established more than both foxtail and velvetleaf in the red clover/timothy treatment. In soybeans following the cover crop treatments, foxtail and velvetleaf populations were low, but lambsquarters emergence was relatively high. we hypothesize that lambsquarters germination was delayed by unfavorable conditions in the cover crops and favored by a more permissive environment in soybeans. Moisture holding characteristics, organic carbon, and populations of microarthropod, entomopathogenic nematode and entomopathogenic fungi were favored in systems that minimized tillage.

2004/01/01 TO 2004/12/31 Densities of lambsquarters, velvetleaf and foxtail seedlings were quantified in May and June in plots being transitioned to organic production. Three seeded weed species were established in different proportions in two cover crop treatments. In plots planted to a rye cover crop, foxtail establishment was higher than both velvetleaf and common lambsquarters. Velvetleaf and common lambsquarters establishment was low in the rye treatment and averaged less than 10 seedlings/m² (except for the high velvetleaf density which was 60 seedlings/m²). Conversely, foxtail establishment in a red clover/timothy treatment was very limited with less than 10 seedlings/m² establishing. Common lambsquarters established more than both foxtail and velvetleaf in the red clover/timothy treatment with a range of 12-18 seedlings/m². These established densities will be monitored over time to gauge the success of mechanical and cultural weed management practices (tillage induced germination, delayed seeding) on the dynamics of the weed populations in this organic system. Physical and biological soil quality indicators were measured: soil bulk density, fertility, aggregate stability, moisture holding characteristics, organic carbon, and populations of microarthropod, entomopathogenic nematode and entomopathogenic fungi. These data are currently being entered for analysis.

2003/01/01 TO 2003/12/31 Soil samples to collect baseline data were collected at the Russell Larson Research Facility at Rock Springs, PA, and on three farms in Pennsylvania during the summer of 2003. Arthropods and insect pathogens were extracted and isolated from the soil samples. These data are being analyzed. An experiment to transition 10 acres at the Russell Larson Research Facility was initiated in October 2003.

IMPACT

2003/09 TO 2008/09 Pest and soil management strategies identified through this project will support farmers transitioning to organic production and those interested in reducing synthetic pesticide and soil fertility inputs. These management tactics will aid farmers by helping them produce high value organic crops, in this case organic feed grains and fruits, and may help growers provide sufficient income to support families on relatively small and medium-sized farms in the Northeast region. Information on the project is available at <http://TransToOrg.cas.psu.edu/>. The project team has developed extension materials which will be disseminated through eOrganic, an eXtension website in development. Information from the project is being used in two undergraduate courses on organic production. A workshop on project results will be conducted at the annual conference of the Pennsylvania Association for Sustainable Agriculture in February 2009. Several publications are in preparation. **PUBLICATIONS (not previously reported):** 2003/09 TO 2008/09 1. Barbercheck, M. 2008. Review of Field Manual of Techniques in Invertebrate Pathology: Application and Evaluation of Pathogens for

control of Insects and other Invertebrate Pests (2nd edition). *Entomologia experimentalis et applicata*. pp. 129:115. 2. Barbercheck, M. E., D. A. Neher, O. Anas, S. M. El-Allaf, and T. R. Weicht. 2008. Response of soil invertebrates to disturbance across three resource regions in North Carolina. *Environmental Monitoring and Assessment*. <http://www.springerlink.com/content/c26u536lm7916550/fulltext.pdf> 3. Jabbour, R. and M. E. Barbercheck. 2008. Soil and habitat complexity effects on movement of the entomopathogenic nematode *Steinernema carpocapsae* in maize. *Biological Control*. 47:235-243. 4. Jabbour, R. and M. E. Barbercheck. 2008. Habitat complexity effects on nematode movement in maize. *Annual Meeting of the Society for Invertebrate Pathology*. Coventry, UK. August 3-7, 2008. p. 97. (Abstract). 5. Jabbour, R. and M. E. Barbercheck. 2008. Habitat complexity effects on nematode movement in maize. 93rd Annual Ecological Society of America Meeting. Milwaukee, WI. August 3-8, 2008. p. 60. (Abstract). 6. Jabbour, R. and M. E. Barbercheck. 2008. Response of soil microarthropods to the application of entomopathogenic nematode-killed insects in crop and refuge habitats. 56th Annual Entomological Society of America Meeting. Reno, NV. November 16-19, 2008. p. 74. (Abstract). 7. Jabbour, R., A. G. Hulting, C. A. Mullen, and M. E. Barbercheck. 2008. Soil management effects on entomopathogenic fungi during the transition to organic. 79th Annual Entomological Society of America-Eastern Branch Meeting. Liverpool, NY. March 9-11, 2008. p. 17. (Abstract). 8. Jabbour, R. 2008. Management Effects on Epigeal and Soil-Dwelling Communities During the Transition to Organic Agriculture. Ph.D. Thesis. The Pennsylvania State University, University Park, PA. 175 pp.

2007/01/01 TO 2007/12/31 Pest and soil management strategies identified through this project will support farmers transitioning to organic production and those interested in reducing synthetic pesticide and soil fertility inputs. These management tactics will aid farmers by helping them produce high value organic crops, in this case organic feed grains and fruits, and may help growers provide sufficient income to support families on relatively small and medium-sized farms in the Northeast region. In 2007, approximately 500 people received information from this project during ten extension presentations. Information on the project is available at <http://TransToOrg.cas.psu.edu/>. Event participants learned that selection of pest management strategies is site specific. If sites selected for organic transition have pre-existing perennial weed problems, primary tillage is needed to suppress such species. The order of crops and management tactics during the transition matter. Those with more soil disturbance and more competitive crops early in the season will have lower weed infestation later. The project team is developing extension materials from the project which will be disseminated in a variety of forms. Information from this project will be submitted to eOrganic, an eXtension website in development. Information from the project is being used in the development of two undergraduate courses on organic production.

2006/01/01 TO 2006/12/31 Crop and soil management strategies identified through this project will support farmers transitioning to organic production and those interested in reducing synthetic inputs. These management tactics will aid farmers by helping them produce high value organic crops, in this case organic feed grains, and may help growers provide sufficient income to support families on relatively small and medium-sized farms in the Northeast region.

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2003/01/01 TO 2003/12/31 Penn State enters the national sustainable and organic agriculture arena. This research will help farmers reduce input costs and improve economic and environmental viability of Pennsylvania farms.

PUBLICATIONS

2007/01/01 TO 2007/12/31 1. Barbercheck, M., D. Mortensen, A. Hulting, R. Jabbour, H. Karsten, E. Sanchez, S. Duiker, J. Hyde, and N. E. Kiernan. 2007. Balancing Pest Management and Soil Quality in a Transitional System. Entomological Society of America 55th Annual Meeting: Making Connections, San Diego, CA. Dec. 8-12, 2007. p. 67 (Abstract). 2. Jabbour, R., M. E. Barbercheck, and C. A. Mullen. 2007. Effect of soil management on naturally occurring entomopathogenic fungi during the transition to an organic farming system. 40th Annual Society of Invertebrate Pathology Meeting, Quebec City, Quebec. p. 46 (Abstract). 3. Jabbour, R., A.G. Hulting, and M. E. Barbercheck. 2007. Effect of the method of transition to organic agriculture on naturally occurring soil-dwelling entomopathogenic fungi. 92nd Annual Ecological Society of America Meeting, San Jose, California. p. 132 (Abstract). 4. Barbercheck, M. and E. Sanchez. 2007. Japanese Beetle Management for Organic Fruit Farms Vegetable & Small Fruit Gazette.(September 2007). pp. 7-10 5. Barbercheck, M. 2007. Managing Weeds and Soil Quality Organically. PSU-SAWG Sustainable Ag Newsletter. July 2007. pp. 1-5. <http://www.ento.psu.edu/extension/sustainableAg/default.html>

2006/01/01 TO 2006/12/31 No publications reported this period

2005/01/01 TO 2005/12/31 No publications reported this period

2004/01/01 TO 2004/12/31 No publications reported this period

2003/01/01 TO 2003/12/31 No publications reported this period

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Biological Buffering and Pest Management in Organic Farming Systems: the Central Role of Organic Matter

Accession No.	0197139
Subfile	CRIS\
Project No.	OHO00944-SS
Agency	NIFA OHO
Project Type	OTHER GRANTS
Project Status	TERMINATED
Contract / Grant No.	2003-51106-02092
Proposal No.	2003-04559
Start Date	15 SEP 2003
Term Date	14 SEP 2008
Fiscal Year	2008
Grant Amount	\$493,343
Grant Year	2003
Investigator(s)	Stinner, D.; Phelan, P. L.
Performing Institution	ENTOMOLOGY, OHIO STATE UNIVERSITY, 1680 MADISON AVENUE

NON-TECHNICAL SUMMARY

Many organic and transitional organic farmers struggle with production limitations owing to various inadequate or inefficient management factors, including pest and organic fertility management. The purpose of this project is to provide information that will assist organic and transitional organic farmers with strategies to optimize management of organic matter, soil fertility, pests and crop health.

OBJECTIVES

1) Investigate relationships between soil organic matter, soil fertility, insect pests and weeds on a range of certified and transitional organic farms; 2) Investigate relationships between soil organic matter, soil fertility and pests in field experiments that evaluate a combination of management strategies based on soil organic matter and crop rotation pattern; 3) Conduct a series of greenhouse experiments designed to discover the mechanisms underlying the relationships observed in Objectives 1 and 2; and 4) Incorporate ecological principles and information from Objectives 1, 2, and 3 into whole farm planning workshops and a "Whole Farm Planning Guide to Organic Farm Management" for organic, transitional organic and conventional farmers who are interested in learning about transitioning to organic farming.

APPROACH

In this project, researchers, extension personnel and farmers will be working together in a systems approach that combines both an overall ecological context for analysis within the reality of working farms and an experimental approach that will allow us to tease apart cause and effect relationships within more controlled settings than working farms. We will start with the whole farm system in an on-farm survey of certified organic and transitional grain farms in Ohio, in which we will document relationships between soil quality, crop quality, and pest insect and weed parameters. Concurrently, we will carry out similar analyses in several existing farming systems

experiments and a new replicated field experiment on our certified organic research land maintained by the Ohio State University. Then we will bring soil from a subset of the farms into the greenhouse and conduct a series of controlled experiments that will be designed to investigate mechanisms involved in the patterns observed in the farms and field experiments. Finally, this information will be incorporated into whole farm planning workshops and organic management educational materials for organic, transitional, and conventional farmers who wish to transition to organic farming.

PROGRESS

2003/09 TO 2008/09 OUTPUTS: Objective 4. A major accomplishment this year was completion of two educational manuals for farmers. The first manual, "A Transition Guide to Organic Crop Management" explains what is involved in organic crop production and how to transition. It covers USDA's Organic Standards related to crop production, handling and processing. Each guideline is stated and then followed by a rationale and examples from both scientific information and farmer experience of how the guideline can be met. These manuals have been used in two "Organic 101" workshops held with the Ohio Ecological Food and Farming Association in Ohio and in professional development venues with agricultural consultants. Our "Organic Whole Farm Planning Workbook" uses Holistic Management as a goal setting and planning framework, and guides the user through developing a transition plan and a completed organic farm plan for organic certification. Both manuals are being distributed to farmers, extension personnel and numerous other agricultural professionals in Ohio and across the US. Objectives 2 and 3. We conducted a series of greenhouse experiments to determine the feasibility of niche differentiation to improve soybean competitiveness with weeds. Because of their relative compact growth form, soybeans are more susceptible to fast-growing weeds than is corn. Although they share many niche dimensions with weeds, as legumes, soybeans show clear niche differentiation along one dimension, that of soil N utilization. In our first experiment, we placed soils from organic and conventional farms in greenhouse pots, determined the levels of NO₃- present, and added enough wheat straw to the pots to create a C:NO₃ ratio of 25 or 50. The pots were planted with one soybean plant, three common broadleaf weeds, and three grass weeds. Additional pots of each soil type received no straw and either contained only a soybean plant (weed-free positive control) or a soybean and the six weeds (negative control) and shoot biomass was determined for each species. Species differences in nutritional niches were suggested first by comparison of growth in the unamended conventional and organic soils. For example, while pigweed grew better in conventional soil, velvetleaf and crabgrass grew better in soil from the organically managed farm. Differences were also evident in response to C amendment. Shoot biomass was reduced for most weed species by C addition, but soybean biomass and bean yield increased. Soybean yield more than doubled with C:N 50 and was not different from yield in pots with no weeds. Pigweed was most dramatically affected by increasing C:N, as most plants died shortly after the cotyledon stage with C:NO₃ 50. The practical feasibility of this mineral niche differentiation approach was tested by applying high C amendments to certified organic OARDC field plots to change soil C:N: sugar or wheat straw to achieve C:NO₃ 50 or oak sawdust for C:NO₃ 50 or C:NO₃ 75. Greenhouse results were confirmed on the field scale; weed biomass was reduced at elevated C:NO₃, while soybean yield was ca. 30% higher in C:NO₃ 50 plots receiving either sugar or straw and 40-50% higher in plots receiving sawdust. PARTICIPANTS: Partner organizations included the Ohio Ecological Food and Farm Association (OEFFA), Innovative Farmers of Ohio (IFO) and Organic Crop Improvement Association (OCIA) Ohio Chapter 2. These are the leading organic and sustainable farming organizations in Ohio. Three of our Whole Farm Planning Workshops were done in conjunction with IFO. Individual members of these organizations were key stakeholders, serving as advisors to the project and as on-farm research collaborators. These farmers included: Dean McIvaine, (OEFFA); Steve Elliot (OCIA); Ed Snively (OEFFA); Charles Eselgroth (OEFFA, IFO); Rex Spray (OEFFA); and Hirzel Farms. In the case of Ed Snively, we tested a practice he developed on his farm for giant ragweed (*Ambrosia trifida*) control in an experiment at OARDC and set up an on-farm experiment on his farm. Researchers who participated in this project included: Larry Phelan, Deborah Stinner, the late Ben Stinner, Emy Regnier, John Cardina, Phil Rzewnick, Margaret Huelsman, Kathy Bielek, Don Beam, Chris Nacci, and Dave McCartney. Dr. Rzewnick left OSU early in the project and Dr. Ben Stinner was tragically killed in Nov. 2004. However, he contributed significantly conceptually. Emy Regnier, a giant ragweed biologist in the OSU Horticulture and Crop Science department, helped design, sample and analyze data from a Giant Ragweed Control Experiment conducted over three years. Dr. Phelan conducted all the greenhouse experiments and two field experiments. John Cardina advised on weed ecology questions. Dr. Deborah Stinner oversaw the overall project, the long-term field experiments, development of the two educational manuals, and conducted the whole farm planning workshops. Dr. Huelsman was contracted to write the "Transition Guide to Certified Organic Crop Management" and "Organic Whole Farm Planning Workbook". Kathy Bielek edited and assisted with the production of both manuals. Don Beam, Chris Nacci and David McCartney assisted with field experiments, including sample collection, processing, and data analyses. Chris Nacci assisted in greenhouse experiments as well. TARGET AUDIENCES: The target audience for this project included existing and transitional organic farmers, conventional farmers thinking about transitioning and

new farmers. Feedback from our whole farm planning workshops has been very positive as to how the information provided helped participants think about their whole farm and make decisions that are more sustainable. While we have not solved the considerable problem we and other organic farmers in Ohio are having with giant ragweed (*Ambrosia trifida*), our studies in this project have added some understanding of factors involved in its prevalence and suggestions for ways to control it. This has been much appreciated by organic farmers. With transitional and conventional farmers, we have stressed how important it is to control giant ragweed from the very beginning so it does not get out of control. Our manuals have been released in the past few months and we do not yet have evaluations on how helpful they have been. However, OSU producing these manuals is helping to raise awareness and legitimacy of organic farming not only in the organic community but also in conventional farming circle. We have received press coverage on these manuals from a broad base of agriculture in Ohio and the Midwest, including mainstream news venues. PROJECT MODIFICATIONS: Not relevant to this project.

2007/01/01 TO 2007/12/31 Objective 1. Seven organic farms were sampled for soil parameters (fraction sand, NH₄, NO₃, microbial biomass N, % organic matter, and particulate organic matter) and weed (total, broadleaves, grasses) estimates as % of total plant biomass. Pre-harvest time sampling at peak grain mass and 50% leaf drop included stand (#/m²), soybean grain, plant, weed and total plant biomass and visual estimates of % weeds. Stepwise regressions were done for the weed and crop parameters versus plant stand and the soil parameters, and the residuals were compared by farm to evaluate farm effect. Evaluations were repeated adding the Spring weed estimates as predictors for fall parameters. Objective 2. We continued collection of soil organic matter, soil fertility and weed data in three field OSU experiments: 1) the Farming Systems Experiment in NW Ohio at the John Hirzel Sustainable Agriculture Research and Education Site 2) the Buckwheat Giant Ragweed Control Experiment, and 3) the Forage Crop Experiment. In addition, based on observations and results of the 2006 on-farm research in Objective 1 we conducted two field experiments on OSU certified organic research land that were designed to evaluate the effect of stand and row width of food grade soybeans on weeds. Objective 3. Soils from organic and conventional farms were placed in greenhouse pots. The levels of NO₃ present were determined and enough wheat straw was added to the pots to create a C:NO₃ ratio of 25 or 50. The pots were planted with one soybean plant, three common broadleaf weeds, and three graminoid weeds. Additional pots of each soil type received no straw and either contained only a soybean plant (weed-free positive control) or a soybean and the six weeds (negative control). Plant growth was monitored throughout the experiment, and at the end, we determined final shoot biomass for each species and soybean yield. The experiment was repeated using the additional treatment of C:NO₃ 75. Objective 4. Three whole farm planning workshops were conducted using Holistic Management as a planning framework. Further development of a Transition Manual and Ecological Management Guide was conducted. Objective 3.

2006/01/01 TO 2006/12/31 Objective 1: Six organic farms were sampled for soil parameters (fraction sand, NH₄, NO₃, microbial biomass N, % organic matter, and particulate organic matter) and weed estimates (total, broadleaves, grasses) as % of total plant biomass. Pre-harvest time sampling at peak grain mass and 50% leaf drop included stand (#/m²), soybean grain, plant, weed and total plant biomass and visual estimates of % weeds. Stepwise regressions were done for the weed and crop parameters versus plant stand and the soil parameters, and the residuals were compared by farm to evaluate farm effect. Evaluations were repeated adding the Spring weed estimates as predictors for fall parameters. ANOVA showed farm differences for all the parameters tested except for fall grassy weed visual estimate and NH₄-N. The residuals were significant for farm effect indicating strong differences in management. Spring weediness was the strongest predictor of fall weeds (positive), followed by crop stand (inverse). Soil parameters were weak predictors of fall weediness. The results point to the importance of good early season weed control and high planting density to minimize late-season weed pressures. Objective 2: The field experiment from last year manipulating soil C:N was repeated with modifications in a different certified organic soybean field. Before planting to soybeans, 3.3m x 6.7m plots in a randomized block design were treated with: poultry manure compost to achieve C:N 5, sugar for C:N 50, sawdust for C:N 50 or 75, sawdust for C:N 50 plus CaCO₃ to achieve Ca:Mg 8:1, interplanted with wheat, or left unamended. Overlaid on these amendment treatments were two planting dates, separated by three weeks. Giant ragweed populations proved to be extremely high, such that early planted areas had to be plowed under midseason. Although giant ragweed plant count was significantly lower in late-planted beans, it remained high within the row even with cultivation. A mid-season weed count census showed no treatment effect on giant ragweed or giant foxtail, the second most common weed; however, total broadleaves except giant ragweed were significantly less numerous in all high C:N treatments than in control plots. At harvest, there were no treatment effects on giant ragweed or soybean plant biomass or yield. Significant effects were recorded for giant foxtail, which was highest in control plots and lowest in all high C:N and wheat plots. No additional benefit was noted for the high Ca:Mg treatment. The results suggest that carbon amendments might reduce many but not all weed

species. The experiment needs to be repeated in a field without giant ragweed. Objective 3: C:N effects on giant ragweed were analyzed in the greenhouse, where plants were grown in soil from organic or conventional farms. Wheat straw was added to pots to achieve C:N 25 and 50, or left unamended (C:N 0). Plants in C:N 50 were significantly smaller than those in either C:N 0 or 25 and plants in conventional soil were smaller than those in organic soil. The largest differences between soils as recorded by mineral analysis for conventional relative to organic were: P and K 3x higher, Fe 1.6x higher, and Cu 3x lower.

2005/01/01 TO 2005/12/31 This project has both fundamental and applied goals, i.e., to elucidate the relationships between soil processes and plant health/community dynamics, while providing practical crop production tools that rely more on biological services than on chemical inputs. The project this year has focused primarily on the effects of soil C:N manipulations in soybean-weed competition. Last years studies of soil C:N effects on weeds were repeated using different soil types and extended to include a wider range of C:N. As before, soil was collected from neighboring organic and conventional farms into pots and randomly assigned to blocks in the greenhouse. Each soil was amended with enough wheat straw to achieve soil C:N 25, a mixture of straw and oak sawdust for C:N 50, or sawdust alone for C:N 75. Pots were then planted with soybeans, three grassy weeds, and three broadleaf weeds. Again, C:N 50 produced the highest soybean yield while suppressing overall weed biomass, with soybean yield in C:N 50 similar to that in unamended soil without weeds. C:N 75 suppressed weeds even more, but also reduced soybean plant biomass and yield. C:N effects were more pronounced for broadleaves than grass species. Also consistent with our previous study, there was a significant amendment x soil source interaction, with C:N effects being generally greater in conventionally managed soils. Pigweed usually did not develop far beyond the cotyledon stage in C:N 50. To separate C:N effects from possible allelopathic effects of wheat straw, a third greenhouse experiment of similar design was conducted, excepting that the same amount of straw was added to all pots, and soil C:N was manipulated by adding different amounts of inorganic N. Once again, C:N 50 suppressed weeds, indicating that the mechanism was not allelopathy, but was related to carbon and nitrogen cycling. Finally, a field experiment was conducted on a certified organic field in which the effects of both carbon amendment quantity and quality on soybean-weed interactions were considered. Using a randomized block design, 3.05m x 3.05m plots received one of the following incorporated treatments: sugar to attain C:N 50, wheat straw to attain C:N 50, oak sawdust to attain C:N 50, oak sawdust to attain C:N 75, or no amendment. Additionally, treatment plots received in-row cultivation once in late Spring, while unamended buffer strips between plots received two cultivations (2x tillage). These 2x tillage areas were also sampled for comparison. Weed pressure was very high, but also very patchy in the field, even in untreated areas. Dominant species were green foxtail, velvetleaf, and giant ragweed. C:N effects were similar to those seen in the controlled greenhouse experiments, with high C:N treatments (except sugar) producing less weed biomass and higher yield. Due to the very high variability in weed distribution, the randomized block design showed no significant differences; however, if replicates of each treatment were reassigned to blocks based on rank of weed level or soybean yield, highly significant differences were measured.

2004/01/01 TO 2004/12/31 Goal: To evaluate the effects of different C:N ratios and soil types on soybean, weed, and insect performance in the greenhouse. By manipulating this ratio, we hope to maintain a microenvironment where the crop plant is successful vegetatively, reproductively, and biochemically while also suppressing the weed community and insect herbivory. Methods: Collected soils from both an organically managed field and a conventionally managed field and placed them in pots. Three C:N ratios were added to each soil, 0, 25, and 50, one week before planting. Three broadleaf weeds and three grass species were planted around soybean in each pot except for a control, which only contained a soybean plant. Measurements were taken over the course of experiment to monitor differences in plant growth of soybeans and weeds. Mexican bean beetle bioassays were conducted with soybean plants grown in different treatments to compare insect developmental performance. We harvested plants and measured biomass to determine weed and crop performance in different treatments. Outcomes: Data analysis is not complete for Mexican bean beetle development and for some plant growth parameters. However, soybean plant size was significantly larger with C:N 50 than with either C:N 0 or 25 in both soil types, and were not significantly different from soybeans growing without weeds. Weed growth response to soil C:N 50 varied among species, and even showed differences between soil types, but was generally inversely related to soil C:N. Pigweed grew best in conventional soil with C:N 0, while almost all plants died in both soil types with C:N 50. Velvetleaf grew best in organic soil with C:N 0, but was suppressed by C:N 50 in both soil types. Implications: These results illustrate that crop-weed interactions can be modified by changing the C:N of the soil. When growing soybeans, tying up mineral N with moderate amounts of carbon inhibits weed growth while conserving that N for future crops.

2003/01/01 TO 2003/12/31 The overall goal of this project is to provide scientific information that will assist organic farmers with agroecosystem management strategies to optimize management of organic matter,

biologically based soil fertility, pests and crop health. In previous studies under controlled laboratory conditions, we have shown how crops grown under organic conditions have increased resistance to certain insect pests, related this finding to soil biological and chemical characteristics, and described this process in terms of biological buffering. This concept states that a sustained influx of organic matter provides a resource base for soil biological communities that then regulate the balance of plant available nutrients in ways that optimize between plant growth and quality, and defense against pests. In the proposed project, we are extending this work with the following objectives: 1) Investigate relationships between soil organic matter, soil fertility, insect pests and weed characteristics on a range of certified and transitional organic farms; 2) Investigate relationships between soil organic matter, soil fertility and pest parameters in replicated organic field experiments that evaluate a combination of management strategies based on soil organic matter and crop rotation pattern; 3) Conduct a series of greenhouse experiments designed to discover the mechanisms underlying the relationships observed in Objectives 1 and 2; and 4) Incorporate ecological principles and management information from Objectives 1, 2 and 3 into whole farm planning workshops and a Whole Farm Planning Guide to Organic Farm Management for certified and transitional organic farmers. Our overall hypothesis in the proposed project is that soil fertility maintained by soil biological communities can simultaneously 1) optimize nutrient requirements for crop growth, 2) create chemical balances within the crops that minimize susceptibility to insect pests, and 3) create soil conditions that alter the competitive balance towards crops versus weeds. This project began October 2003. To date, we have initiated on-farm sampling of certified organic farms under Objective 1. Using soils collected from these organic farms, we are initiating a series of controlled experiments under Objective 2. No results are available at this time.

IMPACT

2003/09 TO 2008/09 Herbicides account for >70% of total pesticide sales. However, their use also produces unintended consequences; they are linked to problems for human health and the environment, and herbicide resistance is on the rise for many aggressive weed species. Organic agriculture disallows synthetic herbicides, but the main alternative, tillage, is labor- and energy-intensive and also has negative environmental consequences. Through a combination of greenhouse and field studies, we have demonstrated how principles from plant ecology can be used to inform agricultural soil management to reduce weed pressures. In hydroponic studies of weed and crop nutrition, we have demonstrated the variation in the mineral requirements of different plant species, suggesting that soil minerals play a role in determining why certain weeds dominate in a field and also opens up the possibility of suppressing weeds by optimizing nutrient management. Secondly, we found that the addition of carbon to the soil can shift the competitive balance of soybeans over competing weeds, resulting in higher soybean yields. The mechanism for the carbon amendments is that by stimulating soil microbes, soil soluble N is moved to the microbial fraction of the soil, depriving fast-growing weed species of this limiting nutrient. We have used these findings to educate organic farmers, as well as those interested in transitioning to organic farming, as to the conditions that create weed problems. The research opens the possibility of ecologically based weed management emphasizing prevention, in which field invasibility to weeds is reduced by optimizing soil fertility levels to selectively enhance crop competitiveness over weeds. When integrated with other cultural controls such as cover crops and field sanitation, farmers might be able to reduce their dependence on chemical intervention or mechanical tillage. **PUBLICATIONS (not previously reported):** 2003/09 TO 2008/09 No publications reported this period

2007/01/01 TO 2007/12/31 Objective 1: Samples and data are still being analyzed. However, thus far it appears that findings will be similar to 2006. Objective 2: Giant ragweed is a very serious weed for organic soybean production and may cause considerable economic loss. It also can present significant problems in small grains and corn if dense enough. Data from our Buckwheat Giant Ragweed Experiment suggests that late tillage could be a possible solution along with the presence of buckwheat. Data from our Forage Crop Experiment suggest that compost application (1T/Ac) during hay establishment can lower weed counts in subsequent parts of a field crop rotation. 2006 outcomes for other field experiments are not available. Objective 3: Shoot biomass was inversely related to the level of C addition for most weed species, while soybean biomass and bean yield was positively correlated. The most dramatic effect came with pigweed, as most plants died shortly after the cotyledon stage with C:NO₃ 50. The second experiment that included C:NO₃ 75 showed that the higher ratio did not suppress weed growth further but did have a negative impact on soybean yield. Objective 4. Evaluations from workshop participants have been highly positive as to their value.

2006/01/01 TO 2006/12/31 Information from this project should assist organic and transitional farmers with agroecosystem management strategies that optimize relationships among soil organic matter, soil fertility, insect pests and weeds. Specifically, our proposed hypothesis of Biological Buffering predicts several benefits from the increase in biologically active soil organic matter, including better mineral balance in crops, lower susceptibility to insects and disease, and greater resilience to environmental stresses. We are now extending the hypothesis to determine how manipulations of soil organic carbon might favorably shift the balance of crop-weed competition while reducing herbicidal inputs and mechanical tillage.

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PUBLICATIONS

2007/01/01 TO 2007/12/31 No publications reported this period

2006/01/01 TO 2006/12/31 No publications reported this period

2005/01/01 TO 2005/12/31 2005/01 TO 2005/12 No publications from this period.

2004/01/01 TO 2004/12/31 No publications reported this period

2003/01/01 TO 2003/12/31 No publications reported this period

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Development and Implementation of Organic Pest Management Strategies for Lowbush Blueberries

Accession No.	0198214
Subfile	CRIS\
Project No.	ME02003-04602
Agency	NIFA ME.
Project Type	OTHER GRANTS
Project Status	TERMINATED
Contract / Grant No.	2003-51106-02119
Proposal No.	2003-04602
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Grant Amount	\$175,128
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Investigator(s)	Drummond, F.; Annis, S. L.; Smagula, J.; Yarborough, D.
Performing Institution	SCHOOL OF BIOLOGY & ECOLOGY, UNIVERSITY OF MAINE, ORONO, MAINE 04469

NON-TECHNICAL SUMMARY

Pesticides used for lowbush blueberry cultivation may be detrimental to the environment adjacent to and within lowbush blueberry fields. This proposal will develop and implement comprehensive season-long pest management programs to key blueberry pest complexes. An organic pest management system for lowbush blueberries may reduce the risk of pesticides to the environment.

OBJECTIVES

The currently available cultural and biological approaches to pest management in lowbush blueberry provide a starting-point for implementation of the basic organic pest management program. Key areas that require further development or optimization will be a focus of research in year 1, 2, and 3 of the project. As the results of the research objectives are completed, these will be integrated into the program for implementation. Objective 1. Effective organic management tactics will be developed and optimized under operational conditions for key pests. Experiments include testing perimeter treatments and deployment strategies for tanglefoot-treated spheres for control of blueberry maggot fly, comparing organic fungicides for their control mummy berry blight, leaf spot and stem diseases, determining the effect of frequency of pruning on weed cover and yield, and comparing the effectiveness of different soil and foliar organic fertilizers. Objective 2. A large plot study at a site transitioning to organic production will be established to look at direct effects of organic fertilizers and the indirect effects due to interactions between fertilizer treatments and pests on crop yield. Objective 3. A cost : benefit analyses of adopting organic strategy will be conducted using data collected from experiments performed in the first 2 objectives and from growers. Objective 4. Proactive educational programs to facilitate adoption of the organic strategies will be developed .Information about this project will be disseminated to growers and Extension Educators during grower meetings organized throughout the year and by fact sheets that will be developed on organic production of lowbush blueberries.

APPROACH

Stakeholders will be involved in establishing priorities and reviewing research during the development of an organic pest management program for lowbush blueberry. Small field trials in fields of growers who transitioning to organic management or at the Blueberry Hill Farm will be used to establish management methods for key pests. Experiments include testing perimeter treatments and deployment strategies for tanglefoot-treated spheres for control of blueberry maggot fly, comparing organic fungicides for their control mummy berry blight, leaf spot and stem diseases, determining the effect of frequency of pruning on weed cover and yield, and comparing the effectiveness of different soil and foliar organic fertilizers. A large plot study at a site transitioning to organic production will be established to look at direct effects of organic fertilizers and the indirect effects due to interactions between fertilizer treatments and pests on crop yield. A randomized complete block split-split-split plot design will be used to determine the interactions of organic pest management, pruning method (mow vs. burn), organic mineral sulfur application (to lower soil pH to 4.0), and an organic fertilizer on the plants and pest populations. Fertilizer treatments will be 0, 22.5 or 45 kg N/ha from application of a commercial organically approved fertilizer. Effects of treatments will be determined by measuring yield, stem length, branching and flower bud formation and nutrient analysis of leaf tissue. Soil nutrient and pH will also be measured. The effect of plant nutrition on insect pests will be use laboratory feeding trials with field collected blueberry stems. We hypothesize that development rate, survival, and fecundity of adult females will increase as fertility of the plants increases. Caterpillars of blueberry spanworm and blueberry flea beetle will be tested. Upon adult emergence, adults will be paired and allowed to mate. The longevity and total number of eggs laid by adult females will also be recorded to determine fecundity. The effectiveness of sulfur in reducing weed competition and interactions with the pruning or fertilizer treatments will also be examined. Weeds will be controlled by cutting in the non-crop year. Weed cover data measured in the prune and crop years and yields will determine the effectiveness of the treatments. The effects of fertility treatment on the incidence and severity of mummy berry blight, leaf spot and stem diseases will be determined. The incidence and severity of leaf spot and the incidence of stem diseases will be evaluated late in the prune and crop years. In the bearing year, the incidence of stems infected with mummy berry will be determined. The economic analysis component of this project will consist of partial budget analysis of each treatment as well as a yield risk analysis of each treatment. Monte Carlo simulations will be used in the yield risk and price risk analyses. Information about this project will be disseminated to growers and Extension Educators during grower meetings organized throughout the year and by fact sheets that will be developed on organic production of lowbush blueberries.

PROGRESS

2003/09 TO 2008/09 OUTPUTS: The results have been disseminated by annual summer field day extension meetings with organic lowbush blueberry growers from Maine and Canada. In 2005 we had 22 growers attend our meeting, in 2006 we had 37 growers attend the meeting, in 2007 we had 29 growers attend the meeting, and in 2008 we had 48 growers attend the meeting. We also published three extension bulletins on pest management and economic aspects of transitioning from conventional to organic lowbush blueberry production.

PARTICIPANTS: Participants were: Drs. Eric Sidemann and Russel Libby of the Maine Organic Growers and Farmers Association. Dr. Kathy Murray of the Maine Department of Agriculture. Many organic growers, but several key growers are: Deborah Aldridge Peter Aldridge Basil Staples Charlie Hitchings

TARGET AUDIENCES: The target audience for our project were growers of lowbush blueberry that were in the process of transitioning to organic production or were thinking about transitioning to organic production in the near future. PROJECT MODIFICATIONS: There were no major changes in our approach to our research or outreach. However, we are attempting to keep the research plots under production so that we can assess the ecological changes in transitioning to organic production over a longer time horizon. The original grant was to assess transition under a two crop cycle duration or four years. We are currently planning to collect data on the sixth year and are attempting to secure funding for several additional years.

2006/10/01 TO 2007/09/30 OUTPUTS: This four year study is a multidisciplinary approach to researching pest management for organic production of lowbush blueberry. Research effort in insect, disease, and weed pest management and soil fertility were combined to assess production management tactics on pest incidence and yield. The research outputs for this research project in 2007 were derived from two different types of studies. The first study was a long-term large scale cropping systems research project that was designed to assess the effects of pruning (burning vs. mowing), soil pH management (sulfur vs no sulfur amendment), and fertilization (three rates). A second set of experiments were more focused designed to assess specific management options for insect, disease, and weed pests under an organic production cycle. An extension output involved the writing of a

management bulletin for organic growers of lowbush blueberry. In addition, a survey of organic blueberry growers was conducted to assess the economics of organic production. Three case studies were included in this economic analysis. PARTICIPANTS: Ms. Beth Choate, graduate assistant - training in biological control. Mr. Daniel Bell, graduate student - training in pollination. Ms. Kathlene Frost - graduate student - training in plant pathology. Dr. John Smagula - soil fertility expert - coPI on project. Dr. David Yarborough - weed management and extension specialist - coPI on project. Dr. Seanna Annis - plant pathologist expert- coPI on project. Mr. Andrew Files - economist - consultant on project. Dr. Aram Calhoun - cooperator on large scale cropping systems experiment - leased the land for project. Mr. Charlie Hitching - blueberry grower consultant. Mr. Eric Sidemann - Research/Extension specialist for Maine Organic Farmers and Gardeners Association. Dr. Kathy Murray - consultant - Maine State Department of Agriculture TARGET AUDIENCES: There are 35 - 40 organic lowbush blueberry growers in the state of Maine. In general they are part-time growers and manage less than 5 acres. Most of the growers are in the eastern part of the state. However, there are more than 600 traditional lowbush blueberry growers some of whom are interested in transitioning to organic production. PROJECT MODIFICATIONS: none

2005/10/01 TO 2006/09/30 A large-scale organic experiment was continued in 2006. It was initially laid out in 2004 as a split-split plot design, included pruning (mowing vs burning) as the main plot, pH (sulfur vs no-sulfur) as split plots and three levels of fertility as split-split plots. The mowed treatments had significantly higher grass and broadleaf weed cover than burned treatments for all three evaluations. In June those stems cut two or three times had significantly less recovery than those uncut or cut once. Stems cut once also had significantly less recovery than the untreated control. Soil analysis indicated that pH was lowered by sulfur treatment from 5.0 to 4.2. Soil sulfur, phosphorus, aluminum, copper, iron and manganese concentration was significantly higher in the sulfur-treated plots but calcium, potassium, magnesium, and zinc concentration was significantly lower. Burned plots had a significantly higher soil sulfur concentration than mowed plots. Fertilizer treatments did not affect soil pH but soil potassium concentrations were raised by each increment of fertilizer application. Soil phosphorus was also increased by fertilizer application. Leaf magnesium was slightly lower in sulfur-treated plots. Burned plots had higher concentrations of iron and zinc. The highest rate of fertilizer application, 40 lbs N/acre from Pro-Holly (4-6-4), raised leaf nitrogen concentrations from border line deficiency levels in the controls (1.58%) to a sufficiency level of 1.61%. The leaf nitrogen standard is 1.6%. Leaf phosphorus concentrations were also raised by the higher rate of fertilizer application to 0.108%; however, this was considerably below the standard concentration (.125%). For insect pests, there was no significant difference in the number of stems infested by red-striped fireworm (RSFW) due to burning method or sulfur application. There were significantly more RSFW in plots that were treated with no fertilizer versus those that were treated with 20 lbs of fertilizer. There was no significant difference between 20 and 40 lbs plots. In general, RSFW damage was low, with less than 1 damaged stem/sq ft. There were significantly more patches of thrips curls in plots that were burned than plots that were mowed. There were significantly more grasshoppers in burned versus mowed plots. There was no significant difference in grasshopper abundance due to sulfur or fertilizer treatment. There was no significant difference in lepidopteran larval abundance, thrips abundance, or grasshopper abundance due to pruning method, sulfur or fertilizer treatment. Organic fungicides did not consistently produce significant decreases in mummy berry disease but some treatments, particularly *Bacillus subtilis*, have potential and should be re-examined. Mulching significantly decreased mummy berry disease in one field and produce plants that looked greener and had more leaves late in the season in the other field. Mulching may be useful as a treatment to control mummy berry in small areas, but is prohibitively expensive for large fields.

2004/10/01 TO 2005/09/30 In a large-scale experiment on an organic farm we found that an application of 20 or 30 lbs N/ acre from a Pro Holly (4-6-4) organic fertilizer treatment had no effect on leaf N concentrations, which were not deficient, nor on leaf P concentrations, which were deficient, compared to the controls. Blueberry Yield was not affected by fertilizer treatment or sulfur application but was larger in burned plots, compared to pruned plots. Pro Holly (4-6-4), at 60 lbs N/acre, was found to be comparable to diammonium phosphate (DAP) in raising leaf N and P concentrations, improving growth, and raising blueberry yield three fold at a site deficient in N and P. Some of the increased yield in burned plots was attributed to the better control of red-striped fireworm than was achieved in mowed plots. Grass and broadleaf weed cover was evaluated at the large scale experiment in August. Mowed sites had significantly more grass and broadleaf cover than burned plots. Plots fertilized with 40 lbs of fertilizer had significantly higher grass cover than those not fertilized. An auxiliary study to observe the effectiveness of cutting trees 0, 1, 2, or 3 times during a season indicates that those cut 3 times significantly reduced individual trees more than 0 or 1 cuts. Additional experiments were carried out on three other organic farms in Maine. The organic fields in this project were in their crop-bearing year so they were monitored throughout the season for insect pests and natural enemies. There were no pest outbreaks in any organic field that we monitored in 2005. When sampling both organic and conventionally managed fields (fields sprayed with

various pesticides throughout the season) for natural enemies, there were more ants found in organic fields and more phalangids in conventionally managed fields. Other common natural enemies like spiders and ground beetles were present in similar numbers in organic and conventional fields. There were greater than twice as many native bees found in organic fields than conventional fields. Housefly pupae were deployed in both organic and conventional fields to measure degree of predation of pupae in a field setting. More pupae were missing from organic fields than conventionally managed fields, but the difference was not statistically significant. Housefly pupae deployed near large ant nests in one organic field were taken at a moderate rate, within 24 hours an average of 3-4 pupae were missing from all treatments.

2003/10/01 TO 2004/09/30 Several organic fertilizers were compared on a small organic blueberry farm. The effectiveness of four organic fertilizers in raising leaf nutrient concentrations were compared to diammonium phosphate, the standard chemical fertilizer used in lowbush blueberry culture. Differences were found in uptake of N,P, and K among the fertilizers. ProHolly was the most effective organic fertilizer, comparable to DAP for getting N into the leaves. The controls averaged 1.51% N and the ProHolly and DAP were 1.68% N and 1.72% N, respectively. The next best organic fertilizer was NutriWave at 1.55%N. Leaf Phosphorus concentrations were raised by ProHolly (.126 P), compared to the control (.122% P); however, the level was not as high as in plots receiving DAP (.144% P). Weed cover was rated and weeds were cut above the height of the blueberry at the end of June, July and August. The effect of the reduction in weed cover on blueberry yield and the cost of treatments will be determined next year. Three groups of pest insect and disease studies were conducted. The first was based upon the large multifactor long-term experiment that was set up in the spring of 2004. This experiment, laid out as a split-split plot design, included pruning (mowing vs burning) as the main plot, pH (sulfur vs no-sulfur) as split plots and three levels of fertility as split-split plots. There were no significant differences in the number of red-striped fireworm tied leaves or thrips-damaged patches due to any of the treatment combinations. Overall, there were significantly more ants and spiders in plots that were mowed vs. burned. Plots were surveyed for stem and leaf diseases in June and August. Red leaf disease was found scattered throughout the blocks with no significant difference between treatments. There were more dead stems in June than in August. The killing of stems in June may be from Godronia canker which is known to infect during prune year. Leaf spot rank and the percentage of stems with leaf spot was significantly higher in mowed treatments compared to burned treatments but fertilizer and sulfur treatment had no significant effect. Another set of insect studies involved sampling four organic blueberry fields and five conventional blueberry fields (all in the prune stage) to determine if insect pest densities or natural enemies differed due to management. There were significantly more Lepidopteran larvae, carabid predators, and phalangids in conventional fields than were in organic fields. Significantly more Orthoptera were found in organic fields than were found in conventional fields. There was no significant difference overall between ants found in organic versus conventional fields and there were significantly more spiders captured in pitfall traps in organic fields than were captured in conventionally sprayed fields. Insect control experiments showed promise for the use of the fungal pathogen, *Beauveria bassiana*, for control of the blueberry flea beetle and the red-striped fireworm. The spinosyn bait formulation GF-120 resulted in excellent control of the blueberry fly.

2002/10/01 TO 2003/09/30 We have only just received this grant. So far the principal investigators have met to discuss the first field season in the spring of 2004 and we have scheduled a meeting for January 2004 to meet with growers and other stakeholders to acquire advice on specific objectives.

IMPACT

2003/09 TO 2008/09 The outcome of this funded project has been very positive. First it fostered a working relationship with growers that enabled us to conduct on-farm research that led to registration of IPM materials approved for organic use such as the blueberry maggot insecticide GF-120, Naturalyte and Entrust, the organic formulation of spinosyn. Second, a very important outcome that this project most likely contributed in part was that organic lowbush blueberry acreage in Maine increased from just over 400 acres at the start of the project to 750 acres at present. **PUBLICATIONS (not previously reported):** 2003/09 TO 2008/09 1. Drummond, F, J. Smagula, S. Annis and D. Yarborough. 2008a. Organic Wild Blueberry Production. Wild Blueberry Fact Sheet No. 304, University of Maine, Orono. 30 pgs. and as MAFES Bulletin in press. 2. Files, A., D. Yarborough and F. Drummond. 2008a. Economic Analysis of Organic Pest Management Strategies for Lowbush Blueberries Using Enterprise Budgeting, University of Maine, Orono. 14 pgs. and as MAFES Bulletin in press. <http://www.wildblueberries.maine.edu/PDF/Management/EconomicAnalysisOrganicPestManagement.pdf> 3. Files, A., D. Yarborough and F. Drummond. 2008b. Growers Survey of Organic Pest Management Practices for

Wild Blueberries in Maine with Case Studies, University of Maine, Orono. 32 pgs. and as MAFES Bulletin in press. <http://www.wildblueberries.maine.edu/PDF/Management/OrganicGrowerSurveyCaseStudies.pdf> 4. Smagula, J. 2008. Gypsum enhances nutrient uptake of lowbush blueberry. *HortScience*. 43:1114. 5. Smagula, J., Yarborough, D, Drummond, F. and Annis, S. 2008b. Organic Production of Wild Blueberries II. Fertility and Weed Management. *Acta Horticulturae*. in press 6. Yarborough, D. 2008. Best Management Practices for Wild Blueberry Production in Maine, Wild Blueberry Fact Sheet No. 251, University of Maine, Orono, ME 04469 2 pgs. <http://www.wildblueberries.maine.edu/PDF/Management/251.pdf> 7. Yarborough, D., J.M. Smagula, F.A. Drummond, and S. Annis. 2008b. Organic Production of Wild Blueberries III. Fruit Quality. *Acta Horticulturae*. In press. 8. Yarborough, D. and F. Drummond. 2008. Insect control guide for wild blueberries. Wild Blueberry Fact Sheet No. 209, University of Maine, Orono, ME 04469 2 pgs. <http://wildblueberries.maine.edu/factsheets/Insects/209.html> 9. Drummond, F., S. Annis, J. M. Smagula and D.E. Yarborough. 2008b. Organic Production of Wild Blueberries. I. Insects and Disease. *Acta Horticulturae*. In press.

2006/10/01 TO 2007/09/30 The best way to transition to organic production of lowbush blueberry (*Vaccinium angustifolium* Ait.), was studied by comparing mowing and burning pruning methods, the use of sulfur to lower soil pH, and two organic fertilizer rates. A split, split block randomized complete block design was used with 8 blocks. Within each of the splits of pruning and sulfur (1120 kg/ha), an organic fertilizer (Pro-Holly, (4-6-4) was applied at 0, 22.4, or 44.8 kg N/ha to 1.8 m x 15 m treatment plots. Sulfur was applied preemergent in 2004 and fertilizer in 2004 and 2006. Weeds were controlled in all treatment plots by pruning with a weed whacker on 21 June, 26 July and 27 August 2004. Treatment effects were evaluated over two prune/crop cycles. Weeds, insects and disease pests were monitored to determine the effect of the main treatments and their interactions on their populations. The effects of treatments on soil and leaf nutrient concentrations and growth and yield were determined. Sulfur, lowered the soil pH each subsequent year resulting in a pH differential of 0.7 units by July 2007. Sulfur increased yield in 2007. Burning affected weed populations and burned plots had higher yields in 2005 and 2007, compared to mowed plots. Leaf N and P concentrations were not affected by sulfur or prune method, but were increased by the higher rate of fertilizer after the second prune-year application, compared to control plots. In both 2005 and 2007 treatment plots that were pruned by burning had a greater number of insect pests than in the mowed plot, possibly due to the significantly greater abundance of the natural enemies (ants and spiders) of these pests that were found in mowed plots. There was no significant difference in the incidence of *Monilinia* blight disease between mowing and burning methods of pruning. There was more *Monilinia* blight in the highest fertilizer treatment (40 lb N/acre) than the control (0 lb N/acre) or low fertilizer treatment (20lb N/acre), but this did not affect yield in 2005. There were no treatment effects on disease revealed at harvest in 2007.

2005/10/01 TO 2006/09/30 The impact of this study should directly assist growers that wish to transition to organic lowbush blueberry production. Since the inception of this study we have developed organic pest management options for all of the insect pests of lowbush blueberry in Maine. In addition, we have a very effective soil pH management program that reduces the abundance of grass weeds. Our objective for the remaining year of the study is to make inroads on organic tactics for mummyberry disease management. In addition we are currently, conducting an analysis of the economics of transitioning to organic production. These accomplishments should reduce the risk for growers considering such a transition.

2004/10/01 TO 2005/09/30 This proposal will focus on the development of organic pest management tactics for lowbush blueberry in Maine. We are studying weed pests, insect pests, and plant disease biology and management and how these processes relate to soil fertility and fertilization. In addition, economic analysis of the transition to organic production is an objective.

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PUBLICATIONS

2006/10/01 TO 2007/09/30 1. Yarborough, D.E. 2007. Cultural management for weeds in wild blueberries. Fact sheet no. 252. Univ. Maine Coop. Extension Publ. 2. Yarborough, D.E. 2007. Cultural Management for Insects and Diseases in Wild Blueberries. Fact sheet no. 253. Univ. Maine Coop. Extension Publ. 3. Yarborough, D.E. 2007. Cultural Management pH. Fact sheet no. 254. Univ. Maine Coop. Extension Publ. 4. Karem, J., S.A. Woods, F.A. Drummond, and C. Stubbs. 2006. Sampling Native Wasps Along Both Vertical and Horizontal Gradients in the Maine Lowbush Blueberry Landscape. *Environ. Entomol.* 35(4): 1083-1093. 5. Booth, S.R., F.A. Drummond, and E. Groden. 2008. Small Fruits. Pp. 597-616. In: *Field Manual of Techniques in Invertebrate Pathology*, 2nd ed. (L. A. Lacey and H.K. Kaya, eds.). Kluwer Academic Publishers, Boston, U.S. 911 pp.

2005/10/01 TO 2006/09/30 No publications reported this period

2004/10/01 TO 2005/09/30 1. Collins, J. A. and F. A. Drummond. 2005. Blueberry flea beetle control, 2004A. *Arthropod Management Tests*, 30 (Electronic Journal). C5. 2. Collins, J. A. and F. A. Drummond. 2005. Blueberry flea beetle control, 2004B. *Arthropod Management Tests*, 30 (Electronic Journal). C6. 3. Collins, J. A. and F. A. Drummond. 2005. Blueberry maggot control, 2004. *Arthropod Management Tests*, 30 (Electronic Journal). C7. 4. Collins, J. A. and F. A. Drummond. 2005. Blueberry maggot control with GF-120 NF fruit fly bait, 2004. *Arthropod Management Tests*, 30 (Electronic Journal). C8. 5. Collins, J. A. and F. A. Drummond. 2005. Red-striped fireworm control, 2004. *Arthropod Management Tests*, 30 (Electronic Journal). C11. 6. Collins, J. A. and F. A. Drummond. 2005. Blueberry flea beetle control in the laboratory, 2004. *Arthropod Management Tests*, 30 (Electronic Journal). L1. 7. Collins, J. A. and F. A. Drummond. 2005. Red-striped fireworm control in the laboratory, 2004. *Arthropod Management Tests*, 30 (Electronic Journal). L2.

2003/10/01 TO 2004/09/30 No publications reported this period

2002/10/01 TO 2003/09/30 No publications reported this period

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Cropping Intensity and Organic Amendments in Transitional Farming Systems: effects on Soil Fertility, Weeds, Diseases, and Insects

Accession No.	0196786
Subfile	CRIS\
Project No.	ILLU-371-522
Agency	NIFA ILLU
Project Type	OTHER GRANTS
Project Status	TERMINATED
Contract / Grant No.	2003-51106-02086
Proposal No.	2003-04618
Start Date	15 SEP 2003
Term Date	14 SEP 2008
Fiscal Year	2008
Grant Amount	\$482,576
Grant Year	2003
Investigator(s)	Eastman, C. E.; Bazik, M.; Cavanaugh-Grant, D. A.; Cooperband, L. R.; Eastburn, D. M.; Masiunas, J. B.; Shaw, J. T.; Wander, M. M.
Performing Institution	NATURAL HISTORY, UNIVERSITY OF ILLINOIS, 505 SOUTH GOODWIN AVENUE

NON-TECHNICAL SUMMARY

Organic farming has become one of the fastest growing segments of U.S. agriculture, but relatively little science-based information is available or readily accessible to producers on how best to transition to organic production, to grow different crops organically, or to solve the problems unique to organic production systems. This project will compare nine strategies for transitioning to organic production and their effects on soil fertility, weeds, plant diseases, and insects; and provide outreach for science-based information on organic management practices.

OBJECTIVES

Our long-term goal is to establish an interdisciplinary, cross-institutional organic farming systems research and education program, guided by an active partnership between organic producers, researchers, and extension educators, that improves the performance of organic farming systems and enhances the ability of Midwestern organic producers to meet the growing local and regional demand for organic produce. The objectives of this project are: 1) to compare the influence of transition schemes that differ in management intensity (cropping, tillage) and organic matter inputs on weed populations, soil organic matter and fertility, soil invertebrates, and the relationship between soil fertility, plant health and insect/disease pressure; and 2) to develop relevant, accessible outreach and educational products for organic producers.

APPROACH

An advisory board of organic producers will be established to refine objectives, lend expertise in farming systems management, provide input on the relevance of experimental approaches and treatments, and evaluate the results of experiments. Studies will be conducted within a farming systems context on land being transitioned for organic certification, and complimented with component research where appropriate. In a planning workshop, our producer contacts identified three strategies for transition to organic vegetable production: 1) immediate, intensive vegetable production with frequent tillage and cultivation, 2) less intensive cash grain production, and 3) extensive grass - legume ley. Each of these will be studied with cover crops or sod only for soil building, with additional raw waste or manure, or with additional compost. Measurements to characterize and compare the systems will include: weed populations, weed seed banks, and weed predation; soil organic matter fractions, nutrient availability and biological activity; soil invertebrate populations; insect pests and generalist predators; disease incidence and disease suppressiveness of soils; and crop injury and yield. Outreach products (fact sheets; web pages; slide presentations) will be targeted to current organic producers, producers transitioning to organic, and educators. This project directly addresses prioritized needs of the organic farming community as identified in our preliminary consultations with producers, and in the most recent national survey of organic producers conducted by the Organic Farming Research Foundation.

PROGRESS

2003/09 TO 2008/09 OUTPUTS: This project began in September of 2003 as a multi-disciplinary effort of the Illinois Natural History Survey, University of Illinois, and University of Wisconsin with these objectives: 1) compare influence of organic transition plants differing in management intensity and organic amendments on weeds, soil fertility, soil invertebrates, and the relationship between fertility, plant health, and insect/disease pressure, and 2) develop relevant, accessible outreach and educational products for organic producers. The research compared three farming system management intensity treatments as viable choices for transitioning land to organic production: 1) intensive vegetable production, 2) less intensive cash grain production, and 3) unharvested grass-legume sod (perennial ley) as the low-intensity treatment. Soil-building amendments were sub-treatments: 1) cover crop residues alone, 2) added manure, or 3) added compost. An advisory board of organic producers helped to refine objectives, lend expertise in farming systems management, and evaluate experiment results. Funds from other sources were used to establish cover crops (fall 2002) at the research site in Champaign, meet with organic advisors, initiate crop rotations (May 2003), and collect baseline field data for comparison with data for these same parameters at the conclusion of transition (2006). Crops grown in the transition seasons in the high-intensity (vegetable) and intermediate-intensity (row-crop) system treatments were tomato and edible soybean (2003), broccoli/cabbage and winter wheat (2004), and winter squash and field corn (2005). Crop management decisions were based on maintaining adequate yields and minimizing nutrient losses. Priorities established separately for each transition scheme (farming-system treatment) determined timing and type of amendment applications. Based on initial soil test values, no additions of lime or mineral K sources were made. Dairy manure and compost were applied to appropriate subplots in the intermediate-intensity system (fall 2003), high- and low-intensity systems (spring 2004), and all systems in fall 2005. Perennial ley (low-intensity) treatment plots were tilled under in spring 2006, marking the end of transition. Thereafter, the research plots differed only in management history. Tomato and pepper varieties (2006), followed by edible soybean (2007), were planted in all plots. Soil-core sampling (2004 - 2006) assessed soil organic matter and biological attributes (including nematode-based indices as potential indicators of soil organic matter status). Soil sampling of mite populations was done each season. Emerged weed and soil seed bank sampling was done in 2003 - 2006. Plant disease levels were evaluated in all treatments each season, and soil samples from the plots were used in greenhouse bioassays to determine suppressiveness effects of the soils on soil-borne soybean diseases. Monitoring of ground beetle predators and weed seed-feeders was done each season (reported in the related project ILLU-875-342). PARTICIPANTS: Edmond Zaborski (Illinois Natural History Survey and University of Illinois); Michelle Wander, Darin Eastburn, John Masiunas, Leslie Cooperband, Deborah Cavanaugh-Grant, and Dan Anderson (research faculty or Extension staff, University of Illinois); Jonathan Lundgren (USDA-ARS, Brookings, SD); Ph.D. students (University of Illinois) Carmen Ugarte and Shin-Yi Lee Marzano; M.S. student (University of Illinois) Isabel Rosa; agricultural interns Gabriella Carrasco, Juan Laso, Griffith Lizarraga, Ayna Salas, Juan Jose Marroquin, Eliana Rosales, and Luis Orellana (Illinois Natural History Survey). In addition, John Shaw (Illinois Natural History Survey) and Martha Bazik (University of Illinois Extension) assisted the project before retiring in 2004. TARGET AUDIENCES: Organic growers and Extension/research individuals working in organic production systems or other sustainable agricultural systems. PROJECT MODIFICATIONS: Nothing significant to report during this reporting period.

2007/01/01 TO 2007/12/31 OUTPUTS: Project ILLU-371-522, "Cropping intensity and organic amendments in transitional farming systems: Effects on soil fertility, weeds, diseases and insects," started in 2003 as a multi-

disciplinary research and outreach effort of the Illinois Natural History Survey, University of Illinois, and University of Wisconsin. Its research objective is to compare the influence of organic transition plans differing in management intensity and organic amendments on weeds, soil fertility, soil invertebrates, and the relationship between fertility, plant health and insect and disease pressure. Management intensity treatments include: 1) intensive vegetable production, 2) less intensive cash grain production, and 3) unharvested grass-legume sod (perennial ley) as the low-intensity treatment. Soil-building amendments are cover crops or sod alone, added manure, or added compost. With the end of transition in 2006, the medium-intensity and low-intensity treatments were disbanded and the same intensive vegetable crops were grown in all plots, which differed then only in treatment history. Marketable fruit yield of tomato in 2006 was influenced by the history of cropping system intensity, with plants grown in the former low-intensity system (perennial ley) producing significantly higher yields. Supplemental soil amendment did not significantly increase yields in the former low-intensity system but did increase yield (depending on tomato variety) in the former intermediate- and high-intensity systems. The 2007 season was the fifth cropping season at the research site and one year after completion of the three-year transition period from conventional to organic production. Soybeans were grown in all plots, which differed then only in treatment history. Soil cores were collected to determine soil organic matter, biologically active N, microbial activity, proportion of soil amino sugars, and soil mite and nematode extraction. In plant disease ratings, soybeans grown in manure-amended areas of the former low-intensity system were found to have higher disease severity levels than in areas that had no supplemental soil amendments. In soil samples evaluated for disease suppression levels in greenhouse bioassays, there were no significant effects of previous soil amendment or previous intensity treatment in the *Rhizoctonia solani* assay, but in the *Fusarium solani* assay root volumes were higher on plants grown in soil from the manure-amended areas within the former medium-intensity system. Ground beetle populations were also monitored in pitfall traps during the 2007 season. In outreach activities, project investigators and graduate students participated in the "Crossing Over: Transitioning to Organic Farming" Tour (Danforth, IL), contributed articles pertinent to organic systems for the New Agriculture Network (<http://www.new-ag.msu.edu/>), and made presentations at the 99th Annual Meeting of the American Society of Agronomy. PARTICIPANTS: Dr. Edmond Zaborski, Illinois Natural History Survey; Dr. Michelle Wander, University of Illinois; Dr. John Masiunas, University of Illinois; Dr. Darin Eastburn, University of Illinois; Dr. Leslie Cooperband, University of Illinois; Deborah Cavanaugh-Grant, University of Illinois; Dan Anderson, University of Illinois; Dr. Jonathan Lundgren, USDA, Brookings SD; Carmen Ugarte, Ph.D. student, University of Illinois; Shin-Yi Lee Marzano, Ph.D. student, University of Illinois; Isabel Rosa, M.S. student, University of Illinois; Juan Jose Marroquin, intern, Illinois Natural History Survey; Luis Orellana, intern, Illinois Natural History Survey; Eliana Rosales, intern, Illinois Natural History Survey. TARGET AUDIENCES: Organic growers and growers interested in sustainable farming practices; Extension and research personnel working with growers interested in organic and sustainable farming.

2006/01/01 TO 2006/12/31 This project started in 2003 as a multi-disciplinary research/outreach effort of the Illinois Natural History Survey, University of Illinois, and University of Wisconsin. Its research objective is to compare the influence of organic transition plans differing in management intensity and organic amendments on weeds, soil fertility, soil invertebrates, and the relationship between fertility, plant health and insect/disease pressure. Management intensity treatments include 1) intensive vegetable production, 2) less intensive cash grain production, and 3) unharvested grass-legume sod as the low-intensity treatment. Soil-building amendments are cover crops or sod alone, added manure, or added compost. The 2006 season was the fourth cropping season at the research site and concluded the three-year transition period from conventional to organic production. Consequently, for 2006 the medium-intensity and low-intensity treatments were disbanded and the same intensive vegetable crops (tomato varieties Classica, Roma, Bellstar; bell pepper varieties Sweet Chocolate, New Ace, Orion) were grown over the entire site. Soil cores were collected to determine soil organic matter, biologically active N, microbial activity, proportion of soil amino sugars, and soil mite and nematode extraction. Nematodes were sorted into five functional groups: bacterial feeders, fungal feeders, plant parasites, omnivores, and predators. Samples from Spring 2006, when the site became eligible for organic certification, suggest that all three management intensity treatments (farming system approaches to transition) maintained or built organic matter levels and soil N supply potential to equal or exceed those found in long-term organic trials or in the surface depth of Illinois soils maintained under no-tillage management. Other 2006 data included emerged weed populations, ground beetle populations, soil mites, and plant disease incidence. From 2003 - 2006 weed numbers per plot decreased. Weed species composition has changed depending on management intensity and year. Common lambsquarters have become less frequent and *Amaranthus* species more frequent. Levels of *Septoria* leaf spot and anthracnose on tomato were significantly affected by previous cropping history and type of organic amendment. The general reduction in disease severity and increase in root length and volume observed since 2003 indicate that the level of disease suppressiveness in soils may be increasing regardless of type of treatment or amendment. In outreach activities, project investigators and graduate students participated in the second (January 11 - 12) and third (December 6 - 7) annual Illinois Organic Production Conference (Bloomington,

IL), contributed articles pertinent to organic systems for the New Agricultural Network (<http://www.ipm.msu.edu/new-ag.htm>), and made presentations at the 98th Annual Meeting of the American Society of Agronomy.

2005/01/01 TO 2005/12/31 This project started in 2003 as a multi-disciplinary research and outreach effort involving the Illinois Natural History Survey, University of Illinois, and University of Wisconsin. Its research objective is to compare the influence of organic transition plans differing in management intensity and organic amendments on weeds, soil fertility, soil invertebrates, and the relationship between fertility, plant health and insect/disease pressure. Management intensity treatments include 1) intensive vegetable production, 2) less intensive cash grain production, and 3) unharvested grass-legume sod. Soil-building amendments are cover crops or sod alone, added manure, or added compost. Plantings in 2005 were winter squash (high intensity), field corn (medium intensity), and grass/legume ley (low intensity). Very dry conditions affected growing conditions during the season. In preliminary findings, D. Eastburn reports that disease severity (% leaf area infected) of common rust on corn was significantly higher in plots receiving added manure compared to plots amended only with cover crop residues, while rust severity in plots receiving added leaf composts was statistically similar among amendment treatments. Powdery mildew severity on squash was significantly less in plots with added leaf composts compared to plots amended with cover crop residues alone, while severity in plots with added manure was not significantly different from other amendment treatments. Severity of downy mildew on squash was not affected by type of soil amendment. C. Eastman reports that use of a Blue Hubbard-type squash planted as a single trap border row around plots of butternut squash reduced numbers of cucumber beetles on butternut squash plants. Bacterial wilt on squash was not detected. Other 2005 data included emerged weed populations, ground beetle populations, soil mites, and nematodes; processing and interpretation of these data are continuing. In other data from 2004, caterpillar pest abundance in broccoli/cabbage plots was not significantly influenced by type of soil amendment. In outreach efforts in 2005, project investigators and graduate students participated in the first Illinois Organic Production Conference (Bloomington), contributed articles pertinent to organic systems for the New Agricultural Network (<http://www.ipm.msu.edu/new-ag.htm>), made presentations at the Soil Ecology Society Tenth Biennial Conference at Argonne National Laboratory (Batavia), presented project results at the North Central Branch-Entomological Society of America meetings (W. Lafayette, IN), and hosted an on-farm tour of the research plots (Champaign) for the Organics from Seed to Table Field Day (part of the University of Illinois Sustainable Agriculture Tour). A manuscript by J. Lundgren and colleagues from the first two seasons (The influence of organic transition systems on beneficial ground-dwelling arthropods and predation of insects and weed seeds) has been accepted for publication in *Renewable Agriculture and Food Systems* in 2006.

2004/01/01 TO 2004/12/31 This project was initiated in September 2003 as a multi-disciplinary research and outreach effort involving participants from the Illinois Natural History Survey, University of Illinois, and University of Wisconsin. The research objective of the organic transitions project is to compare the influence of transition plans differing in management intensity and organic amendments on weeds, soil fertility, soil invertebrates, and the relationship between fertility, plant health and insect/disease pressure. Management intensity treatments include 1) intensive vegetable production with frequent tillage, 2) less intensive cash grain production, and 3) unharvested grass-legume sod. Soil-building amendments are cover crops or sod alone, added manure, or added compost. Plantings in 2004 research plots were cabbage/broccoli (high intensity), winter wheat (medium intensity), and grass/legume ley (low intensity). Data collected during the season included emerged weed populations, plant disease levels, pest and predator insect populations, soil mites, and nematodes (including bacterial and fungal feeders, plant parasites, omnivores and predators). In preliminary research findings, D. Eastburn reports no significant differences in wheat disease incidence among organic amendment sub-treatments except in the incidence of general yellowing of the flag leaf; yellowing was highest in compost-amended subplots. Leaf rust incidence in the grass component of the grass/legume ley subplots was highest in the manure-amended subplots. There were no significant differences in downy mildew or black rot incidence on cabbage and broccoli among sub-treatments. C. Ugarte reports preliminary information that organic amendment, especially with manure, had a greater positive impact on bacterial-feeding nematodes than did management intensity treatment (low versus high-intensity management, the two systems that received manure applications in 2004). Fungal feeders were highest in fall 2004 in the low intensity (grass/legume ley) treatment. Plant parasitic nematodes were not influenced by type of amendment but were affected negatively by the level of management intensity. Findings by J. Lundgren on ground beetles and other predator groups were reported in ILLU-875-342. In outreach efforts, principal investigators contributed articles to the on-line website New Agricultural Network (<http://www.ipm.msu.edu/new-ag.htm>), gave talks at a Professional Development Opportunity for Illinois Extension personnel dealing with organic production, and developed a FACTSHEET on organic certification in Illinois. The investigators also communicated frequently with their organic grower advisory board and participated in on-farm visits with these advisors in 2004.

2003/01/01 TO 2003/12/31 This multi-disciplinary research and outreach effort involves participants from the Illinois Natural History Survey, University of Illinois, and University of Wisconsin. Over six acres on the University of Illinois Cruse Farm (Champaign) have been set aside for this multi-year project. The organic transitions project is designed to 1) compare influence of transition schemes that differ in management intensity and organic amendments on weeds, soil fertility, soil invertebrates, and the relationship between fertility, plant health and insect/disease pressure, and 2) to develop relevant, accessible outreach and educational products for organic producers. Management intensity treatments include 1) intensive vegetable production with frequent tillage, 2) less intensive cash grain production, and 3) unharvested grass-legume sod. Soil-building amendments will be cover crops or sod alone, added manure, or added compost. An advisory board of organic producers has been established to refine objectives, lend expertise in farming systems management, provide input on the relevance of experimental approaches and treatments, and evaluate the results of experiments. The project's goal is to establish an organic systems program--a partnership of organic producers, researchers, and extension educators--that improves performance of organic systems and enhances the ability of farmers to meet the growing demand for organic products. Prior to the official start of the grant, funds from ILLU-875-342 and other sources were used to establish cover crops at the research site (fall 2002), initiate crop rotations (May 2003), and collect baseline field data to increase the start-up value of the project. First-season field data included initial soil fertility parameters, weed seed bank, productivity of summer crops (tomatoes, soybeans), insect pests, soil pathogens, and insect predator (carabid beetle) incidence and activity.

IMPACT

2003/09 TO 2008/09 Soil quality improved during transition in all systems despite quite different management histories. Nematode maturity indices during transition showed a dominance of fungal and bacterial-feeding species that influence N mineralization. All transition strategies maintained target particulate organic matter carbon concentrations and contained high (possibly in excess) labile N concentrations. High structure index values suggest the presence of a diverse, complex nematode community at the end of transition (spring 2006). These values fell regardless of treatment history, however, once intensive vegetable cultivation was done across all plots in 2006, the first post-transition season. There were some effects of amendments on some diseases during specific transition growing seasons. No differences in soil disease suppressiveness associated with either cropping system or amendment were seen in greenhouse bioassays. General levels of suppressiveness over all treatments increased over the three transition years, with a general reduction in disease severity and an increase in root length and volume. *Pseudomonas fluorescens* populations (an indicator species for disease suppressiveness) increased significantly during the two post-transition seasons. There were significant associations between *P. fluorescens* levels and severity levels of downy mildew (2005) and between *P. fluorescens* levels and soybean sudden death syndrome root discoloration severity levels as well as root volumes in response to infection by *Rhizoctonia solani* in greenhouse bioassays. Emerged weeds per plot in the different systems decreased from 2003 - 2006. The low-intensity system had the most weeds initially but the fewest subsequently. Weed species composition changed depending on the management intensity and year, while species diversity in the seed bank increased from 2003 to 2005. The low-intensity system supported larger, more diverse carabid beetle populations during the first two transition seasons. Tomato yields in the first year after transition (2006) were significantly higher in plots previously in low-intensity management for *Classica* and *Bellstar* varieties but only marginally higher for the *Roma* variety. Fruit quality differed among varieties but did not vary based on management history except for brix values, which were significantly greater in *Classica* tomatoes from plots with a history of high-intensity compared with low-intensity management. Soybean yields (2007) were 42% higher in plots with a history of low-intensity management compared to other treatment histories. These results indicate the advantages of a low-intensity (perennial ley) system for transitioning land from conventional to organic management. Results are being disseminated through research publications and electronic newsletters, participation in organic field days and workshops, presentations in professional society meetings, and preparation of articles for the initial launch of eOrganic COP content in January 2009 on eXtension.org. More materials will be developed after completion of Ph.D. dissertations of C. Ugarte and S. Marzano and the M.S. thesis of I. Rosa in 2009. **PUBLICATIONS (not previously reported):** 2003/09 TO 2008/09 1. Lundgren, J.G. 2005. Ground beetles as weed control agents: Effects of farm management on granivory. *American Entomologist*. 51(4): 224-226. 2. Masiunas, J. 2005. Managing Canada thistle in organic cropping systems. *New Agriculture Network* 2(3); <http://www.ipm.msu.edu/new-ag.htm>. 3. Wander, M. 2005. Soil quality, soil testing and organic standards. *New Agriculture Network* 2(10); <http://www.ipm.msu.edu/new-ag.htm>. 4. Zaborski, E. 2005. Feed the soil. *New Agriculture Network* 2(11); <http://www.ipm.msu.edu/new-ag.htm>. 5. Eastman, C., et al. 2005. Progress report on Illinois agricultural research site in transition to organic production. *New Agriculture Network* 2(11);

<http://www.ipm.msu.edu/new-ag.htm>. 6. Masiunas, J. 2006. Integrated weed management for organic field crops. *New Agriculture Network*, Vol. 3(3); May 10. 7. Eastburn, D. 2006. Organic matter amendments and the development of disease suppressive soils. *New Agriculture Network*, Vol. 3(7); <http://www.ipm.msu.edu/new-ag.htm>, July 12. 8. Ugarte, C. and Wander, M. 2006. So you want to manage soil food webs Focus on nematodes. *New Agriculture Network*, Vol. 3(8); <http://www.ipm.msu.edu/new-ag.htm>, July 26. 9. Wander, M. 2006. Philosophies of soil management. *New Agriculture Network*, Vol. 3(8); <http://www.ipm.msu.edu/new-ag.htm>, July 26. 10. Masiunas, J. and Bicksler, A. 2006. Evaluating organic herbicides, summer annual cover crops and mowing for Canada thistle control. *New Agriculture Network* Vol. 3(10); <http://www.ipm.msu.edu/new-ag.htm>, Aug. 23. 11. Cavanaugh-Grant, D. et al. 2005. FAQ about organic agriculture. *New Agriculture Network* 2(5); <http://www.ipm.msu.edu/new-ag.htm>. 12. Masiunas, J. 2005. Thermal weed control. *New Agriculture Network* 2(6); <http://www.ipm.msu.edu/new-ag.htm>. 13. Eastman, C., Zaborski, E., Wander, M., Eastburn, D., Masiunas, J., Cooperband, L., Cavanaugh-Grant, D., Anderson, D., Ugarte, C., Lee, S.-Y., Rosa, I. and Lundgren, J. 2006. Agricultural research site in transition to organic production: What will the fourth season (end of transition) tell us *New Agriculture Network* Vol. 3(11); <http://www.ipm.msu.edu/new-ag.htm>, Sept. 13. 14. Marzano, S.L. and Eastburn, D. 2007. Assessment of disease suppression in organic transition farming systems. *Phytopathology* 97:S71. 15. Eastburn, D. and Marzano, S. 2007. Transition strategies and disease suppressive soils. *New Agriculture Network* Vol. 4(7); <http://www.new-ag.msu.edu/index.htm>, Aug. 15. 16. Eastman, C., Zaborski, E., Wander, M., Eastburn, D., Masiunas, J., Cooperband, L., Cavanaugh-Grant, D., Anderson, D., Ugarte, C., Lee, S.-Y., Rosa, I. and Lundgren, J. 2007. Agricultural research site in transition to organic production: Notes from the home stretch. *New Agriculture Network* Vol. 4(10); <http://www.new-ag.msu.edu/index.htm>, Oct. 10. 17. Masiunas, J. 2007. Managing the soil seed bank in organic crops. *New Agriculture Network* Vol. 4(3); <http://www.new-ag.msu.edu/index.htm>, May 23. 18. Wander, M., Ugarte, C. and Zaborski, E. 2007. Transition practices and soil fertility. *New Agriculture Network* Vol. 4(9); <http://www.new-ag.msu.edu/index.htm>, Sept. 12. 19. Eastman, C. 2008. Illinois reports on six years of transitioning knowledge. *New Agricultural Network*, Vol 5 (11); <http://www.new-ag.msu.edu/index.htm>, Oct. 15.

2007/01/01 TO 2007/12/31 This project is comparing organic transition strategies for their effects on soil fertility, weeds, plant diseases, and insects in order to provide science-based information in a readily accessible way to producers and research and Extension personnel who work with them. The information generated will aid with crucial issues such as best methods of transitioning from conventional to organic production, evaluation of organic farming systems, enhancing natural pest management components, and long-term sustainability. Evaluation of the research findings and plans for their use in outreach publications will be discussed with organic grower advisors in meetings in January and February 2008. The project will seek organic certification of its research field site in 2008.

2006/01/01 TO 2006/12/31 Despite its fast growth, organic farming has relatively little science-based information available or readily accessible to producers on crucial issues such as best methods of transitioning from conventional to organic production, evaluation of organic farming systems, enhancing natural pest management components, and long-term sustainability. This project is comparing transition strategies for their effects on soil fertility, weeds, plant diseases, and insects. It is also developing science-based information on organic management practices for current and potential organic producers. The project will seek organic certification of its research field site in 2007.

2005/01/01 TO 2005/12/31 Despite its fast growth, organic farming has relatively little science-based information available or readily accessible to producers on crucial issues such as best methods of transitioning from conventional to organic production, evaluation of organic farming systems, enhancing natural pest management components, and long-term sustainability. This project is comparing transition strategies for their effects on soil fertility, weeds, plant diseases, and insects. It is also developing science-based information on organic management practices. The project will seek organic certification of its research field site in 2006.

2004/01/01 TO 2004/12/31 This multi-disciplinary research and outreach team is already serving as an active resource for improving the two-way flow of information between Illinois organic growers and agricultural scientists. It is also a focal point for involving other scientists and other disciplines in organic systems research.

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PUBLICATIONS

2007/01/01 TO 2007/12/31 No publications reported this period

2006/01/01 TO 2006/12/31 Lundgren, J.G., Shaw, J.T., Zaborski, E.R. and Eastman, C.E. 2006. The influence of organic transition systems on beneficial ground-dwelling arthropods and predation of insects and weed seeds. *Renewable Agriculture and Food Systems* 21: 227-237.

2005/01/01 TO 2005/12/31 No publications reported this period

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