



Developing Integrated High Tunnel Production Strategies that Enhance the Feasibility and Competitiveness of Michigan Organic Fruit Production

MDARD-SCBGP FINAL REPORT

Michigan Department of Agriculture & Rural Development (MDARD)

Name of Grantee: Michigan Organic Food & Farm Alliance (MOFFA)

Name of Grantee Point of Contact:

John Hooper

P.O. Box 26102

Lansing, Michigan 48909-6102

E-mail: hooperjwr@hotmail.com

Phone: 248-262-6826 Fax: 517-648-0527

Grant Number: 791N4300111

Submitted May 15, 2015

PROJECT JUSTIFICATION

Currently, the availability of locally-produced organic fruit at Michigan farmers markets and groceries is almost non-existent. Organic fruit production in Michigan has been quite limited due to the pest complexes in our humid Midwest environment. Sweet cherries and raspberries are among the highest valued (per lb) fruits grown in Michigan, yet they are very challenging to grow organically due to several negative climatic impacts, including risk of spring frost damage, risk of rain-induced fruit cracking, and risk of rain-disseminated debilitating diseases. In addition, several new invasive pests have appeared in Michigan the two years before this project began, with the spotted wing drosophila (SWD, *Drosophila suzukii*) fruit fly quickly causing substantial losses in 2012 fall raspberry production in Michigan and other states. This and the brown marmorated stinkbug (*Halyomorpha halys*) have further increased the challenges for organic growers.

High tunnels are increasingly used for production of fresh, high value fruit crops because they allow growers to manipulate the environment to minimize climatic constraints and risks associated with weather events, such as the devastating spring climatic conditions in Michigan in 2012. Tunnels can be used to trap supplemental heat for spring frost protection, trap solar radiation to hasten crop development and advance harvest into earlier market windows when fruit prices are higher (or before certain pests become prevalent), reduce the incidence of certain diseases by eliminating wetting of leaves and fruit by rain, alter insect pest movement, or extend harvest of indeterminate crops such as fall raspberries and blackberries later into the fall.

Profitability and competitiveness in organic fruit markets requires high food quality standards, the adoption of suitable cultivars and rootstocks, enhanced cultural techniques, and effective organic strategies for maximizing yields while controlling disease and insect pests. This project addresses those requirements.

Regional markets and consumer demand for organic produce continues to grow year over year. These attractive markets, and MSU's preliminary research on organic cherry and raspberry production, have generated significant interest among Michigan organic food growers who currently primarily grow organic vegetables and herbs. Furthermore, the sudden appearance of SWD fruit flies has created a new, critical management hurdle for organic fruit growers. Thus, a timely and important project has become even more timely and important with respect to the need for on-going research and discovery.

The project was initiated with federal funding from the USDA-Organic Research and Extension Initiative (OREI, 2011-2013). Furthermore, a USDA-Specialty Crop Research Initiative (SCRI) proposal to advance portions of this work was prepared for 2013 consideration, but this fiscal year program never materialized due to Congress' failure to reauthorize and allocate funds to that key portion of the Farm Bill. Therefore, SCBGP funding served to maintain and bridge critical organic fruit research progress for Michigan growers during 2014 until the next generation of federal funding can be obtained.

PROJECT APPROACH

This project addressed current barriers to successful organic fruit production in Michigan—specifically the study of organic management strategies for key insect and arthropod pests as well as diseases and soil fertility for raspberries and sweet cherries grown in high tunnels, and evaluation of raspberry and sweet cherry cultivars, rootstocks, and training systems suitable for organic high tunnel production. In organic cherries, the previously negative impact of aphids was negligible in 2014, but plum curculio and brown rot were problematic with no as-yet effective organic controls. Bacterial canker incidence was minimal under the protective tunnel covers. Overall tree health was impressive, considering the harsh winters experienced during 2013-14 and 2014-15. These reduced summer raspberry yield about 75%, but fall raspberry yield was about 12,000 lbs/acre, about 50% greater than anticipated. SWD was present in 2014, but not nearly to the same extent as in 2013, presumably due to 2014 being a cooler season, preventing rapid population increases. Management strategies of developing narrower rows of fruiting canes and more frequent picking to reduce overripe fruit available for ovipositing likely contributed to the reduced SWD infestation levels. Insect exclusion netting studies appear promising thus far.

The principal investigators for this project were Drs. Gregory Lang and Eric Hanson of the Michigan State University Horticulture Department, assisted by co-investigators Drs. Dan Brainard and John Biernbaum (MSU Horticulture), Dr. Annemiek Schilder (MSU Plant, Soil, & Microbial Sciences), Drs. Rufus Isaacs and Matt Grieshop (MSU Entomology), and Ms. Vicki Morrone and Mr. Adam Montri (MSU Extension Organic Outreach). Two project employees were paid by the grant funds, Josh Moses (field manager for the organic tunnels) and Tammy Wilkinson (research technician for data collection and analysis).

The project team met during Fall 2013 and Fall 2014 to summarize the 2013 and 2014 season harvests, plant performance, and insect/disease incidence, and to plan for the 2014 and 2015 research and production seasons, respectively. Project partners Greg Lang, John Biernbaum, Eric Hanson, Matt Grieshop, Annemiek Schilder, and Vicki Morrone provided updates and outcome data to fruit growers and other organic farmers at the Organic Reporting Session in March 2014, two field days held at the high tunnel facility during the summer of 2014, and a formal presentation at the Great Lakes Fruit and Vegetable Expo in December, 2014.

GOALS AND OUTCOMES ACHIEVED

The four specific research objectives for the project are listed below, with brief descriptions of the activities accomplished relating to each.

- 1) Develop and refine organic management strategies for key insect and arthropod pests of raspberries and sweet cherries in high tunnels; and**
- 2) Develop and refine organic management strategies for key diseases of raspberries and sweet cherries in high tunnels.**

Insect and disease scouting began after budbreak in spring of 2014 and 2015; aphid populations in the cherry tunnels were greatly reduced from 2013. While it could not be determined whether this was due to the new management plan or due to the severe winter of 2013-14, preliminary indications for spring 2015, following a second severe winter, is that the control achieved is due to the dormant oil program. Aphids populations in a comparable non-organic protected environment plot flared up in spite of the 2014-15 winter. Isolated outbreaks of eastern tent caterpillars were easily removed manually before significant damage occurred. Cherry harvest in 2014 was still plagued by insufficient control of plum curculio and brown rot infestations of the fruit, making harvest data collection irrelevant. Further organic cherry pest management research will be needed to develop effective grower recommendations for adequate protection against these pests.

Summer raspberry harvest data were collected in 2014 and insect exclusion netting treatments were imposed for fall raspberry production as a potential management strategy for spotted wing drosophila (SWD). Bumblebees were used for pollination in the netted treatments since native pollinators were excluded.

Analysis of SWD traps gave promising results. Where inadvertent gaps in netting occurred, SWD found entry, but fully-enclosed treatments resulted in SWD-free fruit production. Temperatures did not seem to be adversely affected by the netting treatments. Consequently, exclusion netting is also being considered for potential future control of plum curculio for organic high tunnel cherry production.

3) Develop and refine organic management strategies for soil health and plant/crop nutrition for raspberry and sweet cherry production in high tunnels.

Soil samples were collected and analyzed during 2014, and weed populations were recorded. In late winter 2014 and 2015, raspberry and cherry plants were dormant-pruned and organic mulch was applied to raspberry plots prior to emergence and to cherry plots during the spring and fall. Organic fertigation was applied during the growing season.

4) Evaluate raspberry and sweet cherry cultivars, rootstocks, and training systems most suitable for organic high tunnel production.

Mechanized summer pruning (hedging) was imposed in the cherries for the first time after harvest in 2014. As desired, re-growth was minimal and no structural tree canopy winter damage of significance was observed in spring 2015. As expected, flower bud damage was evident due to several periods of extremely low temperatures, but bud damage was less than that which occurred in winter 2013-14.

Double-cropping of raspberries (production of a summer crop on selected floricanes retained from 2013, followed by a fall crop on new 2014 primocanes) resulted in low yields (1,000-2,000 lbs/acre) for the summer portion due to poor

floricane quality following the severe winter. However, primocane yields were the highest yet achieved under organic management, 10,000 to 12,000 lbs/acre. This is a 35 to 50% increase over previous years, presumably due to improvement in organic nutrient management.

Cane pruning of raspberries for 2015 production will further examine the potential for summer+fall cropping by studying the effect of number of floricanes retained on summer yield, as well as on development of primocanes and subsequent fall yields. The target yields we are working towards are to balance seasonal yield potentials at about 8,000 lbs/acre for each of the cropping seasons, totaling 16,000 lbs/acre annually. One benefit of floricane retention noted in 2014 was taller primocane formation, which may have been a component of the increased fall yields.

The two overall project goals were to increase the number of cherry and raspberry growers in Michigan who utilize organic production methods and high tunnel technologies, and to increase the number of organic and/or high tunnel fruit producers in Michigan at five years after the project is initiated (30 Sept 2018).

With respect to the first goal, there were at the inception of the project no more than five producers of cherries and raspberries utilizing high tunnel, organic production methods in Michigan. The planned performance measure of progress towards achieving the first goal was to survey participants at the organic fruit field day (summer) and the Great Lakes Fruit, Vegetable, & Farm Market Expo (winter) to determine if they will implement one or more of this project's organic and high tunnel fruit production strategies, and if so, which component methods or technologies they plan to adopt or integrate into their operations. The survey following the summer field day revealed few participants who currently grow either crop organically, and few who intended to adopt one or more organic production components right away, though most respondents indicated that they would continue to follow progress in solving the remaining key organic pest control problems. Therefore, the Expo survey was not conducted in the winter, as the summer survey indicated several years of results were desirable in order to affect grower adoption.

With respect to the second goal (increasing the number of organic and/or high tunnel fruit producers in Michigan at five years after the project is initiated), at the beginning of the project less than five of the ~350 commercial high tunnels in Michigan were being used for fruit-growing. Of the more than 250 organic farm operations in Michigan, fewer than five produced organic raspberries or sweet cherries. The planned performance measure of progress towards achieving the second goal will be a five-year survey by MOFFA and MSU Extension educators to quantify the number of commercial growers in Michigan who utilize high tunnels and/or organic methods for fruit production. MOFFA and MSUE now interact more closely as a result of this jointly-conducted grant, with no anticipated barriers to conducting the 2018 survey. The target outcome will be at least 35 high tunnels planted to fruit production, of which at least 20 will be growing organic raspberries or sweet cherries.

BENEFICIARIES

Both organic and non-organic growers of raspberries and sweet cherries have benefitted from the accomplishments of this project. The former group remains extremely limited in number in Michigan, due to the few remaining organic pest control problems. The latter group in Michigan comprises the fourth highest (by acreage) producers of sweet cherries in the U.S.; newly-planted orchard acreage in 2014-15 was at least 20 acres, nearly all of which utilized the tree training system information associated with this project. Twenty acres with mature annual yields of 12,000 lb per acre of fruit valued at \$3.75 per lb farm market price would be \$0.9 million production value annually; once the remaining organic pest problems are solved, a higher price per lb would be expected, and previously established non-organic orchards can transition to organic, so the potential remains for significant future expanded organic and economic impacts.

The partnership between the MSU researchers and extension educators and the MOFFA membership, for reaching out to and informing the organic fruit community, was successful via the organic reporting session and two twilight tours. Project personnel provided oral updates to constituents on March 7, 2014, at the MSU Organic Reporting Session (Eric Hanson, Matt Grieshop, Annemiek Schilder, Vicki Morrone). A twilight tour/field day was held on July 1, 2014, for growers during cherry harvest and was attended by 32 participants (led by Greg Lang, Eric Hanson, John Biernbaum, Vicki Morrone, and Annemiek Schilder). A second twilight tour for educators was held on September 12, 2014, during raspberry harvest and was attended by 27 participants (led by Eric Hanson, Greg Lang, John Biernbaum, and Jeremy Moghtader). Topics for the twilight tours included: organic cherry production, organic raspberry production, production using 3-season tunnels, space-efficient trellising systems for cherries and raspberries, organic pest management, and soil health. Project reports were developed for oral presentation and summaries were handed out at the Great Lakes Fruit and Vegetable Expo held in Grand Rapids in early December 2014.

LESSONS LEARNED

Insights, outcomes, and conclusions from the project include:

- Organic cherry soil health and fertility has been satisfactory throughout the life of the orchard thus far, with certain weed/orchard floor management treatments having the greatest impact on tree growth. Tree performance is best when root competition with weeds or cover crops is minimized during spring through early summer, thereby allowing the sowing of late summer cover crops for soil-building during fall and winter. Once regular cropping begins (as it has been limited by winter flower bud damage as the trees matured), fertility regimes may need adjustment.
- Organic cherry growth and fruiting was not negatively impacted by aphids following adoption of dormant oil applications, but plum curculio remains problematic with no as-yet effective organic control strategies. The typical organic control for PC in apples, the spray application of kaolin clay particles,

is not feasible with cherry due to difficulty with residue removal. Insect exclusion netting, which can also serve as bird exclusion netting, may be one potential solution for organic control of plum curculio (PC). Perimeter trapping of PC may also be effective as part of an integrated approach for control.

- Brown rot remains problematic, with no effective organic control measures yet discovered. Bacterial canker incidence has been minimal under the protective tunnel covers, presumably due to minimal dissemination by rain. Overall tree health has been impressive, considering the two harsh winters experienced during 2013-14 and 2014-15, with minimal tree mortality.
- Organic summer raspberry yield was 2,000 lbs/acre in 2014, about 75% lower than anticipated, as a result of severe low temperature damage to the overwintering floricanes. It is conceivable, though not yet documented, that stable summer yields could reach 8,000 lbs/acre.
- Organic fall raspberry yield was about 12,000 lbs/acre, about 50% greater than anticipated, presumably as a result of the reduced summer crop. It is conceivable, though not yet documented, that if summer yields do reach 8,000 lbs/acre, stable fall yields may be maintained at 8,000 lbs/acre.
- SWD was present in 2014, but not nearly to the same extent as in 2013. 2014 was a cooler season, which likely helped prevent rapid population increases as occurred in 2013. Management strategies of developing narrower rows of fruiting canes and more frequent picking to reduce overripe fruit available for ovipositing likely contributed to the reduced SWD infestation levels. The insect exclusion netting studies (see photo below) appear promising thus far; similar studies of insect exclusion netting in Europe for organic SWD control have also appeared promising.
- Organic raspberry and cherry grower number and acreage surveys were not undertaken by the MSU extension team and the MOFFA partnership, as it appeared (from twilight tour feedback) that such numbers are currently insignificant, and unlikely to change until well-documented organic solutions for SWD (raspberry) and brown rot and PC (cherry) are discovered. The continued study of organic high tunnel raspberry production (see ***Additional Information*** below) will provide additional opportunities to document increases in the number of organic raspberry growers.



Insect exclusion netting for organic control of Spotted wing drosophila (SWD) in the raspberry high tunnels at the MSU-Horticulture Teaching and Research Center.

CONTACT PERSON

Grantee Contact: John Hooper, hooperjwr@hotmail.com, 248-262-6826

Principal Investigator: Dr. Gregory Lang, langg@msu.edu, 517-353-0388

ADDITIONAL INFORMATION

An extension publication, [*Organic Raspberry Production in Three-Season High Tunnels*](#) (Hanson, Morrone, Isaacs; MSU Extension Bulletin E3235) on best management plans (BMPs) for organic raspberry grower clientele was published as a result of this project, as was an extension publication on [*Cherry Training Systems*](#) Long, Lang, Musacchi, Whiting; PNW Extension Bulletin 667). A third planned extension publication, *High Tunnel Sweet Cherry Production for Organic and Other High Value Market Opportunities*, on BMPs for was not completed for organic cherry grower clientele during the project due to the unsolved issues of organic plum curculio and brown rot control.

Organic high tunnel raspberry research will continue with the awarding of a USDA-SCRI grant to E. Hanson for 2014-2019. Organic high tunnel cherry research may or may not continue, as competitive grant proposals submitted in 2014 for organic pest management challenges were not successful.