OREI Project Details

Award Year 2007

7 Research Projects

PROJECT INDEX

Effects of Organic Fertility Management on Crop Health and Phytochemical Content of Vegetables Under Open Field and High Tunnel Production

Accession No.	0210178
Subfile	CRIS
Project No.	KS600601
Agency	NIFA KAN
Project Type	OTHER GRANTS
Project Status	TERMINATED
Contract / Grant No.	2007-51300-03790
Proposal No.	2007-01398
Start Date	01 JUN 2007
Term Date	31 MAY 2012
Fiscal Year	2009
Grant Amount	$500,698
Grant Year	2007
Investigator(s)	Carey, T.; Janke, R.; Williams, K.; Rajashekar, C.; Kennelly, M.; Nechols, J.; Cloyd, R.; Nelson, N.
Performing Institution	HORTICULTURE & FORESTRY, KANSAS STATE UNIV, MANHATTAN, KANSAS 66506

NON-TECHNICAL SUMMARY

The goal of this multidisciplinary project is to improve our understanding of the influence of organic fertilizer sources on crop health, including pest and disease resistance, yield, and quality of vegetable crops. Specifically, we will compare low and high rates of selected organic fertilizer sources and contrast them to equivalent rates of conventional fertilizers in replicated, long-term field and high tunnel (unheated greenhouse) plots. The effect of these four contrasting systems will be measured on plant and soil nutrient status and soil quality attributes. Insect and disease presence and abundance on plants will be assessed. We will also evaluate whether there is an influence on phytonutrient and phytochemical levels (β-carotene, folic acid, vitamin C, vitamin E, individual and total phenolics, and antioxidant levels) and whether these, in turn, affect pest and disease incidence. Crops evaluated will include tomato and pac choi. Tomato is economically important, and pac choi, an important Asian vegetable, has proven to be a valuable model crop in our preliminary studies, due to its responsiveness to fertility, susceptibility to insect attack, and phytochemical response. This three-year effort will emphasize regionally available organic fertility options in experiment station and farm-based studies to produce results with specific regional application, but with broader relevance to global organic production.

OBJECTIVES

1. Determine the levels of selected phytochemicals in tomato and pac choi grown with organic and conventional fertilizers at low and high N application rates. 2. Assess the activation of key genes involved in the biosynthesis of phytochemicals in tomato and pac choi as a potential technique for rapid evaluation of crop response to organic fertility treatments. 3. Measure soil fertility and quality and plant nutrient status in relation to tomato and pac choi production at high and low rates of N-fertilization in open field and high tunnel production systems. 4. Use field

and greenhouse studies to measure the effects of organic N-fertilization and high tunnel production environments on insect and disease pressure in tomato and pac choi. 5. Determine the relationship between phytochemical content (in response to organic N-fertilization) and disease and insect pest reaction. 6. Develop fact sheets, websites, workshops, and other outreach information and evaluate impact using pre- and post-tests. Integrate the outreach information into new courses at KSU and develop formats available for distance-education.

APPROACH

Overview of field site, Replicated trials will be conducted at the KSU Research and Extension Center, Olathe. At this site, 3 organic high tunnels (20ft x 32ft Stuppy Polar Cold Frames, with single layer poly and 5ft rollup sides) and 3 conventional tunnels were established in a paired replicated arrangement in 2002, to allow statistically valid comparisons between organic and conventional systems. Adjacent replicated organic and conventional field plots provide additional environments and permit comparisons between high tunnel and open field conditions. Experimental approach. Soil fertility treatments chosen during the course of trials conducted under this project will be determined by the project team and advisory group, and will be selected based on N availability from mineralization study results, total N content, local availability, cost and other factors, so that the organic fertility treatments represent actual on-farm practices typical of the Great Plains. Soil fertility treatments in the form of composts will be chosen that meet requirements of the National Organics Standards Board for soil fertility and crop nutrient management. Fertility applications will be consistent across all treatment replications and carefully quantified. High fertility levels for organic treatments will be based on soil analyses, and will start from the reference point of our current practice, which is to apply compost at double the conventional N fertilizer requirement for conventionally grown vegetable crops in Kansas. Low fertility levels will be established by applying N at sub optimal rates in organic and conventional plots, with rates to be determined based on soil tests, but aiming to supply one half the required N for the crop. High N plots will likely receive split applications, with shallow pre-plant incorporation of compost followed by fertigation with water soluble fertilizer (e.g., fish emulsion). Low N plots would receive only pre-plant fertility treatments. Inorganic fertilizer salts that are immediately soluble will be applied to the inorganic fertilizer plots. Application rates of other nutrients (P, K, etc.) will be matched between conventional and organic treatments to the extent possible, but the intention of our treatment selection is to represent actual on farm practices. Therefore, effects of any differences in application rates of nutrients besides N, such as micronutrients that are applied via fish emulsion in the organic treatment but not in the inorganic treatment, will be assessed with the plant tissue and soil analyses. Differences between conventional and organic treatments can be correlated to yield and other responses with multivariate statistical analyses. The influences of N-sources at low and high rates on crop phytochemistry, and on disease and pest incidence and reaction will be examined on selected vegetable crops, particularly tomato and pac choi.

PROGRESS

2007/06 TO 2012/05 OUTPUTS: The four-year study examines the health-promoting qualities of pac-choi and tomato in relation to their phytochemicals as influenced by cultural and management practices such various fertility levels in high tunnel and open field conditions under organic and conventional managements during 2008-2012. Typically two crops of pac-choi, cv. Mei Qing Choi (spring and fall) and one summer crop of tomato, cv. Bush Celebrity were grown each year at the K-State Horticulture Research and Extension Center, Olathe, KS. However during 2010 (fourth year of the field trial) only tomato crop was evaluated for the phytochemical content. Open field and high tunnel fields were set up adjacent to each other, each containing organic and conventional plots (9.8 x 6.1 m) receiving either conventional or organic management practices. Each plot was further divided into 3 subplots, each of which received 3 levels of fertility, namely; no fertilizers (control), a basal application of fertilizer or compost (low fertility) and basal doze plus additional fertilization through fertigation with either synthetic fertilizers or fish hydrolyzate (high fertility). The field trial was conducted using a latin square design with 3 replications. Plots were fertilized with basal dose before planting and organic plots were fertilized with Hu More compost. Seedlings were grown in a greenhouse for 4 weeks and transplanted to the field and were drip-irrigated as needed. The two crops were rotated in each plot with fall cover crop (rye) and buckwheat planted between spring and fall pac-choi crops. However, during 2010, only summer tomato crop was grown. The incidence of pests was monitored and pesticide application was not warranted during 2010 crop season. During 2011-2012, phytochemical analyses from field samples and data analyses, interpretation and coordination were accomplished. Soil analyses for available nitrogen (nitrate and ammonium forms) before planting and tissue analyses for nitrate nitrogen at various stages of crop growth were performed to determine the effects of fertility management practices and production environments on crop quality, performance and yield. Crop quality was also evaluated by determining the total phenolic content including the levels of several key phenolic compounds and the antioxidant capacity in pac-choi and tomato fruits at various stages of crop growth. In addition,

complementary greenhouse and field studies were conducted to determine the impact of fertility levels and management practices on the phytochemical content and pest incidence in pac-choi. The results were shared with growers, grower groups, extension personnel and other stakeholders. Outreach activities included presentations made at grower conferences, seminars at universities and presentations at the annual conference of the American Society for Horticultural Science. PARTICIPANTS: In addition to the PIs and Co-PIs following graduate students contributed to this project. Rojee Pradhan, M. S. student involved in phytochemical and crop quality aspects. Myung-Min Oh, Ph.D. student involved in phytochemical and crop quality aspects. May Altamimi, M.S. student involved in soil and tissue analyses. Martin Talavera, Ph.D. student involved in sensory and crop quality analyses. Wendy Johnson, Ph.D. student involved in phytochemical- pest interactions. TARGET AUDIENCES: The target audience includes many segments of our society including professionals involved in academic endeavors, and food and agriculture-related industry, growers, consumers and other stakeholders. PROJECT MODIFICATIONS: The only modifications were two no-cost time extensions of this project until 5/1/2012 with a change of principal investigators to C. B. Rajashekar and Rhonda Janke.

2010/06/01 TO 2011/05/31 OUTPUTS: The study examines the health-promoting qualities of pac-choi and tomato in relation to their phytochemicals as influenced by cultural and management practices such various fertility levels in high tunnel and open field conditions under organic and conventional managements. Typically two crops of pac-choi, cv. Mei Qing Choi (spring and fall) and one summer crop of tomato, cv. Bush Celebrity were grown each year at the K-State Horticulture Research and Extension Center, Olathe, KS. However during the current year (fourth year of the field trial) only tomato crop was evaluated for the phytochemical content. Open field and high tunnel fields were set up adjacent to each other, each containing organic and conventional plots (9.8 x 6.1 m) receiving either conventional or organic management practices. Each plot was further divided into 3 subplots, each of which received 3 levels of fertility, namely; no fertilizers (control), a basal application of fertilizer or compost (low fertility) and basal doze plus additional fertilization through fertigation with either synthetic fertilizers or fish hydrolyzate (high fertility). The field trial was conducted using a latin square design with 3 replications. Plots were fertilized with basal dose before planting and organic plots were fertilized with Hu More compost. Seedlings were grown in a greenhouse for 4 weeks and transplanted to the field and were drip-irrigated as needed. The two crops were rotated in each plot with fall cover crop (rye) and buckwheat planted between spring and fall pac-choi crops. However, during 2010, only summer tomato crop was grown. The incidence of pests was monitored and pesticide application was not warranted during 2010 crop season. Soil analyses for available nitrogen (nitrate and ammonium forms) before planting and tissue analyses for nitrate nitrogen at various stages of crop growth were performed to determine the effects of fertility management practices and production environments on crop quality, performance and yield. Crop quality was also evaluated by determining the total phenolic content including the levels of several key phenolic compounds and the antioxidant capacity in pac-choi and tomato fruits at various stages of crop growth. In addition, complementary greenhouse and field studies were conducted to determine the impact of fertility levels and management practices on the phytochemical content and pest incidence in pac choi. The results were shared with growers, grower groups, extension personnel and other stakeholders. Outreach activities included presentations made at grower conferences, seminars at universities and presentations at the annual conference of the American Society for Horticultural Science. PARTICIPANTS: In addition to the PIs and Co-PIs following graduate students contributed to this project. Rojee Pradhan, M. S. student involved in phytochemical and crop quality aspects. Myung-Min Oh, Ph.D. student involved in phytochemical and crop quality aspects. May Altamimi, M.S. student involved in soil and tissue analyses. Martin Talavera, Ph.D. student involved in sensory and crop quality analyses. Wendy Johnson, Ph.D. student involved in phytochemical- pest interactions. TARGET AUDIENCES: The target audience includes many segments of our society including professionals involved in academic endeavors, and food and agriculture-related industry, growers, consumers and other stakeholders. PROJECT MODIFICATIONS: The only modifications were two no-cost time extensions of this project until 5/1/2012 with a change of principal investigators to C. B. Rajashekar and Rhonda Janke.

2009/06/01 TO 2010/05/31 OUTPUTS: The ongoing-project involving two crops of pac-choi (spring and fall) and a summer tomato crop continued for the third year during 2009. The planning for the various activities scheduled for 2009 began early in February, 2009 and the research team made up of graduate students and their advisers and the supporting technicians and crew met once a month to share information, plan activities, revise the plan of action, if warranted based on past years\' experience, and review progress of the project during 2009. In a four-year field trail at the K-State Horticulture Research and Extension Center, Olathe, pac choi and tomato are being evaluated for their health-promoting qualities under organic and conventional management practices in open field and high tunnels. At this site, plots of open field and high tunnels were set up adjacent each other. Each plot (9.8 x 6.1 m) receiving either conventional or organic management practices was divided into 3 subplots. The fertility treatments were assigned to subplots at three levels; control- no fertilizer, medium fertility- a basal application of

either compost or synthetic fertilizer, and high fertility- basal dose plus fertigation with fish hydrolyzate or synthetic fertilizer. The fertilization rates were based on the soil tests. Organic plots were fertilized with Hu-More compost before transplanting. The fertility levels were assigned using a latin square design with 3 replications. Pac choi (cv. Mei Qing Choi) and tomato (cv. Bush Celebrity) were transplanted into the plots and were drip irrigated as needed Two crops of pac choi and one crop of tomato were grown during the year. The experimental design included crop rotations, with tomato and pac choi rotating to opposite sides of the plot each year, as well as cover crops (rye) and with buckwheat sown between spring and fall pac choi plantings. The pest incidence was monitored through out the growing season and was controlled using organically approved pesticides. Soil analyses for available nitrogen (nitrate and ammonium forms) and tissue analyses for nitrate nitrogen at various stages of crop growth were performed to determine the effects of fertility management practices and production environments on crop quality, performance and yield. Crop quality was evaluated by determining the total phenolic content including the levels of several key phenolic compounds and the antioxidant capacity in pac-choi and tomato fruits at various stages of crop growth. In addition, complementary greenhouse and field studies were conducted to determine the impact of fertility levels and management practices on the phytochemical content and pest incidence in pac choi. Outreach activities included presentations made at grower conferences, seminars at universities and a presentation at the annual conference of the American Society for Horticultural Science. PARTICIPANTS: In addition to the PIs and Co-PIs following graduate students contributed to this project. Myung-Min Oh, Ph.D. student involved in phytochemical and crop quality aspects. May Altamimi, M.S. student involved in soil and tissue analyses. Martin Talavera, Ph.D. student involved in sensory and crop quality analyses. Wendy Johnson, Ph.D. student involved in phytochemical-pest interactions. TARGET AUDIENCES: The target audience includes many segments of our society including professionals involved in academic endeavors, and food and agriculture-related industry, growers, and consumers. PROJECT MODIFICATIONS: The only modification was a no-cost time extension of this project until 5/1/2011 with a change of principal investigators to C. B. Rajashekar and Rhonda Janke.

2008/06/01 TO 2009/05/31 OUTPUTS: Activities during the second year of our project were conducted during parts of the 2008 and 2009 cropping seasons. Activities were planned, and progress reviewed during monthly team meetings, involving all team members including graduate students, and we held a meeting in August of 2008 with our grower steering committee to review results and visit field plots. Teams made up of graduate students and their advisors planned and conducted activities in specific focus areas - plant and soil nutrition; phytochemical analysis; crop health; and sensory analysis. The primary trial site was in the field at the K-State Horticulture Research and Extension Center, Olathe, where pac choi and tomato were evaluated under organic and conventional fertility regimes in the open field and under high tunnels at a trial site established in 2002. At this site, open field plots are in a block adjacent to high tunnel plots, and within these blocks, pairs of plots are managed organically or conventionally. High tunnel and open field plots are 9.8 x 6.1 m, and high tunnels have 1.5 m rollup sidewalls. Within each plot, three fertility levels were established in subplots 3.2m x 6.1m: no fertilizer (control), medium fertility (compost or synthetic fertilizer) and high fertility (compost or synthetic fertilizer, plus fertigation with fish hydrolyzate or synthetic fertilizer). These fertility levels were assigned using a latin square design to control for possible position effects in high tunnel plots. Within each plot, pac choi (cv. Mei Qing Choi) and tomato (cv. Bush Celebrity) were planted in strips occupying one-half of the plot and covering each of the soil fertility treatments. Two crops (spring and fall) of pac choi were grown during the year and one crop of tomato (summer). The experimental design included crop rotations, with tomato and pac choi rotating to opposite sides of the plot each year, as well as cover crops, with plots sown to rye in the winter, and with buckwheat sown between spring and fall pac choi plantings. To avoid confounding of pest attack and fertility effects on crop phytochemical content, pest incidence was monitored and controlled using organically approved pesticides. Tomato diseases were monitored but not controlled, and were a problem, particularly in field plots. Soils and crops were sampled during growth with particular attention to nitrate, phenolic and antioxidant contents, and yield and quality monitored to determine effects of organic fertility management on crop health and phytochemical content. Complementary greenhouse trials were conducted to evaluate effects of organic fertility management on pac choi. In 2008, separate field trials evaluated efficacy of organic pesticides for control of pests of tomato and pac choi. In 2009, controlled greenhouse and field studies evaluated effects of fertility and pest incidence on crop health. Outreach activities included presentations made at grower conferences, seminars presented at universities and a poster presentation at the annual conference of the American Society for Horticultural Science. Many visitors saw and heard about our trials. PARTICIPANTS: Dorith Rotenberg assisted with statistical analysis and integration of data sets produced by the nutrition, plant health, phytochemical and sensory analysis teams. Myung-Min Oh, Ph.D. student under the project, defended his thesis. May Altamimi, M.S. student under the project, defended her thesis. Martin Talavera, Ph.D. student under the project, defended his thesis. Other project partners contributed in an ongoing fashion to project activities through supervision of graduate students, and participation in project meetings. TARGET AUDIENCES: Academic, producer and consumer audiences have been interested in research approaches and results obtained from experiments conducted under this project, and

are eager to receive take-home messages from this research PROJECT MODIFICATIONS: The only modifications which have occurred under the project were the addition of a component of research - sensory analysis - at no extra charge to the project.

2007/06/01 TO 2008/05/31 OUTPUTS: During this initial partial project reporting period activities have been completed related to the goals and objectives of the project. Project partners have met intensively, graduate students and technicians have been recruited, and initial trials have been conducted at the Olathe trial site. Insect and diseases have been monitored, crop fertilizer effects assessed through tissue analysis and yield measurement. These preliminary trials and other activities, including consultation with the project steering committee, have helped set the stage for what we hope will be a productive year of the work in 2008. PARTICIPANTS: Steering Committee partners, including Kansas Rural Center, Kansas City Center for Urban Agriculture, and organic farmers Bob Lominska, Stu Shafer, and Robins Hail and Jim Wood TARGET AUDIENCES: Organic and conventional fruit and vegetable farmers, the broader communities of researchers and consumers interested in health-promoting aspects of organic food. PROJECT MODIFICATIONS: Nothing significant to report during this reporting period.

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IMPACT

2007/06 TO 2012/05 The project examines the effects of cultural and management practices on the quality of pac-choi and tomato with regard to their health-promoting phytochemiclas. The results of this study are expected to provide useful information to growers on the best management practices in relation to fertility management and production practices to improve the health-promoting qualities of pac choi and tomato. The consistent results from the three years of field trial was that both crops grown in open field had higher total phenolic content and antioxidant capacity than did those grown in high tunnels. Spring pac-choi was generally richer in phytochemical content than fall crop. This trend was true regardless of the management conditions and fertility levels. However, there were no significant differences in phytochemical content between management conditions and fertility levels in fall pac-choi. In spring crop of pac-choi the levels of ferulic acid, caffeic acid and sinapic acid were higher when grown in open field than in high tunnels. Also, higher fertility both in organic and conventional plots tend to lower the accumulation of several phenolic compounds including sinapic acid, caffeic acid and ferulic acid. However, there were no significant difference in phytochemicals between pac-choi grown under organic and conventional managements. In tomatoes, the accumulation of rutin, chlorogenic acid and ferulic acid was higher in crops grown in open field than in high tunnels. Higher fertility tend to lower the accumulation of some phenolic compounds in tomato crop both in organically and conventionally managed plots. The results were variable from year to year. There were no overall significant differences in phytochemical content between tomatoes grown under organic and conventional management. The phenolic content of tomato fruit depend on its stage of maturity. Typically unripe fruits had very little of phenolic compounds but accumulate as they mature and ripen. Fully ripe or partially ripe fruits had the highest amount of phenolic compounds including ruitn, caffeic acid, ferulic acid, chlorogenic acid and myricetin. This trend was consistent regardless of growing conditions and crop management practices and fertility levels. The consistent observation that open field improves the phytochemical content in these crops suggests that high light intensity and even UV-B, which is a part of the solar radiation, may have a positive impact on the health-promoting qualities of these vegetables. However, it should be noted that the biomass accumulation and yield were significantly lower in crops grown in open field than those grown in high tunnels. With regard to fertility, soil N levels were affected by management practices, fertility source and rates. Low levels of N produced higher total phenoilc content with significant increase accumulation of specific phenolic compounds in tomatoes. The results suggest that growing tomatoes and pac-choi in open field with low N- fertility

may improve the health-promoting qualities but with lower yield compared to high tunnel production environment. **PUBLICATIONS (not previously reported):** 2007/06 TO 2012/05 1. M. M. Oh, E. E. Carey, C. B. Rajashekar, 2011, Antioxidant phytochemical in lettuce grown in high tunnels and open field, Hort. Environ. Biotechnol. 52: 133-139 2. M. M. Oh, R. Janke, E. E. Carey and C. B. Rajashekar, 2011, Effects of growing conditions and fertility levels on the health-promoting phytochemicals in tomato and pac-choi, Annual meeting of the American Society for Horticultural Science, 2011

2010/06/01 TO 2011/05/31 The study addresses the impact of cultural and management practices on the quality of pac-choi and tomato with regard to their health-promoting phytochemiclas. The results of this study are expected to provide useful information to growers on the best management practices in relation to fertility management and production practices to improve the health-promoting qualities of pac choi and tomato. The consistent results from the three years of field trial was that both crops grown in open field had higher total phenolic content and antioxidant capacity than did those grown in high tunnels. This trend was true regardless of the management conditions and fertility levels. During the 2010 growing season, significant increase in chlorogenic acid, p-coumaric acid and rutin were observed in tomato fruits from crops grown in open field compared to those grown in high tunnels. The rutin content in the fruits from open field was approximately four-times higher than those grown in high tunnels. The ruitn accumulation in tomato increased during fruit ripening while other phenolic compounds including ferulic acid decreased. However, some phenolic compounds including caffeic acid and p-coumaric acid were found only in the ripened fruits but not in green fruits suggesting that the stage of fruit ripening has a significant effect on the composition and the content of phytochemicals. The consistent observation that open field improves the phytochemical content in these crops suggests that high light intensity and even UV-B, which is a part of the solar radiation, may have a positive impact on the health-promoting qualities of these vegetables. However, it should be noted that the biomass accumulation and yield were significantly lower in crops grown in open field than those grown in high tunnels. The overall response of phytochemicals to organic management was variable in tomatoes and a clear trend was not apparent. This is consistent with observations from previous years and with observations on pac-choi. With regard to fertility, soil N levels were affected by management practices, fertility source and rates. Low levels of N produced higher total phenoilc content with significant increase accumulation of specific phenolic compounds in tomatoes. Although this was clear in open field, the results were somewhat variable in high tunnels and with organic management. The results suggest that growing tomatoes in open field with low N- fertility may improve the health-promoting qualities but with lower yield compared to high tunnel production environment.

2009/06/01 TO 2010/05/31 The results of this study are expected to provide useful information to growers on the best management practices in relation to fertility management and production practices to improve the health-promoting qualities of pac choi and tomato. Our preliminary results show that crops grown in open field had higher total phenolic content and antioxidant capacity in both pac-choi and tomato compared to those grown in high tunnels. In addition, significant increase in chlorogenic and caffeic acids in pac choi and chlorogeic acid and rutin in tomato fruits were observed in crops grown in open field. The improved phytochemical content in these crops grown in open field appears to be due to higher light intensity in open field relative to high tunnels. However, the biomass accumulation and yield were significantly lower in crops grown in open field than in high tunnels. The overall response of phytochemicals to organic management was variable in both pac choi and tomato and a clear trend was not apparent. This is consistent with observations from previous years. With regard to fertility, soil N levels were affected by management practices, fertility source and rates. Low levels of N produced higher total phenolic content with significant increase accumulation of specific phenolic compounds in pac choi and tomato. In summary, the results suggest that growing pac choi and tomato crops in open field and with low fertility (N) has a beneficial effect in improving their quality in relation to their health-promoting phytochemicals.

2008/06/01 TO 2009/05/31 Since experiments have not yet been concluded, it is too early to reach conclusions about changes in knowledge that have occurred with respect to our research objectives. Our experimental set-up, with its comparable nutrient levels in organic and conventional systems, should allow us to gain valuable insights into the effects of soil fertility on crop health and nutritional quality, and to evaluate the hypothesis that organic crops are higher in phytochemicals than conventional crops due to limitations of nitrogen in organic systems. The team effort to design and implement a rather complex research project contributed to an appreciation for the challenges and opportunities of interdisciplinary research, and provided graduate students with valuable lessons in teamwork. Four graduate students worked under the project during the reporting period with one completing an M.S. thesis and two completing and defending Ph.D. theses, demonstrating requisite high levels of analytical capabilities and competence.

2007/06/01 TO 2008/05/31 Oh, M-M., E. Carey and C. Rajashekar. 2007. Environmental stresses induce health-promoting phytochemicals in lettuce. HortScience 42:993. This was an oral presentation by Myung-Min Oh, on the results of preliminary studies conducted in the growth chamber.

2007/06/01 TO 2008/05/31 Oh, M-M., E. Carey and C. Rajashekar. 2007. Environmental stresses induce health-promoting phytochemicals in lettuce. HortScience 42:993. This was an oral presentation by Myung-Min Oh, on the results of preliminary studies conducted in the growth chamber.

PUBLICATIONS

2010/06/01 TO 2011/05/31 1. M. M. Oh, E. E. Carey, C. B. Rajashekar, 2011, Antioxidant phytochemical in lettuce grown in high tunnels and open field, Hort. Environ. Biotechnol. DOI 10.1007/s00277-009-0780-0. 2. M. M. Altamimi, Myung-Min Oh, R. R. Janke, K. A. Williams, N. O. Nelson, C. B. Rajashekar, D. Rotenberg, E. E. Carey, 2009, Organic versus conventional fertilization of pac choi and tomato produced in field versus high tunnels influences crop yield, soil and plant quality, HortSci. 44: 1112. 3. M. M. Oh, H. N. Trick, and C. B. Rajashekar, 2008, Secondary metabolism and antioxidants are involved in environmental adaptation and stress tolerance in lettuce, J. Plant Physiol. 166: 180-191 4. M. M. Oh,, E. E. Carey, and C. B. Rajashekar, 2009, Environmental stresses induce health-promoting phytochemicals in lettuce, Plant Physiol. Biochem. 47: 578-583 5. M. M. Oh and C. B. Rajashekar, 2009, Antioxidant content of edible sprouts: effects of environmental shocks, J. Sci. Food Agric. 89: 2221-2227 6. C. B. Rajashekar, E. E. Carey, X. Zhao and M.M Oh, 2009, Health-promoting phytochemicals in fruits and vegetables: Impact of abiotic stresses and crop production practices, Functional Plant Sci. Biotech. 3: 30-38

2009/06/01 TO 2010/05/31 1. Altamimi, M.M., Oh, M.M., Janke, R.R., Williams, K.A., Nelson, N.O., Rajashekar, C.B., Rotenberg, D., and Carey, E.E. 2009, Organic versus conventional fertilization of pac choi and tomato produced in field versus high tunnels influences crop yield, soil and plant quality, HortSci. 44: 1112. 2. Oh, M. M, Trick, H.N. and Rajashekar, C.B. 2008, Secondary metabolism and antioxidants are involved in environmental adaptation and stress tolerance in lettuce, J. Plant Physiol. 166: 180-191 3. Oh, M.M., Carey, E.E. and Rajashekar, C.B. 2009, Environmental stresses induce health-promoting phytochemicals in lettuce, Plant Physiol. Biochem. 47: 578-583 4. Oh, M.M. and Rajashekar, C.B. 2009, Antioxidant content of edible sprouts: effects of environmental shocks, J. Sci. Food Agric. 89: 2221-2227 5. Rajashekar, C.B., Carey, E.E., Zhao, X. and Oh, M.M. 2009, Health-promoting phytochemicals in fruits and vegetables: Impact of abiotic stresses and crop production practices, Functional Plant Sci. Biotech. 3: 30-38

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2007/06/01 TO 2008/05/31 No publications reported this period

2007/06/01 TO 2008/05/31 No publications reported this period

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Building Integrated Weed Management Knowledge in Organic Systems

Accession No.	0210208
Subfile	CRIS
Project No.	MICL05003
Agency	NIFA MICL
Project Type	OTHER GRANTS
Project Status	TERMINATED
Contract / Grant No.	2007-51300-03793
Proposal No.	2007-01417
Start Date	01 JUL 2007
Term Date	30 JUN 2009
Fiscal Year	2009
Grant Amount	$106,335
Grant Year	2007
Investigator(s)	Renner, K. A.; Hill, E. C.; Sprague, C. L.; Mutch, D. R.
Performing Institution	Plant, Soil and Microbial Science, MICHIGAN STATE UNIV, EAST LANSING, MICHIGAN 48824

NON-TECHNICAL SUMMARY

Aside from the information presented in the existing MSU bulletin Integrated Weed Management One Year\'s Seeding (E-2931), the dissemination of information regarding alternative weed management strategies continues to be listed among the top priorities of Michigan commodity groups. In evaluations of the MSU bulletin individual growers requested additional information in specific areas of organic and sustainable weed management in the form of a supplement. This project intends to disseminate information on organic and sustainable weed management strategies to extension educators, university faculty, growers, and agribusiness personnel.

OBJECTIVES

Objective 1-Develop a supplement to the extension bulletin E-2931 titled Integrated Weed Management One Years Seeding. This bulletin will include organic grower profiles, results from on-farm organic research trials that were conducted in response to knowledge gaps that were discovered in writing the original bulletin, and new information published on integrated weed management since February 2005. Objective 2-Conduct a workshop at the North Central Weed Science Society annual meeting. At the workshop authors of the IWM supplement will teach interested extension and university personnel how to effectively use the IWM guide and supplement in teaching integrated weed management to clientele in their states. Objective 3-Hold workshops based on the principles presented in the IWM supplement for organic growers in the North Central states. These meetings would be conducted by local extension educators.

APPROACH

Objective 1: Based on the responses received from the IWM surveys in the spring of 2006 we have summarized the subject areas where growers would like more information. These areas will become the topics of the new

supplement. Proposed topics relating to weed management include: manure/compost, cover crops, economic thresholds, crop rotations, intercropping, thermal weed management, grazing, organic farmer profiles, on-farm weed management trials, and additional weed profiles. Our team plans to gather more information regarding these topics and convert it into digestible forms of text, graphs, and photographs that will be easily understood by growers. The inclusion of additional organic farm profiles ranked as a high priority among survey participants. To develop these profiles, we will travel to organic farms in Michigan and the surrounding states that have been selected through the IWM bulletin survey. During these visits growers will be interviewed about their experiences with various weed control measures. Numerous photographs will be taken during these trips that will be included in the supplement to illustrate some of the practices that these growers use to readers of the supplement. Bulletins will be produced and distributed through the Michigan State University Extension Bulletin Office. We also intend to reach a wider audience by publishing articles related to the IWM supplement chapters on the New Ag Network (www.new-ag.msu.edu/). Objective 2: We will hold a workshop at the 2008 North Central Weed Science Societys (NCWSS) annual meeting on integrated weed management. The focus will be on the topics presented in the supplement. Attendees of the session will receive a copy of the supplement and a CD containing figures and tables from the supplement so that material can be passed on to growers, students, and consultants. Extension specialists that are members of the North Central Weed Science Society have been very responsive to the original IWM bulletin. Their active participation in learning new integrated weed management information from the supplement will provide each of them with additional resources to promote sustainable and organic weed management in their states. Surveys will be distributed immediately following the NCWSS workshop to gauge the impact of our presentation. Objective 3: In 2008 we will cooperate with local extension educators to conduct workshops across the North Central states to spread the information presented in the IWM supplement to organic producers and other interested parties. Presentations at the workshops will be accompanied by a copy of the IWM supplement. We plan to hold a total of ten workshops in conjunction with local extension educators and university personnel. Our goal is to reach 250 organic and sustainable producers. It is our hope that the overall increase in practical knowledge related to sustainable weed management will encourage experimentation with and implementation of sustainable techniques on their own farms. Impact will be accessed using surveys at the conclusion of the programs.

PROGRESS

2007/07 TO 2009/06 OUTPUTS: Objective 1. Produce an extension bulletin focused on integrated weed management (IWM) including grower profiles, on-farm trials, and detailed weed descriptions. During the course of this project, our team worked together to develop a new Michigan State University Extension bulletin, \"Integrated Weed Management: Fine Tuning the System\", covering integrated weed management for organic systems. Topics covered in \"Fine Tuning\" include: diverse crop rotations, cover crops, manure and compost management, flaming for weed control, grazing and other biological controls, thresholds, and weed profiles. Grower input was an important factor in the success of this bulletin. Four of the \"Fine Tuning\" chapters feature the profile of an organic grower who has expertise in that particular area. The crop rotations chapter features a variety of rotations used by growers from Michigan, Ohio, Indiana, Illinois, Wisconsin, and Pennsylvania. And finally, the last chapter of the bulletin features the results of ten on-farm, grower-designed trials conducted throughout the Midwest. In addition to publishing information in the form of an extension bulletin, select information from \"Fine Tuning\" was also placed on our web site, www.MSUweeds.com. Objective 2. Hold a workshop at the North Central Weed Science Society\'s annual meeting to introduce the new bulletin to research and extension personnel from around the Midwest. A symposium titled \"Integrated Weed Management: Tools of the Trade\" was held at the 2009 North Central Weed Science Society meeting in Indianapolis, IN. This half day workshop covered the topics of diverse crop rotations, manure, compost, flaming, grazing and other biological controls, and cover crop innovations by featuring invited speakers from several universities. Also, a grower from Indiana shared his prospective on grazing for weed management. Over 50 researchers, educators, and extension personnel attended this symposium. Each attendee received a copy of the Fine Tuning bulletin, along with a CD containing sample presentations. Objective 3. Conduct workshops for sustainable and organic growers in Michigan and other Midwestern states to present the principles of the new IWM bulletin. Throughout late 2008 and early 2009, information from \"Fine Tuning\" was presented to growers and extension educators at ten different events in Michigan, Ohio, Wisconsin, and Ontario. The total attendance at these events was 556 and the total number of \"Fine Tuning\" and the number of bulletins distributed was 205. Additional talks are scheduled for the \"Building Soil for Better Quality Food\" workshop in Sears, MI and the National Small Farm Conference in Springfield, IL in August and September of 2009. A poster advertising the contents of the \"Fine Tuning\" bulletin was presented at the 2008 Great Lakes Fruit, Vegetable, and Farm Market Expo (Grand Rapids, MI),2008 North Central Weed Science Society annual meeting (Indianapolis, IN), 2009 Weed Science Society of America annual meeting (Orlando, FL), and 2009 Midwest Cover Crops Council annual meeting (Windsor, ON). PARTICIPANTS: The planning and execution of this project has been a collaborative effort of the principle investigator, Dr. Karen

Renner, Dr. Christy Sprague, and Erin Taylor. Additionally, Steve Deming was responsible for the graphic design of the \"Fine Tuning\" bulletin. Other individuals from MSU and other Midwestern universities provided input to various chapters of the bulletin. These individuals include: Dan Brainard, Stuart Grandy, Tim Harrigan, Richard Leep, Todd Martin, Dale Mutch, Mathieu Ngouajio, and Sieg Snapp from Michigan State University; Abram Bicksler and John Masiunas from the University of Illinois; Mark Entz from the University of Manitoba; and Stevan Knezavic and Santiago Ulloa from the University of Nebraska. Many farmers also contributed to the profiles and on-farm trial results included in the \"Fine Tuning\" bulletin. The resulting published bulletin will contribute to the education of growers in the Midwest on the subject of weed management for years to come. TARGET AUDIENCES: Fellow university researchers, lecturers, and extension educators- The symposium that was held at the 2009 North Central Weed Science Society\'s annual meeting in Indianapolis, IN shared our findings on integrated weed management for organic systems with researchers and educators from Midwestern land grant universities. Approximately 50 people attended the half-day symposium. Each attendee received a copy of the \"Fine Tuning\" bulletin, along with a CD with presentation for each chapter that could be adapted for classroom delivery. Extension educators have also been exposed to the content of \"Fine Tuning\" through several workshops held throughout the region (see Outputs, Objective 3). Growers- In addition to the over 500 bulletins that have been distributed/sold, farmers from the Midwestern United States and Canada have had several opportunities to be exposed to the information presented in \"Fine Tuning\" from the workshops held in early 2009 in Michigan, Ohio, Wisconsin, and Ontario. There are also two remaining opportunities coming up in August and September 2009. University students- Information from \"Fine Tuning\" will be presented in Fall 2009 in the Michigan State University undergraduate level weed science course and also in Spring 2010 in the MSU graduate level weed ecology course. It is expected that information from the bulletin will be used in courses at other Midwestern universities taught by weed scientists. PROJECT MODIFICATIONS: Not relevant to this project.

2007/07/01 TO 2009/06/30 OUTPUTS: Objective 1. Produce an extension bulletin focused on integrated weed management (IWM) including grower profiles, on-farm trials, and detailed weed descriptions. During the course of this project, our team worked together to develop a new Michigan State University Extension bulletin, \"Integrated Weed Management: Fine Tuning the System\", covering integrated weed management for organic systems. Topics covered in \"Fine Tuning\" include: diverse crop rotations, cover crops, manure and compost management, flaming for weed control, grazing and other biological controls, thresholds, and weed profiles. Grower input was an important factor in the success of this bulletin. Four of the \"Fine Tuning\" chapters feature the profile of an organic grower who has expertise in that particular area. The crop rotations chapter features a variety of rotations used by growers from Michigan, Ohio, Indiana, Illinois, Wisconsin, and Pennsylvania. And finally, the last chapter of the bulletin features the results of ten on-farm, grower-designed trials conducted throughout the Midwest. In addition to publishing information in the form of an extension bulletin, select information from \"Fine Tuning\" was also placed on our web site, www.MSUweeds.com. Objective 2. Hold a workshop at the North Central Weed Science Society\'s annual meeting to introduce the new bulletin to research and extension personnel from around the Midwest. A symposium titled \"Integrated Weed Management: Tools of the Trade\" was held at the 2009 North Central Weed Science Society meeting in Indianapolis, IN. This half day workshop covered the topics of diverse crop rotations, manure, compost, flaming, grazing and other biological controls, and cover crop innovations by featuring invited speakers from several universities. Also, a grower from Indiana shared his prospective on grazing for weed management. Over 50 researchers, educators, and extension personnel attended this symposium. Each attendee received a copy of the Fine Tuning bulletin, along with a CD containing sample presentations. Objective 3. Conduct workshops for sustainable and organic growers in Michigan and other Midwestern states to present the principles of the new IWM bulletin. Throughout late 2008 and early 2009, information from \"Fine Tuning\" was presented to growers and extension educators at ten different events in Michigan, Ohio, Wisconsin, and Ontario. The total attendance at these events was 556 and the total number of \"Fine Tuning\" and the number of bulletins distributed was 205. Additional talks are scheduled for the \"Building Soil for Better Quality Food\" workshop in Sears, MI and the National Small Farm Conference in Springfield, IL in August and September of 2009. A poster advertising the contents of the \"Fine Tuning\" bulletin was presented at the 2008 Great Lakes Fruit, Vegetable, and Farm Market Expo (Grand Rapids, MI),2008 North Central Weed Science Society annual meeting (Indianapolis, IN), 2009 Weed Science Society of America annual meeting (Orlando, FL), and 2009 Midwest Cover Crops Council annual meeting (Windsor, ON). PARTICIPANTS: The planning and execution of this project has been a collaborative effort of the principle investigator, Dr. Karen Renner, Dr. Christy Sprague, and Erin Taylor. Additionally, Steve Deming was responsible for the graphic design of the \"Fine Tuning\" bulletin. Other individuals from MSU and other Midwestern universities provided input to various chapters of the bulletin. These individuals include: Dan Brainard, Stuart Grandy, Tim Harrigan, Richard Leep, Todd Martin, Dale Mutch, Mathieu Ngouajio, and Sieg Snapp from Michigan State University; Abram Bicksler and John Masiunas from the University of Illinois; Mark Entz from the University of Manitoba; and Stevan Knezavic and Santiago Ulloa from the University of Nebraska. Many farmers also contributed to the profiles and

on-farm trial results included in the \"Fine Tuning\" bulletin. The resulting published bulletin will contribute to the education of growers in the Midwest on the subject of weed management for years to come. TARGET AUDIENCES: Fellow university researchers, lecturers, and extension educators- The symposium that was held at the 2009 North Central Weed Science Society\'s annual meeting in Indianapolis, IN shared our findings on integrated weed management for organic systems with researchers and educators from Midwestern land grant universities. Approximately 50 people attended the half-day symposium. Each attendee received a copy of the \"Fine Tuning\" bulletin, along with a CD with presentation for each chapter that could be adapted for classroom delivery. Extension educators have also been exposed to the content of \"Fine Tuning\" through several workshops held throughout the region (see Outputs, Objective 3). Growers- In addition to the over 500 bulletins that have been distributed/sold, farmers from the Midwestern United States and Canada have had several opportunities to be exposed to the information presented in \"Fine Tuning\" from the workshops held in early 2009 in Michigan, Ohio, Wisconsin, and Ontario. There are also two remaining opportunities coming up in August and September 2009. University students- Information from \"Fine Tuning\" will be presented in Fall 2009 in the Michigan State University undergraduate level weed science course and also in Spring 2010 in the MSU graduate level weed ecology course. It is expected that information from the bulletin will be used in courses at other Midwestern universities taught by weed scientists. PROJECT MODIFICATIONS: Not relevant to this project.

2007/07/01 TO 2008/06/30 OUTPUTS: There are three objectives of this project. 1. Produce an extension bulletin focused on integrated weed management (IWM) including grower profiles, on-farm trials, and detailed weed descriptions. 2. Hold a workshop at the North Central Weed Science Society\'s annual meeting to introduce the new bulletin to research and extension personnel from around the Midwest. 3. Conduct workshops for sustainable and organic growers in Michigan and other Midwestern states to present the principles of the new IWM bulletin. During 2007 and 2008 our team has worked together to develop a new Michigan State University Extension bulletin covering integrated weed management for organic systems. We have developed chapters for the bulletin on how diverse crop rotations, manure and compost management, and the integration of cover crops effect weed growth in agronomic cropping systems. We have also completed a chapter focused on weed control using propane flamers/burners and biological controls. The manure and compost, cover crop, biological control, and flaming chapters of the forthcoming bulletin will each feature a profile of an organic grower who has expertise in that particular area. During the summer of 2008 these interviews were completed with growers from Michigan, Indiana, and Illinois. The diverse crop rotations chapter will feature a variety of crop rotations from Michigan, Ohio, Indiana, Illinois, Wisconsin, and Pennsylvania. Growers from these states were surveyed during the summer of 2008 and are currently being formatted for inclusion in the bulletin. The results of 8 on-farm weed management trials from Midwestern organic farms conducted in 2006 and 2007 have been made available on www.MSUweeds.com through support from Project GREEEN. These same results will also be made placed into the new IWM bulletin. Several of the 12 new weed profiles have been completed and the rest are currently being constructed. A symposium titled \"Integrated Weed Management: Tools of the Trade\" has been scheduled for the 2009 North Central Weed Science Society meeting in Indianapolis, IN. This half day workshop will feature invited speakers and panelists in the areas of diverse crop rotations, manure, compost, flaming, grazing and other biological controls, and cover crop innovations. PARTICIPANTS: Additional funding received in support of projects related to this grant has been received from Project GREEEN (Title: \"Communicating Strategies for Organic Weed Management\"), CSREES North Central IPM (Title: \"Advancing Existnig Knowledge of Integrated Weed Management\"), and CSREES MI SARE (Title: \"Alternative Weed Management Strategies\") TARGET AUDIENCES: Nothing significant to report during this reporting period. PROJECT MODIFICATIONS: Nothing significant to report during this reporting period.

IMPACT

2007/07 TO 2009/06 Change in knowledge. Since the publication of \"Fine Tuning\" in December of 2008, 489 copies have been sold/distributed through the Michigan State University Extension Educational Materials Distribution Center in East Lansing, MI. Around half of these bulletins were distributed through the NCWSS symposium and various workshops held in late 2008 and early 2009. The other bulletins have been ordered from states across the country as far away as New Mexico and three copies were ordered from Germany. We expect the sales of \"Fine Tuning\" to continue throughout the next few years as we continue to promote it at local, regional, and national meetings. Through meetings we have reached an audience of over 600 people thus far. The \"Fine Tuning\" bulletin has also been mention in the popular press through newspaper and magazine articles, online articles, and television and radio spots. The estimated audience for these outlets totals more than 16,000 people. Change in actions. In reaching a wide audience across the Midwest the information provided in

\"Fine Tuning\" has undoubtedly lead to alterations in weed control strategies being utilized on conventional and organic farms. **PUBLICATIONS (not previously reported):** 2007/07 TO 2009/06 1. Taylor, E. C., Renner, K. A., and Sprague, C. L. 2008. Integrated Weed Management: Fine Tuning the System. Michigan State University Extension bulletin E-3065. 2. 2009 North Central Weed Science Society Symposium: Integrated Weed Management: Tools of the Trade (Indianapolis, IN) Taylor, E., Renner, K., and Sprague, C. 2008. Introduction to Integrated Weed Management: Fine Tuning the System and the Symposium. 169. Proc. 63rd NCWSS Annual Meeting. Indianapolis, IN. 3. Renner, K and Sprague, C. 2008. Diverse Crop Rotations and Weed Management Discussion. 170. Proc. 63rd NCWSS Annual Meeting. Indianapolis, IN. 4. Bicksler, A. and Masiunas, J. 2008. Canada Thistle Control with Covers. 171. Proc. 63rd NCWSS Annual Meeting. Indianapolis, IN. 5. Masiunas, J. 2008. Mustards as Biofumigants: Current Status and Future Prospects. 172. Proc. 63rd NCWSS Annual Meeting. Indianapolis, IN. 6. Mutch, D. 2008. Evaluation of a no-till Organic Soybean System in Michigan. 173. Proc. 63rd NCWSS Annual Meeting. Indianapolis, IN. 7. Taylor, E. 2008. Effect of Flaming Time on Weed Control. 174. Proc. 63rd NCWSS Annual Meeting. Indianapolis, IN. 8. Bruening, C and Knezavic, S. 2008. Weed Flaming: An Engineering Approach. 175. Proc. 63rd NCWSS Annual Meeting. Indianapolis, IN. 9. Reding, G. 2008. Livestock, an Important Part of the Weed Control Puzzle. 176. Proc. 63rd NCWSS Annual Meeting. Indianapolis, IN. 10. Leep, R. 2008. Weed Management Strategies in Sustainable Pasture Systems. 177. Proc. 63rd NCWSS Annual Meeting. Indianapolis, IN. 11. Boerboom, C. 2008. Is Weed Competition for Nitrogen Important 178. Proc. 63rd NCWSS Annual Meeting. Indianapolis, IN. 12. Becker, R. 2008. Weed Seed Survival in Livestock Manure Handling Systems. 179. Proc. 63rd NCWSS Annual Meeting. Indianapolis, IN. 13. Renner, K. 2009. Manure \$ense. Monthly. Manure and Weed Seeds. 14. Renner, K. 2009. The Scoop on Animal Agriculture and the Environment. Monthly. Want to keep weeds out of your fields Study your manure applications. 15. Renner, K. 2009. Greenville Daily News. Daily. Want to keep weeds out of your fields Study your manure applications. 16. Renner, K. 2009. Rivervalley Shopper. Daily. Want to keep weeds out of your fields Study your manure applications. 17. Renner, K. 2009. Lakeview Area News. Daily. Want to keep weeds out of your fields Study your manure applications. 18. Taylor, E. 2009. The New Agriculture Network. Biweekly via e-mail. Managing weeds using a stale seedbed approach.

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2007/07/01 TO 2008/06/30 Thus far we have received positive feedback from the online posting of the 8 on-farm weed management trial at www.MSUweeds.com. Following the publication of the bulletin, more outcomes/impacts will be reported.

PUBLICATIONS

2007/07/01 TO 2009/06/30 1. Taylor, E. C., Renner, K. A., and Sprague, C. L. 2008. Integrated Weed Management: Fine Tuning the System. Michigan State University Extension bulletin E-3065. 2. 2009 North Central Weed Science Society Symposium: Integrated Weed Management: Tools of the Trade (Indianapolis, IN) Taylor, E., Renner, K., and Sprague, C. 2008. Introduction to Integrated Weed Management: Fine Tuning the System and the Symposium. 169. Proc. 63rd NCWSS Annual Meeting. Indianapolis, IN. 3. Renner, K and Sprague, C. 2008. Diverse Crop Rotations and Weed Management Discussion. 170. Proc. 63rd NCWSS Annual Meeting. Indianapolis, IN. 4. Bicksler, A. and Masiunas, J. 2008. Canada Thistle Control with Covers. 171. Proc. 63rd NCWSS Annual Meeting. Indianapolis, IN. 5. Masiunas, J. 2008. Mustards as Biofumigants: Current Status and Future Prospects. 172. Proc. 63rd NCWSS Annual Meeting. Indianapolis, IN. 6. Mutch, D. 2008. Evaluation of a no-till Organic Soybean System in Michigan. 173. Proc. 63rd NCWSS Annual Meeting. Indianapolis, IN. 7. Taylor, E. 2008. Effect of Flaming Time on Weed Control. 174. Proc. 63rd NCWSS Annual Meeting. Indianapolis,

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2007/07/01 TO 2008/06/30 No publications reported this period

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Integrating Benefits of Organic Apple and Pork Production

Accession No.	0210223
Subfile	CRIS
Project No.	MICL05002
Agency	NIFA MICL
Project Type	OTHER GRANTS
Project Status	TERMINATED
Contract / Grant No.	2007-51300-03792
Proposal No.	2007-01418
Start Date	15 JUN 2007
Term Date	14 JUN 2009
Fiscal Year	2009
Grant Amount	$33,478
Grant Year	2007
Investigator(s)	Epstein, D. L.; Rozeboom, D.
Performing Institution	ENTOMOLOGY, MICHIGAN STATE UNIV, EAST LANSING, MICHIGAN 48824

NON-TECHNICAL SUMMARY

This project will investigate the opportunities for developing and delivering an organic farming system that integrates organic pork and apple production to address pest and pest-related problems, and that enhances opportunities for increased profitability and environmental sustainability. Peer reviewed scientific research into rotational grazing of hogs in apple orchards is scant, and some very basic questions regarding the effects of hog grazing on pest management and swine health must first be answered prior to development of an integrated approach that optimizes potential benefits. In particular, this project will investigate the abilities of rotationally grazed hogs to manage the insect pest, plum curculio, through consumption of dropped apples on the orchard floor, while meeting swine nutritional requirements for growth and health. Originally envisioned as a four-year project, the PIs for this project are instead requesting one year's funding to answer these basic questions in preparation for a proposal in year two that fully develops, delivers and evaluates an integrated apple-swine production system for organic producers. To develop and evaluate an orchard system for Upper Midwest fruit growers that integrates rotational swine grazing for control of insect and disease pests, while enhancing profit potential through sales of organic pork.

OBJECTIVES

Specific Objectives: Year 1: 1) Monitor the reproduction and health of orchard-raised swine 2) Monitor the growth and carcass attributes of orchard-raised swine. 3) Achievement of organic pork production status 4) Determine plum curculio larval survival with swine ingestion 5) Determine percent of June drop apples eaten by rotationally grazed hogs. 6) Conduct fall field day to deliver integrated management practices to grower community.

APPROACH

The ability of the PC larvae to survive the hog digestive tract will be tested in the first year by feeding PC infested apples to growing pigs followed by examination of the hog feces for PC larval survival. Six pigs, 12 to 16 wk of

age, will be housed in pens allowing for total fecal collection, which will be completed over a 5-day feeding period. A 5-day adaptation period will precede fecal collections. Rate of passage ranges from 16 to 36 hours, and will be determined in this experiment using a ferric oxide marker. Plum curculio adult populations will be monitored weekly from the apple bloom period through harvest using modified PC pyramid traps baited with fruit volatiles, and fruit damage assessments will be conducted 2 times per growing season in June and pre-harvest to establish baseline adult population and fruit injury levels for subsequent research in 2008-2010. Al-Mar Orchards is currently working to obtain organic certification of its pork production enterprise. In May of 2006, 1 male and 3 female Berkshires were purchased. First matings are planned for January, 2007. About 25 to 30 offspring will be born in April and grown in the remainder of the year to market weight, with local, custom harvest of pork scheduled for December of 2007. In that first year, a farm-specific nutritional program, including orchard grazing must be established for both the breeding herd and the growing market hogs. Dropped apples remaining on the orchard floor will be quantified three times per season in June, August, and November to assess the effectiveness of hogs in consuming dropped apples. Specific population densities and species will be identified and grazing management planned so that grazing occurs when vegetation is immature and suitable for monogastric consumption. The nutritional value of several of these nontraditional foodstuffs to pigs in various stages of life has not been studied widely. The effectiveness of rotationally grazed pigs to consume June drop apples will be measured. Electric fencing will be erected by the grower-cooperator around the perimeters of each plot for control of the hogs. A stocking density of one tree per pig will be used, depending on number of pigs produced by the breeding herd. Data will be analyzed using ANOVA and mean separation with Fishers LSD for multiple comparisons. Fecal grab samples will be collected monthly, and analyzed. If additional breeding stock is needed to increase market hog numbers, then it must be brought onto the farm no later than the last third of gestation. An electronic record-keeping program will be utilized. An annual fall field day will be conducted at Al-mar orchards to highlight the research on rotational hog grazing integrated into an apple production system and potential for supplemental income, while discussing the compatibility of the two systems. Roundtable discussions with growers into present and future plans related to adoption of the proposed system will be conducted. A newsletter highlighting project results will be produced and mailed to members of the Upper Midwest Organic Tree Fruit Growers network.

PROGRESS

2007/06 TO 2009/06 OUTPUTS: Three grower field days were conducted at AlMar Orchards on November 2, 2007, November 11, 2008 and June 25, 2009, and were attended by a range of 60-100 growers, members of the public and MSU Extension personnel. Project results were presented at extension and scientific meetings: 2 posters and 2 spoken presentations at the Great Lakes Fruit, Vegetable, and Farm Market Expo in Grand Rapids, MI in 2007 and 2008; spoken presentations at the SE MI Spring Tree Fruit Meeting, Flint, MI and Ag and Natural Resources Week, East Lansing, MI, 2008. Scientific presentations were presented at the American Society of Animal Science, Indianapolis, IN, July, 2008; Michigan State University Department of Entomology Seminar, East Lansing, MI, October 2008; International Organization for Biological Control/WPRS Working Group \"Integrated Plant Protection in Fruit Crops\" in Avignon, France, 2008; and the Entomological Society of America, Reno, NV 2008. 2 written articles were prepared for the MSU IPM Program Annual Newsletter, 2008 and 2009, and 4 written articles have been produced and distributed through the Upper Midwest Organic Tree Fruit Growers Network. The project was featured in print (Good Fruit Grower, newspapers and web news sites \over 700,000 web outlets\), radio (2 features on National Public Radio) and in television media stories. PARTICIPANTS: David Epstein is a Michigan State University Distinguished Academic Specialist working in tree fruit pest management. Epstein quantified aborted June drop apples in research plots, determined percent of June drop apples eaten by rotationally grazed hogs, monitored plum curculio populations and attendant injury to fruit and conducted extension activities to deliver integrated management practices to grower community. Dr. Dale Rozeboom is an Associate Professor and Extension Pork Specialist in the Department of Animal Science at MSU. Dr. Rozeboom monitored the reproduction and health of orchard-raised swine, monitored the growth and carcass attributes of orchard-raised swine, and determined plum curculio larval survival with swine ingestion. Dr. Matt Grieshop is Assistant Professor of Organic Pest Management at MSU. Dr. Grieshop lead the efforts on determining the effects of hog grazing in apple on codling moth and weed management. TARGET AUDIENCES: Target audiences included apple and pork producers, organic farmers, researchers and extension personnel working with fruit and pork producers, other producers of perennial tree fruit and nut crops, cider producers, and consumers of locally produced, orchard grazed organic pork products. Integration of animal and plant agriculture is cited as essential to the maintenance of farm health in classical organic literature. This concept conflicts with the majority of modern farms, where plant and animal production systems operate in isolation of one another and deficiencies in farm health are corrected with petrochemical based energy and inputs. Modern organic farming systems have integrated animals through use of manures to promote soil health. However, even in organic agriculture, farms that more fully integrate animals into plant agriculture are the exception rather than the rule.

The integration of livestock into plant agriculture provides opportunities for organic farmers to enhance farm diversity, ecosystem sustainability and farm profitability while reducing off-farm inputs for pest and nutrient management. Rotational hog grazing provides an ecological pest management approach for suppressing pest populations over time. This will reduce the growers\' need for responsive pest management, typically pesticides applied when pest populations attain outbreak levels. Additionally, hogs are partially fed on apple pumice, a farm waste product, and harvested at maturity, providing an additional high-value product for organic farms with on farm herds. A potential benefit to local swine producers is the development of a \"rental\" market similar to those already developed for sheep and goats for weed management. Thus, in contrast to off-farm-input based pest management, pest management provided by hogs has the potential to either \"pay for itself\" and keep pest management dollars within local agricultural economies. PROJECT MODIFICATIONS: The project received a one year no-cost extension to enable researchers to collect and analyze data through the 2008 growing season and into spring 2009. No other significant changes occurred.

2007/06/15 TO 2008/06/14 OUTPUTS: A grower field day conducted at AlMar Orchard, Flushing, MI on November 2, 2007 was attended by over 60 growers and MSU Extension personnel, and covered by 3 separate news organizations (Flint Journal, Growing GREEEN, and MI Farmer). Project results were also presented during an organic fruit production symposium to an audience of 75-100 at the 2007 Great Lakes Fruit, Vegetable, and Farm Market Expo in Grand Rapids, MI on December 6, 2007. Newsletter articles have been produced by the MSU IPM Program and the Upper Midwest Organic Tree Fruit Growers Network. The project will also be featured in the next edition of the Good Fruit Grower Magazine, Yakima, WA. PARTICIPANTS: David Epstein, Project PI, field investigations into quantifying \"June Drop\" and hog consumption of aborted apples, monitoring insect populations, quantifying insect damage to fruit Dale Rozeboom, Co-PI, animal reproduction, health, growth TARGET AUDIENCES: Organic and conventional fruit producers, hog farmers,apple and pork product consumers, professional crop consultants, extension educators, local rural community members, research scientists working in fruit and animal production PROJECT MODIFICATIONS: No Project Modifications information reported.

IMPACT

2007/06 TO 2009/06 Outcomes: Flash grazing of hogs in apple significantly reduced the incidence of injury to fruit from the two most economically important insect pests of organic apple in Michigan; plum curculio and codling moth. The number of \"June Drop\" apples for Idared and McIntosh was quantified as a mean of 123 apples per tree for both years, 2007-2008. Forty-seven percent of field-collected, aborted apples in 2008 had at least one C. nenuphar oviposition scar, and 15.7% of drops contained viable larvae. Twenty-seven two-month old Berkshire hogs (Ca. 20-30kg) in 2007 and 24 hogs in 2008, grazed prior to predicted emergence of C. nenuphar larvae, consumed 99.8% and 99.9% of dropped apples in 0.4ha plots. Hogs were rotated among 3 grazed plots, spending 2-3 days in each grazed plot per week for 3 weeks. A controlled feeding experiment demonstrated that ingestion of C. nenuphar larvae in apples by pigs was 100 percent lethal to the larvae. Summer C. nenuphar feeding injury, following the start of grazing in 2007, was 4.9 fold higher in non-grazed control plots. Spring C. nenuphar oviposition injury in 2008 was 8.7% in non-grazed plots and 4.1% in grazed plots. Summer C. nenuphar feeding injury was 3.4 fold higher in non-grazed plots in 2008. Flash grazing of hogs in apple significantly reduced within tree row weed cover. Grazed plots had significantly less codling moth injury to fruit, significantly lower percentage grass cover in tree rows, significantly higher bare ground coverage in tree rows, and significantly lower grass biomass in grazed plots. Orchard-reared hogs demonstrated adequate reproductive and growth characteristics. Overall, the health status of all animals was acceptable, and did not require the use of any pharmaceuticals. Apple pulp and discarded whole apples were provided continuously, about 450 kg per day since weaning, providing over 50% of their daily food intake. Impacts: The long-term outcome of integrating hogs into apple production for pest and nutrient management is not yet known. The long-term aspects of organic pork production when conducted in conjunction with organic apple production are also unknown. Initial studies about the economics of hog rearing from farrow to finish under orchard conditions, and the economical impacts of hog grazing on purchase of inputs for pest and nutrient management have not been initiated. Continued monitoring of hog health under this orchard system, in particular infection by internal parasites, also needs to be continued for several years before long-term impacts are understood. The testing of fresh and aged feces done was preliminary and inconclusive. **PUBLICATIONS (not previously reported):** 2007/06 TO 2009/06 No publications reported this period

2007/06/15 TO 2008/06/14 The study quantified the number of \"June Drop\" apples for Macintosh and Ida Red trees as an average of 123 apples over a 3-week period, showed that hogs effectively consume June Drop apples, that PC larvae do not survive the hog digestive system, and that resultant adult PC summer feeding was reduced five-fold where hogs were grazed. The 2007 work with hogs indicated that hog size is an important factor in integrating hogs into an orchard system. Rooting of young hogs (under ca. 60 lbs) in the tree row soil as they foraged through the orchard averaged 4-6 inches in depth. The young hogs readily ranged throughout the 1-acre plots. Rooting by hogs larger than ca. 60 lbs resulted in some exposure of tree roots and some destruction of sod in the drive rows, and movement was restricted to small sections of the 1-acre plots. Adult hogs had no clinical signs of any illness. Two of the 27 pigs experienced growth rates substantially slower than the others from October to December of 2007, and were cared for separate from the group. For all animals, there were no indications of external parasites. Samples from adult sows tested positive for Balantidium coli, a common parasite in swine, but not a cause of decreased health. A few eggs of Ascaris suum and Strongyle Type (Threadworm) were found in one sow in early summer, but were not found in subsequent fecal samples from the same or any other sow. A similar infectivity was observed in growing animals, with an exception of 1 sample, which tested positive for a few Coccidial oocysts. Overall, the health status of all animals was acceptable, and did not require the use of any pharmaceuticals. All lactating animals had ad libitum access to apple products, ground corn, and alfalfa hay. Growing pigs were provided ca. 2 kg of ground corn and hay per day beginning in October. Salt was provided at a rate of 4 to 6% of the supplemental food. In December of 2007 the amount of supplement provided was increased to 5 kg per pig per day. Pigs had not achieved a desirable market weight at 8 months (average weight of 59.9 kg.). Conventionally raised hogs typically reach market weights of greater than 150 kg in the same time period. Al-Mar Orchard owners chose to limit feedstuff purchases by utilizing apple by-products from their farm. Since pigs were not ready to harvest, the objective to measure carcass attributes were not attained.

PUBLICATIONS

2007/06/15 TO 2008/06/14 No publications reported this period

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Development of Sanitizers for Utilization in Organic Food Processing and Crop Production

Accession No.	0210345
Subfile	CRIS
Project No.	MIN-18-G09
Agency	NIFA MIN
Project Type	OTHER GRANTS
Project Status	TERMINATED
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Grant Amount	$747,993
Grant Year	2007
Investigator(s)	Diez-Gonzalez, F.; Feirtag, J. M.
Performing Institution	FOOD SCIENCE & NUTRITION, UNIV OF MINNESOTA, ST PAUL, MINNESOTA 55108

NON-TECHNICAL SUMMARY

Sanitizing is a critical step in the processing of wholesome and safe foods, but organic production systems currently lack organically produced sanitizers. This proposal offers a unique approach not only to identify sanitizers that could be compatible with organic practices, but also to seek and develop biocides that can be produced organically.

OBJECTIVES

The long-term goal of this study is to identify and develop antimicrobial technologies and compounds approved for sanitization of organic food processing equipment and organic fresh produce. The specific objectives of this proposal are to: 1)Determine the antimicrobial efficacy of electrochemically activated (ECA) water, bacteriophages and sodium carbonate that could serve as surface sanitizers and fresh produce disinfectants against indicator bacteria and foodborne pathogens. 2)Assess the extent of compatibility with organic standards for those conditions of ECA water, phages and sodium carbonate that have shown superior antimicrobial performance. 3)Verify the antimicrobial efficacy of sodium chloride and sodium bicarbonate-based ECA water in field trials of organic farms and processing and retail facilities. 4)Assess the feasibility of adopting those technologies by organic farmers and processors.

APPROACH

We plan to accomplish the four objectives outlined above by a combination of research and extension activities. For the first part we will use a series of experiments and for the latter a number of trials and surveys will be conducted with organic processors involved with this project. The execution of the project will be dependent on the active contribution of stakeholders of the Advisory Panel and the group of participating producers,

cooperatives and farmers. RESEARCH COMPONENT 1. Electrochemically Activated Water General project Objectives 1 and 2 will be addressed and the specific aims will be: (1) Determine the optimum generation conditions of sodium bicarbonate (SB)-based ECA water to kill pure cultures of relevant foodborne and environmental bacteria. (2) Assess the effectiveness of neutral sodium chloride (NaCl)-based ECA water and SB-ECA water to inactivate biofilms of a variety of foodborne pathogens and environmental contaminants. (3) Determine the antimicrobial effect of NaCl- and SB-ECA water to reduce the microbial count of E. coli O157:H7 and Salmonella inoculated on the surface of fresh vegetables. (4) Assess the impact of NaCl- and SB-ECA water on the quality of fresh vegetables. 2. Sodium carbonate General objectives 1 will be the focus of this part, and the specific aims will be: (1) Determine the optimum concentration and pH of sodium carbonate to kill pure cultures of bacteria. (2) Assess the effectiveness of sodium carbonate solutions to inactivate biofilms of bacteria. 3. Bacteriophages General objectives 1 and 2 will be targeted by this part of the project. The development of bacteriophages as sanitizers will include three specific aims: (1)Develop a diverse collection of bacteriophages capable of infecting bacteria. (2)Identify groups of at least three bacteriophages capable of killing high titers of specific foodborne pathogens and spoilage bacteria. (3)Determine the spectrum of activity of bacteriophages specific against E. coli O157 and Salmonella strains. (4)Determine the effectiveness of a diverse bacteriophage mixture to inactivate multiple bacterial species in liquid media and on stainless steel surfaces. (5)Determine the effect of specific bacteriophage mixtures against E. coli O157 and Salmonella in fresh vegetables. EXTENSION COMPONENT 4. Electrochemically Activated (ECA) Water General project Objectives 3 and 4 will be addressed and the specific aims that will be pursued in this part of the project will be: (1)Verify the antimicrobial efficacy and the impact on quality and shelf life of fresh vegetables of the optimum generation conditions for organic biocides produced via ECA water as compared to traditional methods used on and in organic farms and processing/retail facilities. (2)Assess the feasibility of adopting ECA water technology by organic farmers, processors and retails/coops. (3)Determine the compatibility of NaCl- and SB-ECA water with current organic practices by providing an assessment according to criteria specified by NOP for petitions to the National List.

PROGRESS

2007/09 TO 2011/08 OUTPUTS: Activities: most of the efforts of this project have been conducting laboratory-based experimental research intended to assess the use of neutral electrochemically activated (NECA) water and bacteriophages against pure cultures of food-borne pathogenic bacteria. The NECA experiments have compared different technologies of electrolyzed water solutions evaluating their effect against pure cultures and biofilms of Listeria monocytogenes, Salmonella and Escherichia coli O157:H7. The bacteriophage experiments have involved the isolation, screening and selection of bacteriophages against specific strains of the same pathogenic bacteria. The bacteriophages specific against L. monoctoygenes have been tested for their efficacy in killing many strains and the effectiveness of a mixture of 6 phages has been tested in different food matrices. In addition to the experimental work, manuscript preparation and presentation at scientific meetings has also been conducted. One Ph. D. student was guided and mentored and three undergraduate students were taught experimental research techniques. Events: researchers attended the International Association for Food Protection Annual Meeting in Milwaukee, WI, to present the results of the bacteriophage treatment against Listeria. Products: research yield a collection of bacteriophages against Listeria referred as LP1 and it is currently being evaluated for patenting. Hongshun Yang successfully passed his Ph. D. oral preliminary exam. Dissemination: one poster was presented at by Dr. Luna Akhtar at the IAFP meeting on the Listeria phages. Researchers discussed their findings with audiences as well as distributed copies of the poster to attendees. PARTICIPANTS: PI: Dr. Francisco Diez-Gonzalez; Co-PI: Dr. Joellen Feirtag; Graduate Research Assistant: Hongshun Yang; Post-doctoral Research Associate: Dr. Mastura Akhtar, Undergraduate students: Phillip Kraemer, Grace Nelson and Kyle Christensen. Collaborators: Dr. Todd Callaway, ARS/USDA, Drs. Andy Brabban, Betty Cutter, Evergreen State University, Dr. Larry Goodridge, Colorado State University, and Dr. Martin Loessner, Switzerland. Mike Magee, Wastewater Treatment Facility, Rice Lake, WI; Scott Joseph and Angella Craft-Reardon, Seneca Wastewater Treatment Plant, Eagan, MN contributed by providing sewage samples. TARGET AUDIENCES: Organic producers and processors, food safety scientists, as well as food producers interested in natural alternatives to artificial sanitizers. PROJECT MODIFICATIONS: The efforts intended to develop other bacteriophages in addition to Salmonella, E. coli O157 and L. monocytogenes was not pursued given the complexity of identifying effective types. The work on NECA water has been focused on studying the mechanism of inactivation, given the lack of success in other approaches and on extension efforts.

2009/09/01 TO 2010/08/31 OUTPUTS: Activities: most of the efforts of this project have been conducting laboratory-based experimental research intended to assess the use of neutral electrochemically activated (NECA) water and bacteriophages against pure cultures of food-borne pathogenic bacteria. The NECA experiments have evaluated different concentrations of free chlorine against biofilms of Listeria monocytogenes,

Salmonella and Escherichia coli O157:H7. The bacteriophage experiments have involved the isolation, screening and selection of bacteriophages against specific strains of the same pathogenic bacteria. The bacteriophages specific against E. coli O157:H7 have been tested for their efficacy in killing bacteria on specific application conditions that involved solid surfaces typical of food processing equipment and vegetable (lettuce and spinach) leaves. In addition to the experimental work, other activities involved manuscript preparation and presentation at scientific meetings. Two Ph. D. students were guided and mentored and two undergraduate students were taught experimental research techniques. Events: researchers attended the American Society for Microbiology Annual Meeting in San Diego, CA to present the work on E. coli O157 and Salmonella bacteriophages, and the International Association for Food Protection Annual Meeting in Anaheim, CA, to present the NECA water treatment findings. Products: research yield a collection of bacteriophages (BEC8) that show promising results against E. coli O157 and Salmonella bacteriophages. Stelios Viazis, a Ph. D. candidate defended his dissertation and graduated in July. Dissemination: two posters were presented at the ASM meeting, one by Dr. Mastura Akhtar on the selection of Salmonella bacteriophages and another one by Stelios Viazis on the application of E. coli O157 phages on solid surfaces. One poster was presented by Hongshun Yang at the IAFP meeting on the NECA water project. At both meetings, researchers discussed their findings with audiences as well as distributed copies of the posters to attendees. PARTICIPANTS: PI: Dr. Francisco Diez-Gonzalez; Co-PI: Dr. Joellen Feirtag; Graduate Research Assistants: Stelios Viazis and Hongshun Yang; Post-doctoral Research Associate: Dr. Mastura Akhtar, Undergraduate students: Phillip Kraemer and Kyle Christensen. The members of the advisory panel are: Jim Riddle, an organic policy consultant and former Chair of NOSB; Emily Brown Rosen, Policy Director of Pennsylvania Certified Organic and consultant for Organic Research Associates; Dr. Carl Rosen, Professor and Extension Soil Scientist at the University of Minnesota; and Dr. Jennifer Ryder Fox, Dean of the College of Agriculture of the California State University-Chico. Collaborators: Dr. Todd Callaway, ARS/USDA, Drs. Andy Brabban, Betty Cutter, Evergreen State University, Dr. Larry Goodridge, Colorado State University, and Dr. Martin Loessner, Switzerland. Mike Magee, Wastewater Treatment Facility, Rice Lake, WI; Scott Joseph and Angella Craft-Reardon, Seneca Wastewater Treatment Plant, Eagan, MN contributed by providing sewage samples. TARGET AUDIENCES: Organic producers and processors, food safety scientists, as well as food producers interested in natural alternatives to artificial sanitizers. PROJECT MODIFICATIONS: The efforts intended to develop other bacteriophages in addition to Salmonella, E. coli O157 and L. monocytogenes will not be pursued given the complexity of identifying effective types. The work on NECA water has been focused on studying the mechanism of inactivation, given the lack of success in other approaches and on extension efforts.

2008/09/01 TO 2009/08/31 OUTPUTS: The overall goal of this project is the development of sanitizers that can be used in organic food production. Specifically we are exploring the use of electrochemically activated (ECA) water and bacteriophages capable of inhibiting foodborne pathogens. We have continued working with our collaborators as well as with our advisory panel. We have been able to receive samples from different companies including Bix, Inc., Seward Coop., as well as sewage samples from different cheese companies and water processing plants to isolate bacteriophages. An expert in Listeria phages has been providing valuable input to obtain these type of phages. The first findings obtained from this project were presented at the 2009 annual meeting of the International Association for Food Protection. PARTICIPANTS: PI: Dr. Francisco Diez-Gonzalez; Co-PI: Dr. Joellen Feirtag; Junior Scientist/Technician: Leena Griffith; Graduate Research Assistants: Stelios Viazis and Hongshun Yang; Post-doctoral Research Associate: Dr. Mastura Akhtar. The members of the advisory panel are: Jim Riddle, an organic policy consultant and former Chair of NOSB; Emily Brown Rosen, Policy Director of Pennsylvania Certified Organic and consultant for Organic Research Associates; Dr. Carl Rosen, Professor and Extension Soil Scientist at the University of Minnesota; and Dr. Jennifer Ryder Fox, Dean of the College of Agriculture of the California State University-Chico. Collaborators: Dr. Todd Callaway, ARS/USDA, Drs. Andy Brabban, Betty Cutter, Evergreen State University, Dr. Larry Goodridge, Colorado State University, and Dr. Martin Loessner, Switzerland. TARGET AUDIENCES: Organic producers and processors as well as food producers interested in natural alternatives to artificial sanitizers. PROJECT MODIFICATIONS: The extension efforts have been delayed because of several reasons: the change of supplier of ECA water technology, the departure of the technician that had been working on the project and the inconsistency of effectiveness to be able to effectively deploy the technology. As a replacement for the sodium carbonate-based ECA water, a number of other alternatives have been evaluated.

2007/09/01 TO 2008/08/31 OUTPUTS: 1) Hiring The single most important activity conducted during the first year of the project was to fill the positions of researchers who would be conducting most of the work. 2) Advisory panel meetings On January 29th, the first meeting with our advisory panel was held in St. Paul, MN. This meeting served as the kick-off event of the project in which we informed the panel about the progress, changes in the activities schedule as well as plans for the rest of the grant. Both PI and Co-PI as well as most of the research and extension team participated in this meeting. On November 14th, 2008, a conference call/webcast was

conducted with the same advisory panel to discuss the latest results and outcomes of the project. We received excellent feedback from the panel members at both of these events and we look forward to continue interacting and collaborating with them. 3) Interactions with collaborators have been very supportive of our efforts in developing our expertise in phage techniques and obtaining initial phage stocks. A new company, IET, Inc., that manufactures electrochemically activated (ECA) water generators has agreed to provide expertise and facilitate the use of their units. 4) Extension efforts The application of water has been tested in three of our industry collaborators facilities for the disinfection of fresh vegetables. These companies include Bix Produce, Inc., Seward Coop and SuperMom\'s Commissary. A group of organic farmers has been selected in order to identify testing sites for ECA water application. PARTICIPANTS: Researchers: PI: Dr. Francisco Diez-Gonzalez; Co-PI: Dr. Joellen Feirtag Junior Scientist/Technician: Leena Griffitth; Graduate Research Assistants: Stelios Viazis and Hongshun Yang; Post-doctoral Research Associate: Dr. Mastura Akhtar. The members of the advisory panel are: Jim Riddle, an organic policy consultant and former Chair of NOSB; Emily Brown Rosen, Policy Director of Pennsylvania Certified Organic and consultant for Organic Research Associates; Dr. Carl Rosen, Professor and Extension Soil Scientist at the University of Minnesota; and Dr. Jennifer Ryder Fox, Dean of the College of Agriculture of the California State University-Chico. Collaborators: Dr. Todd Callaway, ARS/USDA, Drs. Andy Brabban, Betty Cutter, Evergreen State University and Dr. Larry Goodridge, Colorado State University. TARGET AUDIENCES: Organic producers and processors as well as food producers interested in natural alternatives to artificial sanitizers. PROJECT MODIFICATIONS: In addition to exploring the use of ECA water and bacteriophages as potential organic sanitizers we will also investigate the utilization of other natural approaches such as chitosan and citrus extracts. We will be discontinuing exploring the use of sodium carbonate as antimicrobial because of its limited antimicrobial effect. We will, however, continue to study the use of sodium bicarbonate as an alternative salt for ECA water treatment.

IMPACT

2007/09 TO 2011/08 Change in knowledge: 1) NECA water project: A few simpler antimicrobial technologies that are also based on electrolysis or ozonation have been recently marketed by their manufacturers claimed to have sanitizing properties for controlling pathogens. The objective of this study was to determine the sanitizing effect of solutions from some of these commercial technologies (Ionator, Salt Ionator and Lotus) on Escherichia coli O157:H7, Listeria monocytogenes, and Salmonella and compare them with a non-portable ECAW. The results showed that 100 mg/L ECAW generated from STEL 80 ECT US had sanitizing effects of at least 5 log CFU/ml reductions on liquid culture and more than 4 log CFU/coupon reductions for E. coli O157:H7, L. monocytogenes and Salmonella dried on stainless steel surface, respectively. No bacterial cells were detected by direct plate counting post-ECAW treatment. In contrast, the other commercial technologies tested were not effective in sanitizing. These results would be helpful for guiding consumers when choosing a right sanitization to ensure food safety. 2) Bacteriophages against Listeria monocytogenes: Phage treatments were most effective at 10C and 4C in TSB, as viable cells were not detected (\<1 log CFU/mL) after 24 h at 100 and 1000 MOI. Phage cocktail completely lysed L. monocytogenes cells at 1000 MOI after 1 h compared with controls. Phage cocktail, LP1 lysed L. monocytogenes mix cultures (N=5) in liquid medium (TSB) at different temperaures, 4 , 10 and 30C. LP1 had optimum lytic effect at MOI (rate of PFU of phage to CFU of bacteria) of 1,000 at all experimental incubation temperatures, and no viable cells of L. monocytogenes were detected after 1 h of treatment. TEM photographs indicated the LP1 phages belonged to Order Caudovirales, Family Myoviridae. Treatment of milk samples inoculated with mixtures of L. monocytogenes strains with LP1 was able to reduce the count to undetectable levels when incubated at 4C in less than 2 days. Similar results were observed in ham and turkey meats. These findings suggest that LP1 can be a promising alternative to control this pathogenic bacterium in ready-to-eat foods. 3) Bacteriophages against E. coli O157:H7: The objective of this study was to determine the effect of a previously characterized collection of bacteriophages, BEC8, on the inactivation kinetics of a mixture of EHEC O157:H7 strains applied on surfaces of materials commonly found in food processing plants. D-values on any surface material ranged from 3.9 min at 37C to 46.7 min at 12C. Z-values calculated for stainless steel, ceramic tile, and high-density polyethylene resulted in 26.1, 23.7, and 26.7C, respectively for dry cells and 23.2, 23.7, and 24.5C, respectively for liquid cells. There was a significant difference on the effect the phage cocktail had on the E. coli O157:H7 mixture between the two lower temperatures (12 and 23C) vs. the two higher temperatures (30 and 37C). These results indicated that bacteriophage cocktails can be used as an effective antimicrobial against E. coli O157:H7 present in dry or liquid form on hard surfaces. **PUBLICATIONS (not previously reported):** 2007/09 TO 2011/08 1. Viazis, S., M. Akhtar, A. Brabban, J. Feirtag, and F. Diez-Gonzalez. 2011. Isolation and host range characterization of lytic bacteriophages against enterohemorrhagic Escherichia coli. J. Appl. Microbiol. 110:1323-1331. 2. Viazis, S., M. Akhtar, J. Feirtag, and F. Diez-Gonzalez. 2011. Reduction of Escherichia coli O157:H7 viability on hard surfaces by treatment with a bacteriophage

mixture. Intl. J. Food Microbiol. 145: 37-42. 3. Viazis, S., M. Akhtar, J. Feirtag, and F. Diez-Gonzalez. 2011. Reduction of Escherichia coli O157:H7 viability on leafy green vegetables by treatment with a bacteriophage mixture and trans-cinnamaldehyde. Food Microbiol. 28: 149-157. 4. Viazis, S., and F. Diez-Gonzalez. 2011. Enterohemorrhagic Escherichia coli: The 20th. centurys emerging foodborne pathogen. A Review. Adv. Agron. 111: 1-50. 5. Posters: Viazis, S., T. P. Labuza, F. Diez-Gonzalez. 2011. Inactivation kinetics of Escherichia coli O157:H7 on hard surfaces by use of a bacteriophage mixture. IAFP Annual Meeting, Sept. 31-August 3, Milwaukee, WI. 6. Akhtar, M., S. Viazis, K. Christensen, P. Kraemer and F. Diez-Gonzalez, 2011. Isolation of virulent bacteriophages for bio-control of Listeria monocytogenes. IAFP Annual Meeting, Sept. 31-August 3, Milwaukee, WI.

2009/09/01 TO 2010/08/31 Change in knowledge: 1) NECA water project: the culture viability of 34 strains of Listeria monocytogenes, Salmonella and Escherichia coli O157:H7 on coupon surfaces was reduced more than 4 log CFU by the treatment of NECAW. NECAW treatment of biofilms reduced bacterial counts by 1 to 5 log CFU per coupon with an average of 2.4. S. Newport B4442CDC and E. coli O157:H7 ATCC 43895 were the most resistant strains to NECAW for surfaces and biofilms, respectively. The biofilm structures and microbial cells on stainless steel (SS) were destroyed by the treatment with NECAW. Different species and strains of foodborne pathogens had variable sensitivity to NECAW. NECAW could be effective in controlling surface contamination with pathogenic bacteria and biofilm growth. 2) Bacteriophages against E. coli O157:H7: At 37C and 12C on SS chips, no culture survivors were detected (detection limit 10 CFU/chip) after treatment with a bacteriophage cocktail (BEC8) at ratios of viral to bacterial counts of 100 after 10 min and at 23C after 1 h on SS chips. These results indicated that the phage cocktail was effective within an hour against low levels of the EHEC mixture at above room temperature on solid surfaces. Spinach and lettuce leaves treated with BEC8 and trans-cinnamaldehide (TC) individually at low inoculum levels after 24 h at 23 and 37C had no detectable viable cells. When the EHEC inoculum size increased and/or incubation temperature decreased, the efficacy of BEC8 and TC decreased. However, when the two treatments were combined, no survivors were detected after 10 min at all temperatures and inoculum levels on both leafy greens. These results indicated that the BEC8/TC combination was highly effective against EHEC on both leafy greens. This combination could potentially be used as an antimicrobial to inactivate EHEC O157:H7 and reduce their incidence in the food chain. 3) Bacteriophages against Salmonella: A total of 51 phages were isolated , and fifteen phages were purified and selected for further analysis. Phages lysed three different Salmonella Typhimurium strains with high efficiency of plaquing values (almost 1.0). Four phages cross infected serovars. Results of positive spot testing had broad specificity against different serovars. Phage SEA1 infected most Typhimurium, Newport, and Enteritidis strains, and a Tennessee and a Saintpaul serovars. Treatment of tomato surfaces with SEA1 phages previously inoculated with S. Enteritidis caused a reduction of 2.4 logs CFU/g at 23C after 2 h incubation. Phage genome sizes ranged from 45 to 190 kb. These findings suggested that phages can serve as an effective and natural control strategy to reduce the incidence of foodborne Salmonella. 4) Bacteriophages against Listeria monocytogenes: A total of 37 phages were isolated against Listeria monocytogenes from sewage samples. The most efficient phages were tested for different serotypes of L. monocytogenes (N=24). Based on the spot test and EOP data, ten phages had higher efficiency and broader specificity against the tested strains of serotypes 4a, 4b, 3a, 3b, 1/2a, 1/2b, 1/2c; interestingly, none of the isolated phages were effective against 3c serotype.

2008/09/01 TO 2009/08/31 CHANGE IN KNOWLEDGE: 1) ECA water research: A variety of commercially available brands of electrolyzed water were evaluated for their effectiveness against pathogenic microorganisms. In experiments that assess their antimicrobial effect in liquid culture, as well as on surfaces, the only electrolyzed water capable of causing significant viable count reductions was electrochemically activated water with 50 ppm free chlorine. However, in pure culture, some strains of Salmonella and E. coli O157:H7 were not completely killed and residual populations remained after 30 s of exposure. 2) Bacteriophage research: Specific objectives included isolation, identification, characterization and evaluation of phages for controlling Salmonella Typhimurium and Escherichia coli O157:H7. The bacteriophage isolation method included enrichment, spot test, filtration, plaque assays, purification and amplification. Salmonella Typhimurium strains were used as host strains in the isolation process. Isolated phages were tested against pure cultures of different Salmonella serovars. The efficiency of plaquing (EOP) method was used to measure lytic activity of phages. Transmission electron microscopy (TEM) was used to observe phage morphology. From twenty four manure samples, a total of nineteen extracts had some lytic activity against Salmonella and ten phages were further purified. Phages previously isolated were provided. Additional phages were isolated from dairy and feedlot manure using EHEC O157, O26 and O111 strains as hosts. Manure was enriched using tryptic soy (TS) broth and exponentially growing cultures of specific bacterial hosts incubated overnight at 37C. The enriched extracts were centrifuged, filtered, combined with the host strain in tryptone top agar and plated on TS agar. Plaques were purified and screened against additional strains (14, O157; 10, O26; 10, O111) using the efficiency of plaquing method (EOP).

Those phages were capable of lysing three different Salmonella Typhimurium strains including one multidrug resistant isolate with high EOP values (range: 0.05 to 1.0). None of the phages were active against four Salmonella Newport, one S. Montevideo, and two S. Enteritidis. The phages showed very specific lytic activity against Salmonella Typhimurium strains. Phage CEV2 and seven other phages previously isolated were able to lyse all 14 O157 strains with EOP values consistently above 0.001. Four out of six phages isolated from a cattle feedlot were effective against all O157 strains and one O26 strain with EOP values greater than 0.001. Based on TEM, some of the phages were classified as Group 1 Caudovirales. These results indicated that the isolated bacteriophages were highly effective against multiple strains of two EHEC serotypes. This collection of phages can be grouped and potentially used as an antimicrobial cocktail to inactivate Salmonella and E. coli O157 in the food processing environments and on fresh produce. These findings suggest that the use of bacteriophages could be a viable antimicrobial alternative to control foodborne pathogens in the organic food processing environment.

2007/09/01 TO 2008/08/31 Change in Knowledge 1)ECA water research and extension. In order to determine the antimicrobial efficacy of ECA water we used the AOAC method for testing sanitizers against, Escherichia coli, Staphylococcus aureus, Salmonella species and Listeria monocytogenes. The ECA water parameters were 30 ppm free available chlorine, ORP at 800 mV and pH 6.2-7.4. There was a 5 to 6 log reduction of these pathogens when exposed to the above ECA solution. In addition, there was a 1 to 2 log reduction in of aerobic and coliform microorganisms when lettuce was treated. We have also established a 3 month shelf-life of ECA water with respect to the efficacy against the above pathogens. 2)Bacteriophage research A total of 40 strains of bacteriophages were obtained from two of our collaborators. We have identified that at least three of them have broad spectrum against 11 Escherichia coli O157:H7 strains and their morphological characteristics using electron microscopy have been determined. At least 10 additional coliphages have been directly isolated from cattle manure and three of those phages are capable of infecting as many as 10 E. coli O26 strains. Eleven bacteriophages specific against Salmonella have also been isolated from cattle, swine and poultry manure. We have characterized the morphology of 5 of them which they appear to be highly infectious for S. Typhimurium, the serovar responsible for most of the salmonellosis cases.

PUBLICATIONS

2009/09/01 TO 2010/08/31 1. Peer-review papers: Viazis, S., Akhtar, M., Feirtag, J. and Diez-Gonzalez, F. 2010. Reduction of Escherichia coli O157:H7 viability on hard surfaces by treatment with a bacteriophage mixture. Intl. J. Food Microbiol. 10.1016/j.ijfoodmicro.2010.11.021. 2. Viazis, S., Akhtar, M., Feirtag, J. and Diez-Gonzalez, F. 2010. Reduction of Escherichia coli O157:H7 viability on leafy green vegetables by treatment with a bacteriophage mixture and trans-cinnamaldehyde. Food Microbiol. doi:10.1016/j.fm.2010.09.009. 3. Abstracts: Yang, H., Feirtag, J. and Diez-Gonzalez, F. 2010. Effect of neutral electrochemically activated water on the viability and biofilms of foodborne pathogens on stainless steel surfaces. IAFP Annual Meeting, August 1-4, Anaheim, CA. 4. Viazis, S., Akhtar, M., Feirtag, J. and Diez-Gonzalez, F. 2010. Reduction of Escherichia coli O157:H7 viability on hard surfaces by treatment with a bacteriophage mixture. ASM Annual Meeting, May 23-27, San Diego, CA. 5. Akhtar, M., Viazis, S. Thompson, H., Erbach, C., Feirtag, J. and Diez-Gonzalez, F. 2010. Efficacy of bacteriophages for biocontrol of Salmonella serovars. ASM Annual Meeting, May 23-27, San Diego, CA. 6. Dissertation: Viazis, S. 2010. Control of enterohemorrhagic Escherichia coli using bacteriophages. Ph.D., University of Minnesota. 239 pp.

2008/09/01 TO 2009/08/31 1. Diez-Gonzalez, F. and Mukherjee, A. 2009. Produce safety in organic vs. conventional crops. In: X. Fan, B. A. Niemira, C. J. Doona, F. E. Feeherry, and R. B. Gravani (eds.), Microbial Safety of Fresh Produce: Challenges, Perspectives and Strategies, Institute of Food Techonologist Press-Wiley Blackwell, Hoboken, N. J. 2. Akhtar, M., Viazis, S., Feirtag, J. and Diez-Gonzalez, F. 2009. Isolation and identification of bacteriophages against Salmonella Typhimurium, International Association of Food Protection annual meeting, July 12-15, Dallas, TX. 3. Viazis, S., Akhtar, M., Feirtag, J. and Diez-Gonzalez, F. 2009. Isolation and characterization of lytic bacteriophages against enterohemorrhagic Escherichia coli. International Association of Food Protection annual meeting, July 12-15, Dallas, TX.

2007/09/01 TO 2008/08/31 No publications reported this period

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Eorganic: Extension for Organic Agriculture

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Subfile	CRIS
Project No.	ORE00004
Agency	NIFA ORE
Project Type	OTHER GRANTS
Project Status	TERMINATED
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Investigator(s)	Stone, A. G.; Gamroth, M.; Stephenson, G.; Staben, M.; Darby, H. M.; Riddle, J.; Wander, M. M.; Cooperband, L. R.; Masiunus, J.; Cavanaugh-Grant, D.
Performing Institution	HORTICULTURE, OREGON STATE UNIVERSITY, CORVALLIS, OREGON 97331

NON-TECHNICAL SUMMARY

The organic marketplace is growing rapidly, outpacing the availability of high quality, science-based information for farmers and agricultural professionals. This project will develop model livestock (dairy) and crop (vegetable) information for eOrganic, the new eXtension organic agriculture website.

OBJECTIVES

Long-term goal: The long-term goal of this project is to develop eOrganic, in partnership with other organic agriculture information providers, as an effective, national, internet-based, interactive, user-driven, organic agriculture information system for farmers and agricultural professionals. eOrganic will develop and deliver organic agriculture information that is accessible, reliable, credible, and up-to-date. Supporting objectives: Objective 1: To develop and evaluate a vision and framework for eOrganic, including partnerships with ATTRA, National and regional SARE programs, OrganicAgInfo, National Agricultural Library, and other organic agriculture information providers. Objective 2: To develop in-depth eOrganic content in a) diversified vegetable production and marketing systems, and b) dairy production and marketing systems Objective 3: To evaluate eOrganic process, content, delivery, and outcomes Objective 4: To market eOrganic to farmers and agricultural professionals

APPROACH

A vision and framework for eOrganic is being developed and evaluated in partnership with key organic agriculture information providers such as ATTRA and OrganicAgInfo. eOrganic will initially offer searchable content consisting of brief articles, nationally compiled FAQs, interactive Ask-the-Expert, regionally-specific case studies, certification and decision tools, and a portal to in-depth information available from eOrganic, ATTRA, OrganicAgInfo, and other sources. Over time, eOrganic will offer video streaming of expert presentations and certificate and continuing education courses. Organic systems researchers will be convened and IOP, SARE, and

other research results will be collected, discussed, distilled, and translated into eOrganic content to deliver missing systems information to farmers and increase impact of federal research dollars. eOrganic will provide timely information on critical issues such as systems-level soil and pest management, animal health, grazing, feed supplements, community food systems, and international certification requirements. eOrganic will be evaluated from the beginning to the end of the project by organic farmers, conventional farmers, and agricultural professionals to develop the highest quality content and most effective delivery systems for these user groups.

PROGRESS

2007/09 TO 2010/08 OUTPUTS: Activities: eOrganic\'s leadership team, content groups, and administrative groups meet regularly to plan, coordinate and develop eOrganic. The publication and staff groups coordinate the publication of eOrganic\'s articles, FAQs, videos, webinar series, Ask an Expert, newsletters, and other public content. The evaluation group coordinates evaluation of articles and webinars. Staff train members in use of the workspace and group tools including publication to eXtension. Leaders and staff coordinated events including the eOrganic visioning meeting and workshops at the National SARE, NCERA-59, and National Association of County Ag Agents conferences. Products: eOrganic developed its public site at http://www.extension.org/organic production (articles, FAQs, videos, webinars, Ask an Expert, newsletters) and its community and publication workspace at http://eorganic.info/ (group workspaces and tools, community networking, personal pages, help and training, publication to http://www.extension.org/organic production). eOrganic, in partnership with eXtension, developed a feed from eOrganic.info to eXtension.org so content developed at eOrganic.info could be published to eXtension. eOrganic initiated and continues to develop a Facebook site (http://www.facebook.com/eorganic), a Twitter presence (http://twitter.com/eOrganic CP), and a Youtube site (http://www.youtube.com/eorganic) Services: eOrganic provides information, answers, and training to farmers, service providers, and others interested in organic agriculture. eOrganic coordinates peer and NOP compliance review, evaluation, marketing, and outreach for its public content for the eOrganic community. eOrganic supports members and project groups in group management and communication and publication to eXtension. eOrganic trains members in video, webconferencing, and other Web 2.0 tools and strategies. Dissemination: eOrganic members distribute outreach materials, staff booths, and give presentations at major and smaller events around the country, including small farms and dairy conferences and short courses. eOrganic has had a significant presence at 1) EcoFarm, CA (west), 2) Southern SAWG Conference, TN (south); 3) PASA, PA and NOFA-VT (northeast), and 4) the Organic Farming Conference, WI (midwest). eOrganic distributes fact sheets describing the public content and site, eOrganic bookmarks with the url for the public site, and trifold brochures targeted to prospective eOrganic.info members. eOrganic has had a presence at more than 80 conferences, meetings, and workshops and communicated directly with more than 18000 individuals. eOrganic reaches out to eOrganic.info members and public stakeholders through its two bi-monthly newsletters(most recent at http://www.extension.org/article/29037), as well as its webinar series and its Facebook, Twitter, and Youtube presences. In addition, eOrganic reaches out to diversified vegetable farmers through its ads in http://www.growingformarket.com/. PARTICIPANTS: eOrganic Leadership Team: The eOrganic Community of Practice is led by the eOrganic Leadership Team (LT), comprised of leaders of content groups and the Project Leader and Senior Coordinator. LT members included Mary Barbercheck, Penn State and Geoff Zehnder, Clemson (leaders, insect management group); Michelle Wander, U of IL (leader, soils group); Jim Riddle, U of MN (leader, certification group); Heather Darby, U of VT (leader, dairy farming systems group); Danielle Treadwell, U of FL (leader, cover crops group); Tim Coolong, U of KY (leader, diversified vegetable cropping systems group); Corinne Alexander, Purdue (leader, economics group); Eric Gallandt, Univ. of ME (leader, weed management group); Garry Stephenson, Oregon SU (leader, food systems group); Deborah Cavanaugh-Grant , U of IL (outreach); Alex Stone, Oregon State (Project Leader); John McQueen, Oregon State (Senior Coordinator). The LT met by webconference 6 times per year. Project Leader: Alex Stone led the eOrganic CoP and Leadership Team, facilitated long term planning and short term management, supervised staff, oversaw evaluation, supervised editorial management of content, raised funds, and served as eXtension and public liaison. eOrganic salaried staff Workspace Developer Roger Leigh provided eOrganic with insight into emerging web technologies; developed the eOrganic.info workspace and feed to eXtension in cooperation with John McQueen; identified, tested and installed suitable open source software for the project (built around a core Drupal content management system), provided required functionality by creating custom code when not publicly available, and maintained the workspace. Senior Coordinator, Web 2.0 Coordinator, and Workspace Manager. John McQueen provided eOrganic with insight on how best to adopt and adapt Web 2.0; administered the workspace, YouTube, Facebook, Twitter and eXtension websites; trained staff and members; assisted Leigh with workspace development; provided workspace support, identified usability and workflow issues; led testing on all enhancements and updates; provided technical support for webinars and short course software; and acted as technical liaison to eXtension. Communications Coordinator Alice Formiga coordinated the webinar series, authored user guides, and published eOrganic News. Content coordinators: Deb Heleba coordinated the dairy group, as well as peer review and eOrganic.info membership for the first two years;

Ed Zaborski coordinated the soils, insect, weed, and cover crops groups, and acted as Senior Editor; Alice Formiga coordinated the vegetable and disease groups. eOrganic Core Contractors. NOP Compliance Reviewer and Certification Coordinator Jim Riddle reviewed all content for NOP compliance, authored certification content, and presented webinars. Evaluator. Michael Coe of Cedar Lake Research Group coordinated evaluation of eOrganic\'s articles and webinars. Thirty-nine eOrganic members presented webinars and 69 authored articles (see publication section); in addition, 108 members answered Ask-an-Expert questions. TARGET AUDIENCES: eOrganic considers its primary Community of Interest (stakeholders of its public content) to be organic farmers and other farmers interested in organic agricultural information, as well as the Extension and other agricultural professionals who support them. During eOrganic\'s first 3 years, the primary stakeholder groups were organic dairy farmers, diversified fresh market vegetable farmers, and the service providers who support them. eOrganic\'s stakeholders also include its more than 700 eOrganic.info community members, comprised of researchers, educators, extension professionals, farmers, and other organic agriculture practitioners and service providers. PROJECT MODIFICATIONS: Not relevant to this project.

2008/09/01 TO 2009/08/31 OUTPUTS: Articles: Website visit counts and page visit duration are an indication of website use and utility. As of February 11, 2010, eOrganic\'s homepage (http://extension.org/organic production) at eXtension.org has seen a total of 11,751 page views (8,075 unique users) since eOrganic first published content on Jan 22 2009. In total for 2009, eOrganic pages have seen more than 225,000 unique page views. While eOrganic\'s pages represent only 1.5% of eXtension.org pages, its content accounted for 6% of all eXtension page hits from April to December 2009. eOrganic\'s content on eXtension.org boasts a 45% higher than average page visit time than the website as a whole. Videos: eOrganic maintains a \'channel\' at YouTube (http://www.youtube.com/eOrganic); as of February 10, 2010, this site has seen 101,000 views of its 112 videos since its inception in late 2008. eOrganic\'s most-viewed video is of Suzy and Robelee Evans of Foundhorn Farm demonstrating their Reigi weeder, with 10,870 views. Ask-an-Expert: Ask-an-Expert is an interactive question-answering system hosted by eXtension. To date, eOrganic has answered 354 questions submitted to Ask-an-Expert, with an average response time of 40 hours. Webinars: eOrganic initiated two webinar (virtual seminar) series in December 2009; the first is for a farmer and agricultural professional audience and the second is for a researcher audience (http://www.extension.org/article/25242). While the webinar initiative is very new, 425 people have attended these first 6 webinars. Outreach: eOrganic members have presented and staffed booths on behalf of eOrganic from late 2007 through February 2010. Outreach geared up in winter 2008-09 as eOrganic prepared for the launch of its first public content at eXtension.org. Last and this winter, eOrganic has had a significant presence at 4 major regional events including 1) EcoFarm, CA (west), 2) a major southern conference (Southern SAWG Conference, TN, 2009; Georgia Organic Conference, 2010); 3) PASA, PA (northeast), and 4) the Midwest Organic Farming Conference, WI (midwest). eOrganic members distribute outreach materials, staff booths, and give presentations at major events and at smaller events including small farms and dairy conferences and short courses. eOrganic distributes fact sheets describing the public content and site, eOrganic bookmarks with the url for the public site, and trifold brochures targeted to prospective eOrganic.info members, at these events. eOrganic to date has had an outreach presence at more than 60 conferences, meetings, and workshops and communicated directly with more than 9000 individuals. PARTICIPANTS: eOrganic Leadership Team: The eOrganic Community of Practice is led by the eOrganic Leadership Team (LT), comprised of leaders of content groups and the Project Leader and Senior Coordinator. Current LT members include Mary Barbercheck, Penn State (leader, insect management group); Michelle Wander, U of IL (leader, soils group); Jim Riddle, U of MN (leader, certification group); Heather Darby, U of VT (leader, dairy farming systems group); Danielle Treadwell, U of FL (leader, cover crops group); Tim Coolong, U of KY (leader, diversified vegetable cropping systems group); Corinne Alexander, Purdue (leader, economics group); Eric Gallandt, Univ. of ME (leader, weed management group); Alex Stone, Oregon State (Project Leader); John McQueen, Oregon State (Senior Coordinator). The LT meets by webconference 6 times per year. Project Leader: Alex Stone leads the eOrganic CoP and Leadership Team, facilitates long term planning and short term management, supervises staff, co-coordinates the evaluation of the workspace, supervises editorial management of content, raises funds, and serves as eXtension and public liaison. eOrganic salaried staff Workspace Developer. Roger Leigh provides eOrganic with insight into emerging web technologies; develops the eOrganic.info workspace and feed to eXtension in cooperation with John McQueen; identifies, tests and installs suitable open source software for the project (built around a core Drupal content management system), provides required functionality by creating custom code when not publicly available, and maintains the workspace. Senior Coordinator, Web 2.0 Coordinator, and Workspace Manager. John McQueen provides eOrganic with insight on how best to adopt and adapt Web 2.0; administers the workspace, YouTube, Facebook, Twitter and eXtension websites; trains staff; assists Leigh with workspace development; provides workspace support, identifies usability and workflow issues; leads testing on all enhancements and updates; provides technical support for webinars and short course software; and acts as technical liaison to eXtension. Communications Coordinator and Editorial Manager Alice Formiga conducts trainings; authors user guides; coordinates membership, AaE, and outreach; publishes eOrganic News; and

oversees peer review and other editorial tasks in cooperation with group coordinators and group and project leaders. Content coordinators: Deb Heleba coordinates the dairy group; Ed Zaborski coordinates the soils and cover crops groups; Kelly Gilkerson coordinates the weed and insect groups; Alice Formiga coordinates the vegetable and disease groups. eOrganic Core Contractors NOP Compliance Reviewer and Certification Coordinator Jim Riddle reviews all content for NOP compliance, authors certification content and presents webinars, and leads the certification group. Evaluator. Michael Coe of Cedar Lake Research Group coordinates evaluation of eOrganic\'s public content (articles, AaE, and webinars), the utility and usability of the eOrganic.info workspace, and eOrganic\'s tools and strategies to support networking and collaboration. TARGET AUDIENCES: eOrganic\'s stakeholders: eOrganic considers its primary Community of Interest (stakeholders of its public content) to be organic farmers and other farmers interested in organic agricultural information, as well as the agricultural professionals, including Extension professionals, who work with them. PROJECT MODIFICATIONS: Not relevant to this project.

2007/09/01 TO 2008/08/31 OUTPUTS: Objective 1: Develop and evaluate a vision and framework for eOrganic, including partnerships with ATTRA, National and regional SARE programs, OrganicAgInfo, National Agricultural Library, and other organic agriculture information providers. eOrganic has hosted two webconferences and one 5 hour in-person meeting with SARE, NAL, ATTRA, OFRF and NEW Farm to work towards strategies for collaboration as content providers. eOrganic and New Farm partnered on a Specialty Crops Research Initiative proposal to develop an on-line course on transitioning to organic production for vegetable farmers (not funded). eOrganic and SARE are in a discussion on how eOrganic can bring SARE publications into the eOrganic workspace so they can be collaboratively updated and re-published to eXtension/eOrganic. Objective 2: Develop in-depth eOrganic content in: a. diversified vegetable production and marketing systems b. dairy production and marketing systems c. certification. eOrganic in 2007-08 worked with group leaders, staff and authors in workspace use and content authoring and editorial policies and procedures. eOrganic currently hosts 16 disciplinary groups (from soils to economics), 3 cropping systems groups (vegetables, dairy, and tree fruits), and 14 research/outreach project-based groups. All of these groups are engaged in the development of content for publication to eXtension/eOrganic. The eOrganic workspace provides training materials for workspace use and content development and publication. In addition, eOrganic staff offer approximately 3 open webconference trainings per month, and webconference trainings for specific groups as needed. In 2007-08 eOrganic conducted 23 webconfernce trainings on the workspace, involving approximately 60 individuals. Approximately 40 members have contributed eOrganic content for publication at eXtension.org. eOrganic will publish its first content in December 2008 and hold its media launch at the Ecofarm conference in Monterey CA in January 2009. No content was published during year one. Objective 3: Evaluate eOrganic process, content, delivery, and outcomes The activities related to this objective will all take place in year two. Objective 4: Market eOrganic to farmers and agricultural professionals Most of the marketing activities will take place in year two. However, several marketing events occurred in 2008. Alex Stone gave an eOrganic presentation in the USDA Integrated Organic Program (IOP) PI workshop (40 attendees) at the National SARE Conference. In addition, eOrganic hosted a focus group session with IOP PIs after the PI workshop (20 attendees). At the SARE conference, eOrganic leadership team members and staff presented 3 workshops (140 attendees) on eOrganic\'s workspace and eXtension, and staffed a resource table. Jim Riddle reported on eOrganic to the National Organic Program. Alex Stone presented eOrganic to the Oregon State University Extension Leadership group. PARTICIPANTS: 1. PIs: Alexandra Stone: Lead PI. Leads most project initiatives. Leads vegetable production group and led disease group. Heather Darby and Mike Gamroth: Co-lead dairy group. Michelle Wander: Leads soils group and the research project group initiative. Jim Riddle: Leads certification group, reviews all content for compliance with organic certification regulations. Is head of the leadership team. Garry Stephenson and Deborah Cavanaugh Grant: co-lead the marketing and foods systems group. Deborah is also the lead of the outreach effort this winter. Micaela Colley: Leads organic seed and organic breeding groups. John Masiunas and Leslie Cooperband: never worked on this project. Staff. John McQueen: Lead coordinator, membership coordinator, assistant workspace developer. Vegetable, seed, breeding group coordinator. Roger Leigh: Lead workspace developer. Ed Zaborski: Insect and weed content coordinator. Emily Marriott: Soils coordinator. Debra Heleba: Dairy coordinator, review coordinator. Mary Staben Halbleib: No longer with project (was the evaluator, but stayed home after maternity leave). Partner Organizations: ATTRA, National Agriculture Library, New Farm/Rodale Institute, SARE. ALl of these organizations are collaborating with eOrganic on how we can best share information and co-develop content. eOrganic trains faculty, staff, and agricultural professionals on use of the eOrganic workspace and content authorship, review and formatting. TARGET AUDIENCES: In 2007-08 our target audience was solely the eOrganic Community of Practice (primarily LGU faculty and staff, certifiers, organic agricultural professioanls, some farmers); our intention was to bring them into the eOrganic workspace and web community to network, learn together, and develop eOrganic content. In 2008-09 we will engage a different target audience - our content users. PROJECT MODIFICATIONS: Not relevant to this project.

IMPACT

2007/09 TO 2010/08 eOrganic did not exist at the beginning of this project. In September 2010, three years later, eOrganic is a significant national organic agriculture web resource and one of eXtension\'s most-accessed resource areas. eOrganic has published more than 180 articles, 90 FAQs, 200 videos, and 25 webinars to eXtension.org/organic production and www.youtube.com/eOrganic. eOrganic\'s pages at eXtension.org have received more than 270,000 page views since October 2009 and its Youtube videos have been viewed 250,000 times. eOrganic\'s community has answered more than 600 Ask-an-Expert questions. Two thousand people from all over the country attended the first 23 webinars hosted by eOrganic in winter and spring 2010. eOrganic communicates bi-monthly with its more than 2700 newsletter subscribers and keeps in frequent touch with its 500 Facebook fans, 500 Twitter followers, and 280 Youtube subscribers. eOrganic also reaches out to more than 8000 farmers and agricultural professionals through booths and other activities at 3 or 4 major (and many more minor) organic farming conferences across the US each winter. eOrganic is now in the process of surveying its users to evaluate the quality and impact of its resources and activities. In addition, eOrganic.info (eOrganic\'s community and publication workspace) was developed; this site currently has more than 700 members (researchers, educators, extension professionals, farmers, certifiers, and service providers). More than 10 NIFA proposals have included eOrganic in their plans of work. Reviewers of eOrganic articles indicate that articles have high relevance, quality, and utility. Of the reviewers, 29 percent described themselves as farmers, 38 percent researchers, and 33 percent extension personnel. On average, the reviewers (from Florida, Idaho, Indiana, Kentucky, Maine, North Carolina, Oregon, Pennsylvania, Virginia, and Washington) have been involved in agriculture and organic agriculture for 18.1 and 10.0 years, respectively. They considered the information to be accurate (100 percent strongly/moderately agreed); very relevant to important farming problems or issues (93 percent strongly/moderately agreed); useful and practical and could be applied in real farming practice (90 percent strongly/moderately agreed). Feedback from the first 215 webinar participants (49% farmers, 21% agricultural professionals, 12% extension personnel, 7% researchers, 7% non-profit staff, 4% master gardeners) has been collected. 30% from northeast, 26% central US, 33% west, and 11 % south. Eighty-eight percent said the webinar improved their understanding significantly/moderately. 86 percent said they would apply the knowledge in their work a lot/somewhat. 94 percent would recommend the webinar to others. eOrganic will evaluate the impact of past webinars on participant knowledge and practices in winter 2010-11.
PUBLICATIONS (not previously reported): 2007/09 TO 2010/08 1. Andrews, N. and B. Baker, 2009. Can I Use This Input on My Organic Farm. eOrganic article. Available at http://www.extension.org/article/18321. 2. Andrews, N. and B. Baker, 2009. Can I Use this Product for Disease Management on my Organic Farm. eOrganic article. Available at http://www.extension.org/article/18360. 3. Barbercheck, M. and E. Zaborski, 2009. Insect Pest Management: Differences Between Conventional and Organic Farming Systems . eOrganic article. Available at http://www.extension.org/article/19915. 4. Barbercheck, M., 2009. Biological Control of Insect Pests . eOrganic article. Available at http://www.extension.org/article/18931. 5. Barbercheck, M., 2009. Decomposers in Organic Farming Systems. eOrganic article. Available at http://www.extension.org/article/18905. 6. Barbercheck, M., 2009. Ecological Understanding of Insects in Organic Farming Systems. eOrganic article. Available at http://www.extension.org/article/18906. 7. Barbercheck, M., 2009. Ecological Understanding of Insects in Organic Farming Systems: Diversity, Stability, and Productivity. eOrganic article. Available at http://www.extension.org/article/18534. 8. Barbercheck, M., 2009. Ecological Understanding of Insects in Organic Farming Systems: Ecological Succession. eOrganic article. Available at http://www.extension.org/article/18911. 9. Barbercheck, M., 2009. Ecological Understanding of Insects in Organic Farming Systems: Factors that Influence the Size of Insect Populations. eOrganic article. Available at http://www.extension.org/article/18569. 10. Barbercheck, M., 2009. Ecological Understanding of Insects in Organic Farming Systems: How Insects Damage Plants. eOrganic article. Available at http://www.extension.org/article/18903. 11. Barbercheck, M., 2009. Ecological Understanding of Insects in Organic Farming Systems: Insect Life Cycles . eOrganic article. Available at http://www.extension.org/article/19194. 12. Barbercheck, M., 2009. Ecological Understanding of Insects in Organic Farming Systems: Insect Populations. eOrganic article. Available at http://www.extension.org/article/18192. 13. Barbercheck, M., 2009. Ecological Understanding of Insects in Organic Farming Systems: Insects in Communities . eOrganic article. Available at http://www.extension.org/article/18908. 14. Barbercheck, M., 2009. Ecological Understanding of Insects in Organic Farming Systems: Plant Defenses against Insects . eOrganic article. Available at http://www.extension.org/article/18913. 15. Barbercheck, M., 2009. Natural Enemies in Organic Farming Systems. eOrganic article. Available at http://www.extension.org/article/18907. 16. Barbercheck, M., 2009. Physical and Mechanical Pest Controls . eOrganic article. Available at http://www.extension.org/article/18929. 17. Barbercheck, M., 2009. Planning Crop Location and Timing to Avoid Insect Pests. eOrganic article. Available at http://www.extension.org/article/18575. 18. Barbercheck, M., 2009. Pollinators in Organic Farming Systems.

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2008/09/01 TO 2009/08/31 Quality, Relevance, and Utility of eOrganic Articles and Ask an Expert Answers. We are currently pilot testing surveys that can be used with both expert and lay audiences to assess online articles developed by the project to educate users about organic agriculture topics. Data from 26 early respondents indicate that the currently available articles are generally considered to have high relevance, quality, and utility, though the audience varies in their preference for technical detail, and some particular articles need improvement in organization, writing, and utility. Of the reviewers, 29 percent described themselves as farmers, 38 percent as researchers, and 33 percent as extension personnel. On average, the reviewers (from Florida, Idaho, Indiana, Kentucky, Maine, North Carolina, Oregon, Pennsylvania, Virginia, and Washington) have been involved in agriculture and organic agriculture for 18.1 and 10.0 years, respectively. The following are averages responses from the 28 reviews; reviewers also provided recommendations which are being used to revise specific articles. The information was accurate (100 percent strongly or moderately agreed); the article was very relevant to important farming problems or issues (93 percent strongly or moderately agreed); the information presented was useful and practical and could be applied in real farming practice (90 percent strongly or moderately agreed). In November 2010 and each year thereafter, online surveys will be sent to a stratified random sample of stakeholders to measure the extent to which eOrganic articles are being read, and to gauge user opinions of the quality, relevance, and utility of the articles. Members of eOrganic\'s 16 member stakeholder advisory group will also evaluate eOrganic webinars, articles, FAQs, and Ask an Expert responses. Quality, Relevance, and Utility of eOrganic Webinars as a Training System. Surveys and focus group protocols have been developed to evaluate webinars. The surveys have been implemented during 2010 for 12 webinars and will be used for all future webinars; the focus group methodology has also been used for one webinar and will be used for selected webinars in the remainder of 2010. Feedback from 215 webinar participants (49% farmers, 21% agricultural professionals, 12% extension personnel, 7% researchers, 7% non-profit staff, 4% master gardeners) has been collected. Thirty percent were from the northeast, 26% from the central US, 33% from the west, and 11 % from the south. Eighty-eight percent reported that the webinar improved their understanding \"significantly\" or \"moderately\". Eighty-six percent reported that they intended to apply the knowledge they gained in their work \"a lot\" or \"somewhat\". Eighty-seven percent reported that the information was at a technical level that was \"just right.\" When asked if they would recommend the webinar to others, 94 percent said \"yes\", 6 percent said \"maybe\". Eighty-four percent of participants found accessing the webinar \"very easy\" and 10% found it to be \"somewhat easy\". Open-ended survey question response are being used to plan topics and improve the delivery of future webinars.

2007/09/01 TO 2008/08/31 Thus far, only eOrganic Community of Practice members have been impacted by this project. eOrganic members have an increased understanding of Web 2.0 and eXtension; they have learned how to use the Drupal workspace to author and edit content and upload images. eOrganic members will publish approximately 150 articles, 100 videos, and 150 FAQs in early 2009.

PUBLICATIONS

2008/09/01 TO 2009/08/31 No publications reported this period.

2007/09/01 TO 2008/08/31 No publications reported this period

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Midwest Organic Research Symposium

Accession No.	0210285
Subfile	CRIS
Project No.	WISW-2007-01384
Agency	NIFA WISW
Project Type	OTHER GRANTS
Project Status	TERMINATED
Contract / Grant No.	2007-51300-03797
Proposal No.	2007-01384
Start Date	15 JUN 2007
Term Date	14 DEC 2008
Grant Amount	$50,000
Grant Year	2007
Investigator(s)	Padgham, J.; Landeck, J.

NON-TECHNICAL SUMMARY

A. Quality research on organic systems is becoming more common. B. Access to research results is difficult for working farmers. c. Researchers have limited contact with farmers to understand their most immediate research needs. D. Researchers and students have limited venues for communication with each other about research initiatives, collaboration and funding possibilities. A. This project will bring together researchers, students and farmers interested in organic systems in order to allow them to learn from each other.

OBJECTIVES

This project proposes to make relevant organic research accessible to farmers through a Midwest Organic Research Symposium on February 21-23, 2008. The primary audience will be farmers who have collected to attend the Upper Midwest Organic Farming Conference (UMOFC) in La Crosse, WI. A diversity of presentation and discussion options will allow participants access to important information relevant to their organic production systems through formats that are most effective for them.

APPROACH

Two days of roundtable research discussions will allow researchers to explain the results and implications of their work to interested organic farmers and others. Small group discussion will encourage engaged participation and a customized approach to explaining result relevance or research findings to individual farming systems. Farmer reaction and comment to research results may be used to improve and direct follow up research. Written project summaries collected into a proceedings publication and distributed to the anticipated 2400 attendees of the UMOFC and also made accessible through the MOSES and partner websites will significantly improve farmer and other access to important organic farming research results. Posters explaining organic research will additionally enhance farmer access to information. A facilitated meeting on Thursday afternoon will bring together graduate students, experienced researchers and others to discuss research funding opportunities, priorities and potential collaborations. An Organic Growers Social and Economic Research Priority session on Thursday evening will allow farmers and others to offer researchers suggestions for priority organic research areas in the Midwest. This Symposium will be a joint project between the Midwest Organic and Sustainable Education Service (MOSES) and the Organic Farming Research Foundation (OFRF).

PROGRESS

2007/06 TO 2008/12 OUTPUTS: This project made important organic research accessible to farmers through a Midwest Organic Research Symposium, held on February 21-23, 2008, and a published collection of research summaries. The primary audience was 2,400 farmers gathered to attend the MOSES Organic Farming Conference (OFC) in La Crosse, WI. This Symposium was a joint project between the Midwest Organic and Sustainable Education Service (MOSES) and the Organic Farming Research Foundation (OFRF). In mid-summer 2007 a call for proposals was circulated to academic researchers, graduate students and farmer researchers throughout the country. Notices were sent to 34 academic departments within colleges of agriculture in the core Midwestern states, sent as press releases to partnering organizations, and in announcements in both OFRF and MOSES print newsletters and websites. 63 proposals for research presentations were received. 55 research projects were selected to be presented, including researchers from 8 land grant universities, the Rodale Institute, 3 farms, and USDA-ARS. Research categories included: Weed Management in Organic Systems, Issues in Organic Fruit and Vegetable Production, Issues in Organic Livestock Systems, Soil, Seeds and Systems, Pest and Disease Management in Organic Systems, Economics of Organic Systems, Student Papers, Posters. Researchers submitted summaries of their results for the Symposium Research Summaries and prepared 5-minute presentations for the general sessions. Researchers were instructed to answer the following questions: How are the results of your research relevant to organic farming systems? What other outcomes of your research did you observe that could be applied to organic farms? A Thursday afternoon session featured eight graduate students making 20-minute presentations on their research and responding to questions from the audience, which consisted primarily of their peers. Nineteen individuals attended and participated. This provided the students with a valuable opportunity to prepare their work for presentation and to present it in front of other students and professors involved with organic research. On Thursday evening, 300 people attended a keynote presentation featuring young people reflecting on the future of organic farming and research titled \"The Next Generation of Farmers and Researchers.\" Three sessions were held on both Friday and Saturday for a total of six presentation sessions. The format consisted of five researchers presenting 5-minute overviews of their work in general session. The participants were then invited to join each researcher in breakout sessions for more intimate conversations for the remaining 60 minutes of the time period. Participant numbers in the general sessions ranged from over 200 to approximately 24. 17 posters were installed for general viewing. The Symposium proceedings were printed in a 66-page Research Summaries booklet. A copy of the Summaries booklet was handed to each of 2,400 attendees of the OFC. Additional copies will be distributed at events attended by project partners, and a pdf of the publication is available on the OFRF (www.ofrf.org) and MOSES (www.mosesorganic.org) websites. PARTICIPANTS: This project was a partnership between the Midwest Organic and Sustainable Education Service (MOSES) and the Organic Farming Research Foundation (OFRF). MOSES is a 501(c)3 educational institution that serves farmers striving to produce high quality, healthful food using organic and sustainable techniques. MOSES provided project oversight, participated as a member of the planning committee, planned logistics for the event, provided on-site volunteers and other staff support, managed layout and production of the Symposium Research Summaries, and provided fiscal and project management and support. OFRF\'s mission is to sponsor research related to organic farming, to disseminate research results to organic farmers and to growers interested in adopting organic production systems; and to educate the public and decision-makers about organic farming issues. OFRF participated as a member of the project planning committee, oversaw outreach to researchers and managed the proposal collection process. OFRF staff also acted as primary contact for researchers, and collected summaries for the Research Summaries booklet. Both organizations provided staff at the event and participated in completing reporting requirements. Jody Padgham, MOSES Education Director and Financial Manager, acted as Project Director. In this role she managed general oversight of the project, maintained records and financial management, and participated in the planning committee. She also edited, laid out and completed final production of both print and on-line versions of the Research Summaries booklet, coordinated logistics and acted as on-site staff at the event. Jonathon Landeck, OFRF Deputy Director, was project co-investigator. Mr. Landeck participated as a member of the project planning committee. Jane Sooby, OFRF Organic Research Specialist, became the primary staff contact at OFRF. Ms. Sooby acted as the contact for the researchers and students, and managed the call for proposals and intake of research summaries and presentations. She participated as a member of the project planning committee, co-edited the Research Summaries booklet and developed a \"Resources for Organic Research\" page for the booklet. She also acted as on-site staff for the event. Ms. Sooby also prepared and presented a summary poster of the project for the CSREES Project Director Workshop and participated in the reporting process. TARGET AUDIENCES: This project is directed at four target audiences: farmers interested in learning more about research relevant to organic systems, researchers interested in or already undertaking research relevant to organic systems, graduate or other level students interested in organic related research and ag professionals to whom organic research has implications. 2,400 individuals attending the adjoining Organic Farming Conference, 80% of

whom are farmers, received copies of the project proceedings, Organic Research Summaries. Over 500 of these individuals participated in one or more additional project offerings (Student Session, Keynote, Research Discussion Sessions, Poster Session). An additional 1000+ individuals have accessed either the MOSES or OFRF websites to download the 66-page Research Summaries booklet. Evaluations tell us that the participants enjoyed the unique format of the Symposium and appreciated intimate conversations with researchers. 55 Researchers participated as either session or poster presenters (17 posters). 8 of the 55 were graduate students, 3 were farmer- researchers and one was a government researcher (USDA-ARS). Evaluations indicate that although some of the researchers struggled with the format of the Symposium, in general they had excellent interactions with farmers. They indicated they made good contacts, appreciated the in-depth questions and learned things that will help direct further research that they would not have learned in a more structured presentation format. Eight students gave presentations to peers in the Student Session, four of these also gave presentations and led discussions as part of the general Symposium. One of the eight also gave a keynote presentation to an audience of over 300. Students gave overwhelmingly positive feedback that all of the discussions offered valuable comments to further their research. More than 20 ag-professionals participated directly in the Symposium workshops, although many more received Research Summaries booklets. Ag professionals, and all involved, now hold contact information for researchers and can follow up on research that may be relevant to their educational or business work. PROJECT MODIFICATIONS: The project was generally not modified, with 3 minor exceptions. Project co-director Jonathon Landeck handed primary work responsibilities to coworker Jane Sooby, who took over those responsibilities early in the project term and stayed with the project to completion. Project Director Jody Padgham submitted a budget change request in mid-May, 2008. Expenses dedicated toward printing costs (for the Research Summaries) were less than anticipated, and a portion of these funds, as well as those allocated for indirect expenses, were requested to be reallocated to cover expended personnel costs. Due to a late submission of the budget change request, we also submitted a non-cost project extension, in case the budget change approval is not made by the end of the project period.

2007/06/15 TO 2008/12/14 OUTPUTS: This project made important organic research accessible to farmers through a Midwest Organic Research Symposium, held on February 21-23, 2008, and a published collection of research summaries. The primary audience was 2,400 farmers gathered to attend the MOSES Organic Farming Conference (OFC) in La Crosse, WI. This Symposium was a joint project between the Midwest Organic and Sustainable Education Service (MOSES) and the Organic Farming Research Foundation (OFRF). In mid-summer 2007 a call for proposals was circulated to academic researchers, graduate students and farmer researchers throughout the country. Notices were sent to 34 academic departments within colleges of agriculture in the core Midwestern states, sent as press releases to partnering organizations, and in announcements in both OFRF and MOSES print newsletters and websites. 63 proposals for research presentations were received. 55 research projects were selected to be presented, including researchers from 8 land grant universities, the Rodale Institute, 3 farms, and USDA-ARS. Research categories included: Weed Management in Organic Systems, Issues in Organic Fruit and Vegetable Production, Issues in Organic Livestock Systems, Soil, Seeds and Systems, Pest and Disease Management in Organic Systems, Economics of Organic Systems, Student Papers, Posters. Researchers submitted summaries of their results for the Symposium Research Summaries and prepared 5-minute presentations for the general sessions. Researchers were instructed to answer the following questions: How are the results of your research relevant to organic farming systems? What other outcomes of your research did you observe that could be applied to organic farms? A Thursday afternoon session featured eight graduate students making 20-minute presentations on their research and responding to questions from the audience, which consisted primarily of their peers. Nineteen individuals attended and participated. This provided the students with a valuable opportunity to prepare their work for presentation and to present it in front of other students and professors involved with organic research. On Thursday evening, 300 people attended a keynote presentation featuring young people reflecting on the future of organic farming and research titled \"The Next Generation of Farmers and Researchers.\" Three sessions were held on both Friday and Saturday for a total of six presentation sessions. The format consisted of five researchers presenting 5-minute overviews of their work in general session. The participants were then invited to join each researcher in breakout sessions for more intimate conversations for the remaining 60 minutes of the time period. Participant numbers in the general sessions ranged from over 200 to approximately 24. 17 posters were installed for general viewing. The Symposium proceedings were printed in a 66-page Research Summaries booklet. A copy of the Summaries booklet was handed to each of 2,400 attendees of the OFC. Additional copies will be distributed at events attended by project partners, and a pdf of the publication is available on the OFRF (www.ofrf.org) and MOSES (www.mosesorganic.org) websites. PARTICIPANTS: This project was a partnership between the Midwest Organic and Sustainable Education Service (MOSES) and the Organic Farming Research Foundation (OFRF). MOSES is a 501(c)3 educational institution that serves farmers striving to produce high quality, healthful food using organic and sustainable techniques. MOSES provided project oversight, participated as a member of the planning committee, planned logistics for the event, provided on-site volunteers and other staff support, managed

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IMPACT

2007/06 TO 2008/12 The Midwest Organic Research Symposium project created changes on several levels. Changes in knowledge occurred as over 500 farmers met with 55 researchers and students to understand the implications of research relevant to organic farming systems. Through short synopsis presentations, participants learned highlights of 35 research projects. Follow-up small-group discussions allowed participants to learn the direct relevance of each research project to their specific farm situation. 17 posters highlighted results of additional research projects. Evaluations show that participants appreciated the intimate format, and direct access to researchers to ask targeted questions. Direct, small group conversations, with groups of from 5 to 50 farmers allowed researchers to gain insights from farmer participants. Evaluations submitted by researchers indicate value in connecting with possible future research farms and/or partners, important input to guide future

research and the posing of new research related questions that had not otherwise been considered. 2,400 farmers and others learned of the existence, quality and diversity of research with relevance to organic farming that has been done through the Symposium Research Summaries. Additional farmers and others continue to gain similar knowledge by downloading or picking up additional copies of the Research Summaries from the MOSES and OFRF websites and at various upcoming events. Research Summaries, containing contact addresses for researchers, provide the ability for additional learning, contact or follow up with all research projects presented. It is expected that both participants of the Symposium and readers of the Research Summaries will change future actions. Farmers will try new production practices, such as attempting a no-till system for organic corn production, based on research involving no-till success and planting dates gained at the Symposium. Researchers will act by pursuing new questions in upcoming research projects. The one-year timeline of this project does not allow us to document actual changes in behavior, but evaluations indicated that changes were planned by both researchers and participants. It is possible that changes in conditions may also occur. Evaluations indicate the value of getting information about research into farmer\'s hands, so they have the potential to advocate on a national level for additional organic research dollars. **PUBLICATIONS (not previously reported):** 2007/06 TO 2008/12 Research Summaries, Proceedings from the Midwest Organic Research Symposium, Feb. 21-23, 2008, La Crosse, WI. Edited by J. Sooby and J. Padgham. Spring Valley, WI: Midwest Organic and Sustainable Education Service. 66 pp.

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PUBLICATIONS

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Developing Small Grains Cultivars and Systems Optimally Suited for Organic Production

Accession No.	0210057
Subfile	CRIS
Project No.	NEB-22-322
Agency	NIFA NEB
Project Type	OTHER GRANTS
Project Status	TERMINATED
Contract / Grant No.	2007-51300-03785
Proposal No.	2007-01437
Start Date	01 AUG 2007
Term Date	31 JUL 2012
Fiscal Year	2009
Grant Amount	$0
Grant Year	2007
Investigator(s)	Baenziger, P. S.; Shapiro, C. A.; Lyon, D. J.; Knezevic, S.; Hein, G. L.; Wegulo, S. N.; Flores, R. A.; Schlegel, V. L.; Wehling, R. L.
Performing Institution	AGRONOMY & HORTICULTURE, UNIVERSITY OF NEBRASKA, LINCOLN, NEBRASKA 68583

NON-TECHNICAL SUMMARY

Wheat varieties developed for conventional production often do not perform well in organic production systems. This project examines breeding new wheat cultivars specifically for organic systems with an enphasis on disease and pest resistance, response to organic fertilizers, and end-use quality.

OBJECTIVES

The long-term goal of our project is to develop small grains cultivars and cropping systems incorporating small grains that will improve the profitability and competitiveness of organic producers. The specific objectives of our research are to: 1. a. Determine if current advanced experimental wheat lines and released cultivars have potential for organic wheat production. b. Conduct workshops and provide web-based materials that explain the wheat breeding process. 2. a. Based upon what we learn in the organic wheat trials, augment our wheat breeding program to develop wheat cultivars ideally suited to organic production and the needs of organic producers and consumers. b. Prioritize desirable traits for an organic wheat through meetings with cooperating organic farmers and organic food industry personnel. 3. a. Develop an integrated organic soil fertility management program to supplement breeding efforts to increase grain protein content, and hence add value to the grain. b. Utilize local organic farmers in an experiment planning process that produces an organic wheat fertility experiment that includes treatments most likely to be used by producers. 4. a. Reduce tillage or increase soil organic matter in organic systems by the use of small grains cover crops to suppress weeds, or to suppress weeds by flaming. b. Integrate the results of the experimental portion of this project into a cropping system, utilizing winter wheat that is suitable for each of the three agroecozones that this project covers.

APPROACH

Objective 1. The University of Nebraska coordinates the State Variety Trials. The trials will be grown under the prevailing organic cultural practices at each site using incomplete block designs with four replications. The date of planting, flowering date, plant height, grain yield, grain volume weight (syn. test weight), disease and insect damage, and ability to suppress weeds will be measured at each site. To determine the effects of different environments, microquality assays (grain protein content, mixograph time and tolerance, and SDS sedimentation) will be done for each entry from a location in the Plant Quality Laboratory. Objective 2. Based upon what we learn in the organic testing sites in the state variety trials, we will grow the preliminary yield trial (F6 lines) at two locations (Sidney and Mead). These two testing sites were chosen because they represent diverse regions within the Great Plains. In the preliminary yield trial, there are 288 experimental lines and 4 check cultivars (the latter are replicated three times) for a total of 300 plots. The same agronomic traits will be measured as in the State Variety Trial. Quality analyses (microquality analyses and milling and bake tests) will be done on the best lines which will be advanced based to the intermediate nursery and is grown at Sidney and Mead. Approximately 25 lines will be advanced to the elite nursery. The same agronomic traits will be measured as in the State Variety Trial. Quality analyses (microquality analyses and milling and bake tests) will be done on those lines that are retained in the nursery. Select cultivars that show higher antioxidative and total phenol content relative to others will also be tested for total dietary fiber content. Objective 3. In the east (Concord) the manure would be applied after corn and before winter wheat planting. In the west (Sidney) the manure would be applied the previous spring and the ground would be kept weed free through tillage. To each of these pre-treatments an organic nitrogen source would be applied at one rate at either planting, early spring, or late spring. In addition, there would be another set of treatments that would have a half-rate applied at planting and either early spring or late spring. Objective 4. The first experiment will be planted after the spring or winter grain using four replications. We will use two methods of killing the cover crops in the spring; tillage and flaming. In the fall, we will measure emergence date, ground cover at killing frost, dry matter production, and weed density. In the spring we will measure cover crop survival, weed density, dry matter production, soil moisture content, and soil fertility. We are interested in determining wheat variety tolerance to flaming as influenced by the propane dose (e.g. flame intensity) and flaming time (crop growth stage). The hypothesis is that not all wheat varieties are equally tolerant to flaming.

PROGRESS

2007/08 TO 2012/07 OUTPUTS: From 2008 through 2011, 56 wheat varieties and experimental lines were evaluated in organically-managed state variety trials (SVTO) at four locations for wheat yield, testweight, height, anthesis date and canopy cover, 18 for all four years, 8 for three years, and 16 for two years, including 14 cultivars tested prior to 2008. Canopy cover was measured with Greenseeker technology, digital photos (analyzed with VegIndex software) and visual rating at Feekes 8 stage. SVTO protein data for 2011 at two locations for top-dressing and manure treatments complemented four years of SVTO evaluations of top-dressing for protein enhancement at Haskell Ag Lab (HAL) using OMRI-approved liquid fermentation products at 20 lbs./acre N at boot stage (7-0-0 for two years, 3-0-0 in 2010 and 3-2-1 in 2011). UNL baking tests (2008 - 2010) and mixographs (2011) were conducted for SVTO entries and selected F9 lines. Industry collaborators conducted quality tests (vomitoxin content, baking, alveograph, viscosity and dietary fiber) in 2009. In 2010, flour was blended to obtain 12 % grain protein content for more relevant baking comparisons. Total phenolic acid and flavonoid content and antioxidant capacities were completed for 19 winter wheat cultivars from the 2010 and 2011 harvest at four locations and were analyzed with 2009 data across three years. A subset of 9 entries was analyzed for antioxidants across four years. About fifteen hundred experimental lines in F6 - F10 breeding nurseries were evaluated under organic management at two locations. Selections based on yields from conventional and organic management were compared. Sedimentation and mixograph quality of F6 entries was evaluated to determine worth for future crossing blocks. Manure and top-dressing treatments were studied for two years at HPAL and three years at HAL for effect on protein of a single wheat cultivar. Two years of various cover crops and methods of suppression (winter-kill, spring disk, flaming, and roller-crimping) were evaluated for the effect on subsequent crops of corn (Zea mays) (following legumes) and soybean (Glycine max) (following small grains). Following-up, twenty triticale experimental cultivars were evaluated in 2011 for biomass, weed density and seed germination as responses to suppression by flaming before or after crimping, or flaming alone. SVTO yield, agronomic results and research updates were made available after harvest each year on the internet and via email each year to up to 250 constituents. Summaries were presented at summer plot tours at all four locations each year. Comparisons between organic and conventional breeding data and methods were reported in a peer-reviewed journal. Three Annual Organic Wheat Conferences at either Mead or Ogallala NE provided farmers and industry with research updates and opportunities to provide input. Beyond the scope of the grant: Variety trials were continued for 2012 and 2013 at fewer locations; and seed of promising experimental lines and cultivars was provided to South Dakota (2011 and 2012 seasons) for weed competition studies, and to Iowa

(2010 season), New Hampshire, Maine and Vermont (fall 2012) for performance trials. PARTICIPANTS: Nothing significant to report during this reporting period. TARGET AUDIENCES: Nothing significant to report during this reporting period. PROJECT MODIFICATIONS: Nothing significant to report during this reporting period.

2010/08/01 TO 2011/07/31 OUTPUTS: Results from 2011 organic wheat variety trials (SVTO) and breeding nurseries for yield, testweight, height, and anthesis date are available on the web and will not be reported here. Canopy cover was measured with Greenseeker technology at Feekes 8 stage for all nurseries and locations. Micro-quality tests for breeding nurseries and canopy cover will be included only in the final report. Protein data in 2011 for SVTO at four Nebraska research stations (HAL, ARDC, SCAL and HPAL) is reported here in the context of summarizing protein enhancement efforts. Baking tests for the previous year (2010) of 39 cultivars advanced to SVTO were conducted using reduction flour of 50:50 composite samples of two locations, HPAL and ARDC, blended to obtain grain protein content of 12.0 percent. Eight of these samples were also evaluated at Heartland Mill, Inc. by alveograph. Phenolic acid levels were determined for 19 winter wheat cultivars from the 2010 harvest at four locations. Antioxidant analyses for 2011 are in process. The second year of cover crop experiments at HAL were completed and are summarized for both years. Third and fourth year SVTO evaluations of protein enhancement at HAL using OMRI-approved liquid N top-dressing were completed. In 2010, 20 lbs./acre N from an approved 3-0-0 organic liquid fertilizer were applied in a single treatment at boot stage. In 2011, the N source was switched to a 3-2-1 liquid by-product of ethanol production, (since the fermented products used in previous years, 7-0-0 and 3-0-0, were no longer OMRI-listed), and was applied at both HAL and ARDC. At SCAL, manure was applied to three reps of the SVTO to evaluate protein enhancement of cultivars. The third and final year of wheat data for the wheat fertility study at HPAL and HAL has been collected. Grain and straw is being analyzed for total N. Once these data are received, data analysis for the entire study will begin. At HAL, twenty triticale experimental cultivars were evaluated as a cover crop in 2011. Triticale biomass and weed density were evaluated for suppression by flaming before or after crimping, disking, and mowing. Mature triticale seed data will be collected before analysis is conducted. Two years of a cover crop experiment were evaluated for the effect on subsequent crops of corn (Zea mays) and soybean (Glycine max). Leguminous cover crops were planted prior to corn, and small grain cover crops prior to soybeans. Treatments were winter-kill, spring disk, flaming, and roller-crimping. Data on weed suppression, cover crop dry matter production, soil moisture, soil fertility, and yield was collected. SVTO yield, agronomic results and research updates were made available on the UNL Variety Testing and UNL Small Grains Breeding websites and via email to 250 constituents after harvest. Summaries from the previous year were presented at plot tours at all four locations, attended by 46 constituents and media in June 2011. Comparisons between organic and conventional breeding data were reported in the on-line Sustainability journal, which received over 700 abstract views and 170 full-text views since publication in August. PARTICIPANTS: As indicated in a previous section, Heartland Mill, Inc. did quality tests on UNL organic wheat samples. Two organic farmers who are also certified seedsmen, grew increases of McGill, NW03681 and NE05425. Heartland Mill, Inc. will stone-grind flour of these three increases for distribution to bakers. TARGET AUDIENCES: Nothing significant to report during this reporting period. PROJECT MODIFICATIONS: On farm testing of protein enhancement treatments was curtailed by loss of OMRI-approved status of affordable top-dressing treatments. Farmers have been keenly interested in applying our results to their farms, but did not see a cost benefit for currently available products. On-farm testing of small grain cover crops was not possible within the time-frame of this grant, since there was not an opportunity to increase seed of the favored triticale cultivars between the time of testing at the experiment station and the time needed for planting on the farm. Growing of unreleased cultivars on farms was hampered by the need for material transfer agreements and the requirement that the UNL breeding program retain control over the seed. Seed availability was another issue, as the foundation seed program uses Storicide, a food-grade insecticide which is not OMRI-approved, on all seed increased for release to farmers. This limited us to quantities that could be readily produced within the breeding program. An agreement must be worked out in which foundation seed can be grown either on organic farms or university organic land. Therefore, we distributed our limited quantity to only two farmers who were familiar and willing to work within the restrictions.

2009/08/01 TO 2010/07/31 OUTPUTS: We planted and harvested and collected yield, testweight, height, anthesis date and protein data for the state variety trials on certified organic land (SVTO) at four Nebraska research stations (HAL, ARDC, SCAL and HPAL) and the F6 and F7 breeding nurseries and NIN-Nebraska Interstate Nursery (F8-F10) at ARDC and HPAL. We also scored leaf- spotting diseases at ARDC and HAL. Wheat competitiveness against weeds was evaluated with photos of all plots at stem elongation stage. Coleoptile length was measured for all lines advanced beyond F5. Gluten strength was assessed with sedimentation tests for lines from the conventional F5 nursery selected for the F6 nursery and all four locations for SVTO. Baking tests of 37 lines advanced to SVTO were conducted using reduction flour of composite samples of two locations, HPAL and ARDC. Micro-quality tests including mixograph, single kernel hardness and rapid visco analyzer were

performed on lines advanced to NIN. Antioxidant capacities were determined for 21 winter wheat varieties that were previously screened for phenolic and flavonoid levels for samples harvested in 2008 at four locations. Ten of the same hard red winter wheat varieties from the 2009 Variety Trials at four locations were also evaluated. Twenty-five composite samples from the four organic SVTO locations were milled and evaluated by Baystate Milling and Heartland Mill, Inc. Kellogg Company evaluated 37 samples from HPAL for digestible fiber and starch viscosity. To eliminate the partial fallow that can exist between winter wheat harvest in July and spring row crop planting two years of cover crop experiments were conducted at HAL. In the first year, the effects of four residue management methods (winter kill, spring disk, roller/crimper, and flaming) were measured by the yield of spring row crops that followed. The second year of cover crop experiments at HAL are in process. A third year of evaluation of protein enhancement using OMRI-approved liquid nitrogen source for top-dressing is being completed for all varieties in the 2010 SVTO at HAL. The second year of the HPAL soil fertility trial, with dry pea green manure and composted cattle manure treatments, was completed in summer 2010 with the collection of wheat yield, wheat nitrogen content and soil nitrate levels. Suppression of winter wheat as a cover crop using broadcast flaming was evaluated at HAL in 2010. Treatments were three rates of propane at boot stage on 30 cultivars. SVTO yield and agronomic results were made available on the UNL Variety Testing website immediately after harvest to aid farmers planting decisions and at the day-long UNL Second Organic Wheat Conference attended by over 80 farmers at Ogallala, NE (12-11-09), co-sponsored by NEOCIA#2 and SARE. Representatives of UNL, Heartland Mill, Inc. and Baystate Milling presented quality data at the conference. Advisors met with researchers following the conference and provided periodic input through phone conferences. Periodic research updates were posted on the UNL organic website, which received 175 unique hits for 12 months, averaging 1.5 minutes per hit. PARTICIPANTS: Teshome Regassa, as indicated in the 2009 report, should be listed as an investigator, as he replaced Len Nelson as the director of Crop Perfomance Testing, and is responsible for state variety trial plots. As indicated in a previous section, Baystate Milling, Heartland Mill, Inc. and Kellogg Company did quality tests on UNL organic wheat samples. Representatives of Baystate and Heartland Mill presented the data at the Second Organic Wheat Conference. TARGET AUDIENCES: The express objectives of the Second Organic Wheat Conference held in Ogalalla, Nebraska on October 11, 2009 were: to plan a framework for variety release of small grain specialty varieties that serves all segments of the organic wheat community; and to reveal opportunities for the organic wheat industry to flourish. Small group discussions among farmers and seed and milling industry representatives were recorded. Discussion notes were presented at the Organic Advisory Committee Meeting immediately following the meeting. The distilled viewpoints were represented by Richard Little at the State of Organic Seed Breeding Symposium prior to the M.O.S.E.S. conference in Wisconsin in February 2010. PROJECT MODIFICATIONS: Nothing significant to report during this reporting period.

2008/08/01 TO 2009/07/31 OUTPUTS: We planted and harvested and collected yield, testweight, height, anthesis date and protein data for the state variety trials on certified organic land (SVTO) at four Nebraska research stations (HAL, ARDC, SCAL and HPAL) and the F6 and F7 breeding nurseries and NIN-Nebraska Interstate Nursery (F8-F10) at ARDC and HPAL. We also scored leaf rust and green leaf duration at ARDC. Assessment for wheat competitiveness against weeds was simplified to one measurement of canopy cover, with photos of all plots at stem elongation stage assessed in a database application we developed. Coleoptile length was measured and gluten strength was assessed with sedimentation tests for all lines advanced beyond F6. Baking tests of 90 lines were conducted using reduction flour of composite samples of either two locations (NIN) or four locations (SVTO). Ten red winter wheat varieties from each of four locations and an additional eleven entries from HPAL, including white wheat lines, were screened for bound and unbound fractions of phenols and flavonoids (antioxidants). Soil fertility, nitrogen top-dressing and cover crop experiments at HAL initiated in 2008 were completed. Cover Crop trial treatments were: 10 cover crops planted in fall 2008 following winter wheat, 4 cover crop kill methods (flamer, disk, roller/crimper and winter kill) and 2 subsequent crops (soybeans and corn). Measurements included soil moisture prior to planting cover crops and periodic estimation of percent kill of broadleaf weeds, grassy weeds and cover crop. Prior to harvest, plant population was estimated for both crops and chlorophyll readings were taken on corn. For the final evaluation of nitrogen top-dressing with Summit Ten on varieties in the SVTO at HAL, wheat samples were analyzed for protein and sedimentation. The HAL Fertility trial, with manure rate, manure timing, and supplemental nitrogen (Summit Ten) treatments, was completed with the collection of wheat yield and protein data. The first year of the HPAL fertility trial, with dry pea green manure, composted cattle manure, and Summit Ten treatments, was completed in summer 2009 with the collection of wheat yield, wheat nitrogen content and soil nitrate levels. Winter wheat tolerance to broadcast flaming was evaluated at HAL in 2008 and 2009. In the first study a single variety of winter wheat was flamed once at four growth stages: 4 leaves, 3 tillers (3T), stem elongation (SES), and boot stage. In the second study 29 organic winter wheat varieties were flamed at two growth stages (3T and SES). SVTO results were made available on the Variety Test website immediately after harvest to aid farmers planting decisions and at the following events attended by over 100 farmers: SCAL and ARDC farm tours (August 2008); booth at the Western Conference in

Sidney (12-6-08); a day-long UNL Organic Wheat Conference sponsored by NE-OCIA#1 at ARDC (1-10-09); presentations to OCIA International in Lincoln and to NE-OCIA#2 and HPAL board in Sidney (all in February 2009). Periodic research updates were posted on the UNL organic website. Advisors met with researchers in Lexington (12-16-08) and provided periodic input through phone conferences. PARTICIPANTS: NEOCIA 1 sponsored our first UNL Organic Wheat Conference. Dr. Dipak Santra, UNL Alternative Crops Breeding faculty, took over responsibility for the organic breeding trials at HPAL. Dr. Teshome Regassa assumed duties for state variety testing. TARGET AUDIENCES: Nothing significant to report during this reporting period. PROJECT MODIFICATIONS: Nothing significant to report during this reporting period.

2007/08/01 TO 2008/07/31 OUTPUTS: We planted and harvested the state variety trials on certified organic land at four Nebraska research stations \Concord (HAL), Mead (ARDC), Clay Center (SCAL) and Sidney (HPAL)\ and the F5, F6 and F7-F12 breeding nurseries at Mead and Sidney. Protein tests were conducted immediately after harvest on all entries. End-use quality evaluations are ongoing. We are using the organic testing sites and input from organic farmers and food industry personnel to determine if we need to develop a selection protocol for organic production. Wheat competitiveness against weeds was estimated by measuring plant height, canopy closure and light reaching the ground (using a Quantum Sensor) at three growth stages in the variety trial plots at the four locations. Testing for coleoptile length was broadened to include nurseries preceding the variety test to enable selection for this criterion for organic production. A crossing block is being assembled for developing lines with excellent bread-making quality at moderate or lower protein levels, to match the typically lower-nitrogen environments of organic farms. A preliminary nitrogen top-dressing study (spraying a fermented poultry manure and plant-based product) was conducted to raise protein content without harming the plants. A dilution experiment was conducted prior to treating the variety trial plots. Two of the five reps of the organic variety trials at Mead and Sidney were then top-dressed at half strength at 7 lbs N/acre at early stem elongation (Zadocks 3.0) and 7 lbs N/acre three weeks later. Chlorophyll data were taken as a preliminary estimate of protein response. Four reps of wheat variety trial plots were flamed at 3 propane rates and 2 growth stages (early stem-elongation for weed control and boot stage for suppression as a cover crop). At wheat heading stage (in mid-June), 25 farmers attended organic wheat variety trial plot tours at Mead (ARDC) and Concord (Haskell) research stations. Variety descriptions and preliminary results for canopy closure and chlorophyll responses to nitrogen top-dressing were presented. A flamer was demonstrated. Flaming trials on wheat variety trial plots were toured at Concord. Similar information was presented to extension personnel during a July bus tour of Concord and Clay Center organic plots. Wheat organic variety trial results were made available on-line immediately after harvest. PARTICIPANTS: Not relevant to this project. TARGET AUDIENCES: Organic seed producers and growers, millers and bakers, and consumers. PROJECT MODIFICATIONS: Nothing significant to report during this reporting period.

IMPACT

2007/08 TO 2012/07 Observations of bunt contaminated seed (Tilletia caries) in the fifth year pared from nine experimental hard winter wheat lines to four that met baking quality and agronomic criteria: NW07555 and NW03666 statewide, and NE07444 and NE02558 for sub-humid ecozones. Unfortunately, these lines have short coleoptiles and on the other hand, the latter three had high digestible fiber in tests in 2009. UNL provided seed of the latter three lines to a Nebraska organic farm coop for increase and licensing. NW07505 is being increased for potential release for both organic and conventional production. Of released cultivars, only three met organic production criteria statewide: Camelot and potentially Lyman for the bread market; and Overland for the breakfast cereal market. Karl 92 represents a tradeoff between consistently high quality and low yields. Of the above, only Camelot had acceptable yield and testweight in very wet conditions in Iowa in 2010. Recent additions of three experimental lines to the SVTO first screened in F6 organic plots have long coleoptiles suitable for the semi-arid ecozone: NE06545, NE08457 and NE09491. NE10525, one of four F6 lines singled out for strong gluten quality for future crossing, has a long coleoptile. Crosses with promising experimental lines are represented in 2013 F3 nurseries. Tests of promising lines on commercial organic farms revealed that protein was inadequate for the bread market. Farmers were aware that top-dressing significantly improved protein in three of five organic plot trials. Available top-dressing products were considered too expensive by the farmers (fermented liquid fertilizer) or were not approved for the Japanese market (Chilean nitrate). A Nebraska manufacturer is seeking OMRI approval for a product that could remedy this situation. The final two years of antioxidant testing confirmed top and bottom-ranked lines for phenolic acids, flavonoids and ORAC. For 2010 - 2011, NW07505, NE05425 and McGill were consistently the highest of the 19 entries for flavonoids and Pronghorn and Buckskin were consistently the lowest at each location. For 2009-2011, McGill was in the top quartile for all three parameters and Buckskin ranked 17th of 17. Of nine common entries (excluding McGill) from 2008-2011, Pronghorn and

Buckskin ranked 8 and 9, and Overland ranked in the top quartile for all three parameters. Interactions of entries with years and locations were evident in four-year but not in three-year analysis, indicating that testing for multiple years and locations may be necessary before using the data to make selections. As a follow-up to poor suppression of volunteer cover crop growth by either flaming or crimping, crimping then flaming resulted in ten times fewer viable seeds and three times less regrowth of triticale than with the treatment of flaming alone, with no detectable differences among 20 triticale lines. Significant differences existed among lines for vegetation index, but not for percent kill or viable seeds, suggesting an advantage of some lines for biomass, but not for suppression. Of the 20 lines tested, the tall triticale, NT10430, excelled for vegetation index a week after treatment. **PUBLICATIONS (not previously reported):** 2007/08 TO 2012/07 Baenziger, P.S., R. A. Graybosch, T. Regassa, L.A. Nelson, R. N. Klein, D. K. Santra, D.D. Baltensperger, L. Xu, S. N. Wegulo, Y. Jin, J. Kolmer, Ming-shun Chen, and Guihua Bai. 2012. Registration of NE01481 hard red winter wheat. Journal of Plant Registrations 6:49-53.

2010/08/01 TO 2011/07/31 For the third and fourth consecutive years, N top-dressing trials in the SVTO at HAL provided positive results for protein response. In 2010 half of the 36 cultivars increased protein content by more than 0.7 % on a 13 % moisture basis. Of those cultivars, twelve increased to above an 11.5% protein content threshold that would position them for a higher value market. Some of the increased protein content could be attributed to lower grain yield. However, five cultivars increased in both protein content and yield of which two, MCGILL (increased by 10.2 bu/acre and 1.05 percent) and SD07165 (increased by 11.5 bu/acre and 1.68 percent protein), are of commercial interest. For a subset of 20 of the 2010 cultivars in the SVTO, we found significant differences in phenol content among locations (HAL 0.635, HPAL 0.619, SCAL 0.570, ARDC 0.467 mg/g, lsd = 0.042) and among wheat cultivars at HAL and SCAL, but not at ARDC or HPAL. Interactions between genotype and locations were marginally significant (p = 0.105). NW07505 ranked at the top at Haskell for phenols, but toward the bottom at Clay Center. On the other hand, MCGILL (0.718 and 0.663 mg/g) and Alice (0.730 and 0.633 mg/g) ranked at the top and HATCHER (0.535 and 0.478 mg/g) ranked near the bottom at both locations (HAL and SCAL, respectively). Yield was positively correlated and height was negatively correlated with phenol content in 2010 across locations and at SCAL, but together only accounted for 7 percent of the variation in phenol content. Of the top 15 in the SVTO for bread score in 2010, eight were also in the top 15 the previous year: NW03666, NE01481 (MCGILL), PRONGHORN, NE04424, NE02558, NW03681, NE07569, and NE05425. MCGILL had the best loaf volume, slice area, and exterior score. Of eight samples evaluated by alveograph, NE02558 tested very good, NE04424 was good and NE05496 and NW03681 were acceptable. Others were marginal to unacceptable. Several experimental wheat lines have been outperforming most released varieties for yield and bread quality. NW07505, NE07444, and NE02558 were among the five top-ranking lines for eastern Nebraska in the 2010 SVTO. Two exemplary lines, NE04424 (which ranked third for yield in 2010 in eastern Nebraska and fifth at HPAL), and NW03681 (first in yield rank at HPAL in 2010) were discontinued from the conventional breeding program, but continue to show promise in the organic sector. Also discontinued from the conventional program, NE05425, with its strong gluten, has promise for the whole wheat bread market. MCGILL is suited for conventional and organic production systems that have adequate nitrogen, although the protein content threshold for excellent bread production is unknown. For the cover crop experiment, we concluded that winter-kill and spring disk treatments produced the highest average yields in corn and soybean, at 6.83 Mg/ha (corn) and 2.66 Mg/ha (soybean). The roller-crimper and flaming treatments both reduced yields by 68% and 62% in corn, and by 36% and 27% in soybeans, respectively. Differences in weed control and crop population were the apparent causes of the yield reductions.

2009/08/01 TO 2010/07/31 Germplasm selections for our organic variety trial are focused on quality traits for bread, with a secondary emphasis on yield. Several experimental wheat lines have been outperforming most released varieties for yield and bread quality. Two exemplary lines, NW03681 and NE04424, were discontinued from the conventional breeding program, but continue to show promise in the organic sector. NW03681 is a white complement to the red phenomenon, Hatcher, in the western part of the state, with a similar high yield and excellent baking quality. However, neither line can be planted deep when topsoil is dry, because of short coleoptiles. Among long-coleoptile, good bread quality lines, NE06469, may replace lower-yielding Buckskin, the predominant organic variety in western Nebraska. Organic plots with low nitrogen availability enabled us to identify lower protein lines that make a good loaf of bread. Of this group, NW07505 yielded near the top at all locations for yield. For 2008 harvest samples, antioxidant capacities did not mirror phenolics and flavonoid levels or the ratio between the two for hard red wheat lines. Dramatically lower phenolic levels for two hard white wheat lines, Alice and NW03681were reflected in lower antioxidant capacities at two locations, but not at a third location. Preliminary analyses for ten hard red winter wheat samples from the 2009 harvest revealed that phenolic and flavonoid levels did not differ significantly from 2008. For the soil fertility experiment at HPAL, yield and test weight differences among treatments were more pronounced for the 2010 crop than the 2009 crop. The

reduced wheat yield following green manure fallow (51.6 bu/ac) compared to traditional black fallow (67.7 bu/ac) can be attributed directly to reduced soil water at wheat seeding following green manure fallow. No grain protein differences were observed in the 2009 winter wheat crop and have not yet been determined for the 2010 crop. A small plot of a promising alternative cover crop, Laramie annual medic (Medicago rigidula), for which seed availability was extremely limited, was planted for observation. Protein and sedimentation measurements for the HAL N-Top-dressing trial are in process. For the cover crop experiment following wheat at HAL in 2009, the roller crimper and the flamer were not able to control the cover crops and the weeds that were growing at the time when treatments were imposed. A late spring treatment was necessary for the small grain cover crops (rye and triticale) to be mature enough to be killed. Final corn stands were 29400 and 38700 plants per ha for the roller crimper and flamer compared to 48200 and 48000 for the winter kill (which was disked) and disk. Use of the roller or flamer did not meet the objectives of reducing tillage and suppressing weeds in 2009. Yields were greatly reduced for corn for flamer and roller crimper treatments. When compared to the two disked treatments corn yields were 21 and 41 %, respectively. Soybeans compensated better with the roller crimper and flamer yields being 66 and 78% of the disked soybean yields, respectively. Data has not been analyzed for wheat suppression via flaming.

2008/08/01 TO 2009/07/31 Despite high yield performance, two varieties with consistently poor testweight (TW) were discontinued from further testing (Harry) or removed from recommendation for organic production (Wahoo) in response to organic grain buyer criteria. Buckskin, popular in western Nebraska with grain buyers for high TW and excellent milling quality and with organic farmers for tall height and long coleoptile, yielded tenth of 30 at HPAL in 2009, and yielded erratically in previous years. Old popular varieties added to the 2009 SVTO trial, Karl 92 and Clarks Cream, yielded poorly at all locations. Despite low TW, NE03490 was retained for excellent gluten quality and high yields. Several lines were advanced exclusively to 2010 SVTO based on performance in organic trials: NE05425 (baking and canopy cover), NW03681 (milling and baking quality), NE04424 (antioxidant levels) NW07505 and NE07444 (milling, baking and NIN yield). White wheat lines tested dramatically lower for all antioxidant fractions than most red wheat lines. Although all antioxidant fractions differed significantly among entries and locations, variety ranks for these fractions were the same for all locations. To remedy a shortage in the breeding program, germplasm with long coleoptiles and drought resistance from Australia crossed with regionally adapted lines, was obtained from Oklahoma. The HAL N-Top-dressing trial showed significant improvement for protein (mean increase of .75 in 2009) for plots treated with Summit Ten, and significant differences among varieties. In the first year of the HPAL Fertility trial, reduction of wheat grain yields following green manure compared to summer fallow was likely the result of decreased soil water at winter wheat seeding following green manure. Nitrogen removal rates were greater following summer fallow compared to green manure, suggesting mineralization rates were too slow to benefit winter wheat. Few treatment differences were observed among the composted manure or liquid fertilizer treatments. We will continue to follow soil nitrate levels and nitrogen removal in the 2009 sunflower crop following winter wheat. The HAL organic fertility trial concluded with wheat averaging less following alfalfa (53.8 bu/acre) than following corn (57.4 bu/acre). Alfalfa regrowth likely impacted wheat yields due to competition for moisture, but may add benefit as a hay crop or as a nitrogen source for a future crop. Fall manure application averaged 7 bu/acre more than spring or no manure applications. Late spring manure application damaged the crop and reduced yields by 5 bu/acre compared to the no manure fall application. Grain protein was not affected by manure rate, but was increased from 13.3 to 13.7 % for the later timing, and from 13.3 to 13.6 for the higher N top-dressing rate. In the Flaming Trial wheat plants recovered 28 days after treatment regardless of the growth stage. However, significant yield losses of as much as 60% occurred when flaming was done at 4L and BS stages. Significantly lower yield losses of about 21% and 32% occurred when wheat was flamed at the 3T and SES stages, respectively, with little difference in visual injury among varieties.

2007/08/01 TO 2008/07/31 Interestingly, the tall or conventional height wheat cultivars (Goodstreak and Pronghorn) did best across the four environments in 2008. One new line with an excellent yield record in eastern Nebraska, NE01481, that also has great end-use quality and very good disease resistance (including soilborne mosaic virus resistance\--rare in our releases), is being increased for conventional and organic production. In addition, NI04421, which has an excellent conventional grain yield history, has been dropped from consideration as an organic wheat due to its susceptibility to stinking smut. Ironically, the line that did best in our elite trial grown in organic conditions was NH03614 (released as Settler CL), an herbicide-resistant wheat that is unlikely to be used in organic production. We are beginning to understand how best to incorporate data from our organic trials to help select and identify wheat lines ideally suited for organic production. Many of our best lines do equally well in organic and conventional production, but it also appears that organic production weights some attributes more importantly than does conventional production. For example, tall wheat cultivars seem to be favored in organic production (at least in 2008), but in conventional production they often lodge and would be discarded.

Lodging appears to occur less often in organic production than in conventional production. The taller varieties at various growth stages, with a few exceptions, appeared to provide more shade to compete against weeds in 2008. A long coleoptile, which is highly correlated with plant height, is desired when planting deep to reach moisture in dry locations. In breeding for conventional production, very few of the recently released varieties and advanced lines have exhibited long coleoptiles. Unfortunately, none of the lines in the F6 and F7 nurseries with very long coleoptiles performed well enough to select for retention in 2009 nurseries. However, three experimental lines, NE07487 and NW03681 and NE01481, that have moderately long coleoptiles (at least 8.3 cm) plus good baking quality, performed well enough to be retained in 2009 nurseries. In dilution experiments for the nitrogen top-dressing study, scant injury of the flag leaf was reported using full strength product at 15 lbs. N/acre at Concord and no visual damage occurred at Sidney. Significant differences existed between treated and untreated reps for chlorophyll readings at Concord, but not at Sidney. Differences between varieties were non-significant. Protein data are yet to be analyzed. Results of the study were used in planning a split split-plot fertility trial with different rates of manure, top-dress N and presence or absence of cover crop. Because of the positive results from the flaming experiment, flaming is being considered as the primary weed control practice for the organic wheat breeding nurseries.

PUBLICATIONS

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