Final Report
Grant No. 12-25-B-1497
Specialty Crops Block Grant Program
Wisconsin Department of Agriculture, Trade and Consumer Protection

Report Date: November 18, 2015

Ben Brancel
Secretary

Wisconsin Department of Agriculture,
Trade and Consumer Protection
2811 Agriculture Drive
Madison, WI 53718
Phone: (608) 224-5015

<u>Contact for Specialty Crop Block Grant Program</u>

Program Coordinator:

Juli Speck
Grant Specialist
Division of Agricultural Development
Phone: (608) 224-5134
Email: juli.speck@wi.gov

INTRODUCTION

The Wisconsin Department of Agriculture received $883,592.01 from the Specialty Crop Block Grant Program, Grant No. 12-25-B-1497. The Department was able to fund 18 projects to promote and improve specialty crops industries in the state of Wisconsin or the Midwest. Two additional projects were added with unused funds. WI DATCP used 10% of the funds to cover some administrative costs for the finance department to track and disperse the funding.

Enclosed are the reports submitted by all 20 grantees.

Grant Projects:

FY12-001 Improving fresh market potato varieties
FY12-002 Wisconsin's harvest medley: healthy blends for WI schools
FY12-003 Developing IPM for rust diseases in turfgrass
FY12-004 Expanding the market for CSA shares in southern WI
FY12-005 Cultivating alternative apple pollinators
FY12-006 Refined pest management strategies for ginseng
FY12-007 Pest and disease forecasting for onion and carrot
FY12-008 GAP/GHP cost share
FY12-009 Developing IPM for high tunnel tomatoes
FY12-010 Development of good manufacturing processes for the Wisconsin hop production industry
FY12-011 Timing of Tissue analysis in cranberry
FY12-012 Neonicotinoid use patterns in Central Sands
FY12-013 Development of a sustainability program for Wisconsin strawberry producers
FY12-014 Driftwatch program education and outreach
FY12-015 Development of IPM, grape vanopy, and index tools
FY12-016 Potential control of Powdery Mildew and Leaf Spot Disease
FY12-017 Local produce in the middle
FY12-018 Survey of Christmas tree fields for a new root rot disease
FY12-019 Production tools for minority growers
FY12-020 Virus and emerging pest survey of Wisconsin greenhouses and nurseries

1) Improving fresh market potato varieties (FY12-001)

Report Date: October 28, 2015

I. Project Summary

Potatoes are the most valuable horticultural crop in Wisconsin, with an estimated farm gate value of $256 million in 2012, and approximately 50% of the crop is sold into the fresh market. Within the fresh market sector, the primary categories are russets and reds, with a smaller emphasis on yellow, round white, and specialty potatoes. The current market-leading varieties in these categories have well-known deficiencies, such as rough shape (Russet Burbank), poor expression of potato virus Y (Silverton), susceptibility to Verticillium wilt (Russet Norkotah), loss of skin color in storage (Red Norland), and susceptibility to common scab (Yukon Gold). Because of a historical legacy to breed for chip processing quality in the University of Wisconsin breeding program, as well as coordinated research efforts on a national level for processing markets, the intensity and sophistication of new variety development for the fresh market has been somewhat underdeveloped in Wisconsin relative to its market share.

This proposal was designed to expand the UW fresh market variety development program, drawing on the expertise of several UW faculty and commercial potato growers.

B. This project did not build on any previously funded Specialty Crop Block Grants.

II. Project Approach

Objective 1: Identification of new varieties with production and market potential in WI
and
Objective 3: Screen varieties for resistance to key potato diseases

Nearly 150 different breeding lines and varieties were evaluated in 2013 in small (8 or 16 plant) plots at multiple locations across the state. Trials were located at two public research farms (Hancock and Langlade Agricultural Research Stations) and on commercial farms in Coloma, Endeavor, Kingston, Nekoosa, Bancroft, and Arena. Harvested plots were weighed to record total yield, and disease incidence in a 10-tuber sample was measured for common scab, silver scurf, and black scurf, all of which reduce the marketability of potatoes. Table 1 presents the reliability (or broad-sense heritability) for each trait, which is defined as the squared correlation between the estimated and true genetic potential for each variety. A value of 1 indicates perfect correlation, while a value of 0 indicates no consistency across the locations. The reliability for yield was somewhat low for the russets ($r^2 = 0.48$) but otherwise acceptable. Of the disease traits, silver scurf was the most reliable except for the yellow category, which showed poor heritability for all three diseases.

Table 1. Reliability of yield and disease incidence. Values range from 0 to 1.

Category	Total yield	Common scab	Silver Scurf	Black Scurf†
Russet	0.48	0.61	0.79	0.57
Red	0.81	0.52	0.71	0.38

Yellow	0.75	0.35	0.00	0.00
White	0.62	0.34	0.68	0.63
Specialty	0.83	0.59	0.59	0.19

† Log transform

Tables 2 – 6 contain the multi-location averages for each variety, grouped by market category. Silver scurf and black scurf results are not provided for the yellow category because of the poor reliability. In every market class, we found breeding lines with favorable yield and disease performance compared to the check varieties. An open house was held October 30–31, 2013, at the UW Hancock Research Station to showcase the breeding lines to professionals in the fresh market potato industry.

Table 2. Results for the yellow fresh market. Check varieties are highlighted in yellow. Disease scores refer to the number of infected tubers in a 10-tuber sample.

Name	Yield (cwt/a)	Scab
Soraya	735	3.6
Solome	732	
W9576-11Y	681	
MSM288-2Y	616	5.8
Cascada	590	4.5
Alegria	586	3.8
NDA081451CB-1CY	584	6.0
W9576-27Y	581	6.0
Talent	539	2.4
Fidelia	537	5.0
NDTX081451CB-1Y/Y	525	5.0
Gala	494	3.4
NDTX059886-1Y/Y	462	7.5
W9576-13Y	457	2.3
Yukon Gold	445	1.8
W6703-5Y	422	6.5
W6703-1Y	373	4.3
B2932-6	371	3.7
Mean	541	4.5
Standard Error	71	1.4

Table 3. Results for russets. Check varieties are highlighted in yellow. Disease scores refer to the number of infected tubers in a 10-tuber sample.

Name	Yield (cwt/a)	Silver Scurf	Black Scurf	Scab
A071012-4BF	616	2.8	0.3	0.0
A061006-1CR	577	0.0	0.3	3.6
A07103-1T	568	0.0	0.0	0.0
CO05068-1RU	544	0.0	1.0	1.1
A06403-12LB	532	1.8	0.0	3.2
COO07025-1KF	525	4.0	0.7	0.1
A01010-1	522	0.0	0.3	0.9
A061071-3CSR	520	0.3	0.2	3.3
W9739-2rus	516	0.0	0.7	0.0
CO05152-5RU	515	4.1	0.6	0.3
A06021-1T	513	0.0	0.0	4.6

CO05189-2RU	511	0.2	0.7	4.5
Goldrush	510	1.0	0.0	0.0
A99029-3E	496	0.6	0.0	0.0
AO07469-2	495	6.4	1.1	1.1
A02507-2LB	491	0.0	0.0	1.0
Russet Norkotah	490	3.6	0.0	0.9
Silverton	485	0.0	0.5	1.1
CO05175-1RU	481	0.0	0.8	0.5
CO05024-11RU	474	8.6	0.0	0.7
A07001-7TE	465	0.0	0.4	2.7
W9759-1rus	459	0.0	0.0	0.0
W9133-1rus	452	0.0	0.0	2.5
A07073-1	450	0.2	0.8	1.7
CO05189-3RU	447	0.5	0.3	0.2
AO06070-1KF	444	4.1	2.5	2.7
AF4532-9	443	0.0	1.2	1.2
A08010-2TE	439	0.0	0.4	0.1
A07008-4T	436	2.4	0.0	1.3
A06029-4T	434	0.0	0.0	1.9
AO02060-3	409	5.0	1.6	1.3
A07431-6LB	409	1.5	1.3	0.0
AO01114-4	407	5.4	2.5	0.1
CO05110-6RU	396	2.8	0.1	1.9
CO05040-1RU	395	3.6	1.2	0.4
MN09079BB-01Rus	380	0.0	0.0	0.0
CO05132-2RU	370	2.1	0.6	0.9
AF4532-8	362	3.9	2.1	0.0
TXA549-1RU	359	0.0	1.8	1.9
A07011-2TE	357	1.6	0.3	1.4
A08014-10TE	339	0.4	0.0	0.0
MN09135BW-01Rus	307	1.1	0.0	0.0
W9135-1rus	300	0.0	0.0	1.9
AF4445-3	290	1.3	0.3	0.4
CO05149-3RU	273	1.0	0.0	0.7
Mean	449	1.4	0.3	1.1
Standard Error	68	1.1	0.3	0.9

Table 4. Results for reds. Check varieties are highlighted in yellow. Disease scores refer to the number of infected tubers in a 10-tuber sample.

Name	Yield (cwt/a)	Silver Scurf	Black Scurf	Scab
W9426-3R	690	4.5	1.9	1.0
A05182-7RY	665	0.5	2.3	2.2
W8405-1R	602	6.0	0.7	2.2
W9765-3R	596	4.9	5.0	2.2
ATTX98453-3R	537	1.5	2.1	2.6
ATTX98453-6R	516	5.6	0.1	1.8
ATTX98462-3R/Y	492	4.9	1.1	2.2
ATX06264-4R/Y	490	6.9	0.0	1.3
MN10003PLWR-06R	489	4.4	1.1	1.2
H122-4	486	0.5	0.5	2.7
W6002-1R	468	7.9	0.2	1.7
Dark Red Norland	442	7.9	0.7	1.7

W8890-1R	439			
MN10020PLWR-04R	421	7.7	0.7	1.4
MN10003PLWR-03R	419	5.9	0.2	2.2
CO05228-4R	398	4.3	1.5	1.5
W8370-2R	395	10.4	0.2	0.2
CO04067-8R/Y	380	7.3	0.5	4.4
MN10013PLWR-03LR	376	8.1	0.5	3.4
Red Gold	374			
MN10011PLWR-01R	371	7.1	0.5	1.0
MN10003PLWR-02R	365	6.1	0.4	2.5
CO05037-2R/Y	362	8.9	0.2	1.2
W8886-3R	350	6.0	0.6	6.0
MN10018PLWR-08R	335	4.8	0.0	1.7
W9396-4R	334	5.4	0.2	0.2
BNC314-5	312	5.8	0.0	3.7
W9443-4R	302	6.4	0.2	0.2
W9746-4R	301	6.4	0.2	1.7
W9430-1R	300			
ATTX06246-1R	295	3.1	0.0	5.8
MN10001PLWR-01R	294	8.5	0.3	0.4
CO00291-5R	292	4.1	0.2	6.7
MN10008PLWR-07R	268	6.9	0.2	2.7
B2676-2	255	2.1	0.0	1.0
CO05211-4R	242	6.5	0.5	0.7
NDTX050184-1R/Y	237	1.4	0.2	2.7
MN10003PLWR-07R	211	7.4	0.2	2.7
W8893-1R	206	8.4	0.2	2.2
CO04159-1R	200	2.7	0.9	2.8
MN10025PLWR-07R	185	4.4	2.0	0.2
MN10020PLWR-05R	152	2.9	0.2	3.2
COTX04193-2R/Y	140	5.9	0.2	5.7
Mean	**372**	**5.5**	**0.4**	**2.3**
Standard Error	**70**	**1.4**	**0.3**	**1.2**

Table 5. Results for whites. Check varieties are highlighted in yellow. Disease scores refer to the number of infected tubers in a 10-tuber sample.

Name	Yield (cwt/a)	Silver Scurf	Black Scurf	Scab
MN02586	740	3.5	0.0	4.0
AF4463-8	654	0.0	6.3	2.4
MSQ086-3	635	1.0	0.5	3.6
ATTX05186-3W/Y	634	3.3	0.2	3.6
AF4640-1	617		0.0	0.0
MSS206-2	603	3.3	0.9	3.2
NY141	594	1.0	0.0	3.8
AF4138-8	573	4.0	0.0	0.4
CO04099-3W/Y	525	2.0	0.0	5.6
MSL211-3	480	0.4	1.4	4.2
MSQ131-A	465	1.0	0.0	5.6
Superior	448	2.0	0.0	1.0
MSQ440-2	422	1.3	0.9	2.6
CO05037-3W/Y	422	6.0	0.6	0.0
NY150	393	3.0	0.0	1.5
NY143	377	1.0	0.0	4.0
MN10013PLWR-02	282	4.0	0.0	2.5
Mean	521	2.3	0.3	3.0
Standard Error	81	0.8	0.3	1.4

Table 6. Results for specialty types. Check varieties are highlighted in yellow. Disease scores refer to the number of infected tubers in a 10-tuber sample.

Name	Yield (cwt/a)	Silver Scurf	Black Scurf	Scab
AF4614-2	741	0.0	1.5	7.3
COTX08376-2R/Yfing	678	3.1	0.3	2.7
MSS576-5SPL	627	1.8	0.2	2.1
A05180-3PY	607	4.7	0.1	1.7
AC05175-3P/Y	504	5.0	0.0	0.2
AC99329-7PW/Y	482	1.0	1.6	1.7
COTX09040-1P/Y	457	4.0	0.0	1.7
A06305-2YR/Y	442	3.4	0.4	1.3
COTX04050-1P/P	409	4.1	0.0	2.0
B2538-5	400	4.0	0.0	1.2
Red Thumb	348	4.0	0.2	0.8
BNC244-10	343	2.0	0.0	3.7
CO04056-3P/PW	328	1.0	0.4	1.2
CO04063-4R/R	310	5.0	0.0	2.7
COTX08365-1P/Pfing	294	8.0	0.0	3.2
CO00405-1RF	218	3.0	0.4	4.2
COTX08365-4R/Rfing	217	5.5	0.0	1.2
B2928-6	203	9.0	0.0	0.2
TC05276-7P/PW	202	7.7	0.0	1.0
COTX08046-8P/P	135	4.7	0.0	4.3
Purple Majesty	69	1.6	0.0	1.4
Mean	382	3.9	0.2	2.2
Standard Error	78	1.5	0.2	1.1

Objective 2: Screen potential varieties for improved culinary characteristics.
Based on the agronomic and disease results (Objectives 1 and 3), subsets of the most promising russet and red breeding lines were evaluated for culinary traits in Spring 2015. Seven potential russet varieties were compared against three standard varieties (Russet Norkotah, Goldrush, and Silverton), and six potential red varieties were compared against the standard Dark Red Norland. The human subjects were an untrained group of students, staff, and faculty from the Departments of Horticulture and Agronomy at UW-Madison. Each subject performed two consecutive evaluations, with each evaluation consisting of two experimental lines and one standard. The potato samples were coded and randomized using a balanced incomplete block design, with each experimental sample replicated six times. This required 21 human subjects for the russet potato group and 14 subjects for the red potato group (these two experiments were conducted on different days).

For each trio of samples, subjects were given an evaluation sheet with four attributes: bitterness, sweetness, mealiness, and overall acceptability. Subjects were asked to mark the position of each sample on a horizontal line segment representing the range of values for each attribute (e.g., waxy to mealy for mealiness), and these graphical responses were converted to numerical values by measuring the distance from the left end of the scale. All three samples were scored on the same line.

The results of the overall statistical analysis are presented in Table 7. Human subject was a significant factor for the bitterness scores for both market types, while sweetness was influenced by subject for the reds but not the russets. The only trait for which the taste panel was able to consistently differentiate between the potato varieties was mealiness, and only for the reds. Compared with the standard variety Dark Red Norland, the breeding lines CO05228-4R and W8886-3R were rated as significantly less mealy (i.e., more waxy, Table 8).

Table 7. Analysis of variance for the sensory panel.

	Reds		Russets	
	Variety	Subject	Variety	Subject
Bitterness	NS	*	NS	*
Sweetness	NS	*	NS	NS
Mealiness	***	NS	NS	NS
Overall Acceptability	NS	NS	NS	NS

NS = not significant
*,**,*** = significant at 0.05, 0.01, and 0.001 levels, respectively

Table 8. Red variety means from the sensory panel.

Variety	Bitterness†	Mealiness‡	Sweetness†	Overall Acceptability†
Dark Red Norland	4.0	8.9[A]	4.7	7.6
CO05228-4R	4.6	5.0[B]	6.4	6.1
W6002-1R	4.7	7.5[AB]	6.2	9.7
W8405-1R	3.9	10.0[A]	5.6	8.9
W8886-3R	5.6	4.3[B]	6.7	7.6
W8890-1R	3.5	9.2[A]	7.3	9.3
W8893-1R	6.1	7.5[AB]	4.9	8.0

† No significant differences between the varieties

‡ Means with different letters are significantly different at the 0.05 level

Objective 4: Produce virus-free seed for varieties with the greatest fresh market potential
Before new potato varieties can be commercialized, certified seed must be produced from the breeder's seed. For the UW breeding program, breeder's seed refers to tubers propagated at the Rhinelander Agricultural Research Station since the breeding line was created from true seed. Typically 6–7 years of propagation on the breeding farm has occurred before a decision is made to produce certified seed. The first step of that process, known as virus eradication, involves initiating the breeding line into tissue culture and curing in vitro plantlets of disease through a combination of chemical and heat treatments. Once virus-free plantlets have been generated, which typically takes one year, certified minitubers are produced in greenhouses at the UW Lelah Starks Seed Farm.

This project has supported virus eradication from 7 fresh market varieties: three russets (W9433-1rus, W9519-3rus, W9523-1rus), one red (W8890-1R), and three yellows (W9576-11Y, W9576-13Y, W9577-6Y). Additionally, certified minitubers were produced for two russet and two red varieties for the first time: W8516-1rus, W9133-1rus, W8886-3R, and W8893-1R.

III. Goals and Outcomes Achieved

The key measurable outcome in the grant proposal, which was authored by the original PI Bussan, was to identify 20 breeding lines with commercial potential and advance them through the certified seed system. This goal was set based on the idea that breeders from other states would allow UW to produce virus-free seed of their new varieties, for which there was little precedent. Endelman, who leads the UW breeding program, became PI of this grant in Feb. 2014 when Bussan left UW. Several lines from the Colorado State University breeding program were identified as having commercial potential based on our field trials, but the Colorado program declined to allow UW to produce virus-free seed.

Certified seed production of 11 new fresh market varieties from the UW program was supported by this grant. The established timetable for releasing certified seed of new varieties to seed growers is after two years of field multiplication (following the minituber production cycle) at the Lelah Starks Seed Farm. Under this timetable, four new varieties will be offered to growers in 2017 (W9133-1rus, W8516-1rus, W8886-3R, W8893-1R), three in 2018 (W9576-11Y, W9576-13Y, W9433-1rus), and four in 2019 (W8890-1R, W9519-3rus, W9523-1rus, W9577-6Y).

B. See section A

IV. Beneficiaries

The primary beneficiary of this research is the Wisconsin fresh market potato industry. New varieties from this project have the potential to increase marketable yield, reduce post-harvest losses, or increase the competitiveness of Wisconsin growers in the US market. The potential economic impact to the WI potato industry is difficult to quantify, but the farm-gate value of the Wisconsin fresh market crop is over $100 million annually.

V. Lessons Learned

We fell short of the original goal of 20 new varieties because other states were not willing to cede control of the certified seed supply for their new varieties. In hindsight this could have been anticipated, as there is strong competition between the potato industries in different states. On a positive note, the project has affirmed the willingness of WI potato growers to donate their land and expertise for research that can improve their industry.

VI. Additional Information

None

VII. Contact Info

Tamas Houlihan
Executive Director
Wisconsin Potato Industry Board
P.O. Box 327
Antigo, WI 54409
715-623-7683
thoulihan@wisconsinpotatoes.com

2) Wisconsin's harvest medley: healthy blends for WI schools (FY12-002)

Report Date: June 30, 2014

I. Project Summary

A. In 2011, approximately 25% of Wisconsin high school students were overweight or obese (2011 CDC YRBSS). Furthermore, 22.6% of Wisconsin children are considered food insecure, meaning there is uncertainty of access to adequate amounts and varieties of healthful foods. To address these growing nutritional and diet related concerns, there is a sense of urgency to increase production and access to healthy fruits and vegetables to reach institutional food service settings. Federal, state, and local public health officials are beginning to partner with the agricultural sector to address these issues by stimulating the development of local food systems that address an increase in production *and* access to fresh and nutritious foods.

Pairing these local food system efforts with current work on farm to school is not only needed, but timely. In 2010, the federal Child nutrition Reauthorization Act (Healthy, Hunger-Free Kids Act) passed, issuing the strictest nutritional guidelines in US history. Schools had to come into compliance with this new law by September 2012, which includes requirements that school lunch programs ensure a significant increase in students' access to fresh fruits and vegetables. Nationally and in Wisconsin, this has begun to impact our need to produce more of these crops, as Wisconsin schools involved in the National School Lunch Program feed approximately ½ million children every day. The new requirement to serve increased vegetables (special focus on orange and leafy green produce) poses other large challenges to most schools beyond supply. The potential cost of fruits and vegetables, skilled labor required for on-site processing and preparation, and student preferences all raise concern in order to comply with these new nutritional guidelines.

Farm to school programs have the potential to bring fresh and local produce into the lunchroom, and offer a new market for small farmers. Often farm to school programs operate at small scales with direct procurement from farmers, but there are many schools and districts that have yet to seize this opportunity due to some common barriers: seasonality, price/cost, volume needed, consistency of product, labor convenience and processing capability, and student familiarity. As School Food Authorities (SFAs) are faced with tighter budgets and more restrictions, the need for affordable, fresh, convenient and local produce is evident. Additionally, Wisconsin vegetable growers are interested in selling to schools and other institutions but the industrial supply chain infrastructure does not readily provide that connection.

B. This project did not build on a previous SCBG.

II. Project Approach

The WI Harvest Medley Project involved significant coordination across food industry sectors and engaged partners at the WI Department of Agriculture, Trade and Consumer Protection, School Food FOCUS, and the Center for Integrated Agricultural Systems at the University of Wisconsin—Madison. The project facilitated WI grown and minimally-processed produce to reach school markets via schools' existing distributors, and showed the future potential for such products. It also allowed SFAs to meet the new nutritional guidelines, particularly with the orange vegetable category.[1]

The project provided easy access to Wisconsin grown minimally-processed vegetable blends available to schools (and other institutions) across the state through their existing distributors. Compared to a traditional farm to school model that typically operates at a small scale and relies on direct procurement from individual farms, the WI Harvest Medley was intended to not only provide convenience for SFAs in terms of product delivery via a prime vendor distributor, but also provide schools access to a reliable volume of minimally-processed and local products. Not only does this benefit the schools, but holds greater potential for positive economic impacts for WI producers in terms of new access to stable and large institutional markets.

The WI Harvest Medley was originally modeled after an existing pre-cut, fresh, and ready to roast root vegetable blend (components were sourced regionally and nationally) developed for Milwaukee Public Schools. The goals of the WI Harvest Medley project were to work with this existing supply chain to source the same product locally, and to create new supply chains for locally grown WI root vegetable blends (fresh and frozen). Other goals included the creation of educational and promotional materials to add value to the local vegetable products, promote the WI farmers and farmer groups, and teach school food service, students and families about where the vegetables came from and how they were grown.

Originally two root vegetable blends were identified for promotion and market development: WI Harvest Medley (carrots, parsnips, and sweet potatoes), and WI Roasted Potato Blend (a flexible mix of cubed, fresh or frozen, potatoes varieties). However, over the course of the project it became clear that there was a great potential for not only these specific products, but also for variations of these blends. A significant part of the project's ultimate success has been the various industry partners picking up the concept and independently developing a diversity of fresh and frozen vegetable blends using various combinations of locally grown root vegetables.

By facilitating relationships across the supply chain from farmers, processors, distributors, and schools, the groundwork was laid for increasing the amount of healthy and local produce in cafeterias. The goals of this project were initially conceived quantitatively, based on volumes of local product, but early on project staff realized it would be more about relationships, partnerships, and networking across the supply chain. Setting high production goals was deemed to be too risky primarily for the producers (but also for other partners responsible for selling the product), considering that all supply chain logistics were not in place, and more significantly,

[1] Schools are required to serve 3.75 cups of vegetables per week, .75 cups of which must be in the red/orange vegetable category (Healthy, Hunger-Free Kids Act)

that the demand for such products had only been established via needs assessment, not via actual sales history.

The work of this project has contributed to the local food system infrastructure and helped WI producers access growing, new institutional markets as a result of the increasing requirement, pressure and demand for healthy, local products to be served in schools. This project has built a strong foundation for future product development and marketing of minimally processed, locally grown and producer identified root vegetable blends.

III. Goals and Outcomes Achieved

The goals of this project, according to the original grant proposal, were focused on volume of locally grown product, and total servings of the vegetable blends. The project team realized that supply chain development, relationship building and strategic planning were all necessary for those quantitative goals to be accomplished over time. Listed below are the expected measureable outcomes of the WI Harvest Medley Project as well as supply chain models for the different vegetable blends.

Goal	**Accomplishment**
To increase the number of lbs of WI potatoes, root vegetables, squash and herbs sold into supply stream to produce the Harvest Medley and the Roasted Potato Blend.	Total pounds of Wisconsin-grown potatoes, root vegetables, and squash sold into the supply stream (raw vegetable form) to produce the Harvest Medley and Fifth Season Blends: **80,421 lbs**. An additional **37,960 lbs** of Wisconsin-grown produce was produced, processed and sold to schools in the form of spin-off blends (FarmLogix Holiday Medley and V. Marchese Harvest Blend) and fresh cut vegetables (carrots that were originally grown for the WI Harvest Medley project were ultimately sold to FarmLogix and served in Chicago Public Schools as well as the CESA 2 School Cooperative Buying Group). An additional total of **27,191 lbs**. of regionally grown produce was used in blends.
To increase the number of servings of the WI Harvest Medley and the Roasted Potato Blend purchased and served in WI Schools	3/8 cup servings of WI Harvest Medley: 160,000 3/8 cup servings of Fifth Season Blends: 450,000
To develop and provide "producer identified" educational materials to accompany the sales and utilization of the WI Harvest Medley and/or Roasted Potato Blend to support farm to school programs. These materials will reach 339,556 students minimally, as well as their families and school staff.	See attached producer-identified educational sheets. The educational materials of all the vegetable blends reached approximately 186,940 students across the state of Wisconsin.[2]

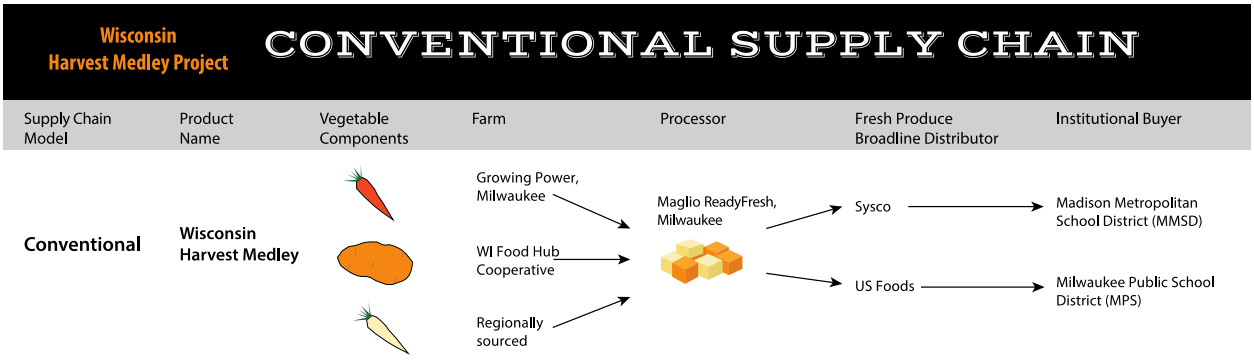
[2] Data from DPI Enrollment 2013.

Develop and disseminate a promotional video for the purpose of educating school communities and professionals about the project and the importance of school's supporting WI agriculture through their purchasing power.	The WI Harvest Medley video was completed in September 2013 and promoted online to all involved project partners, and to schools state-wide. This video will continue to be available to industry partners to promote the blends, especially targeting potential buyers in the school and institutional food service sector, as well and agricultural professionals and local food advocates. Link to video: http://www.youtube.com/watch?v=BMiDq6Y-cmM
Develop and disseminate a UW CIAS Research Brief	Final draft under peer review. See attached.

In the following comparison of supply chain models resulting from the WI Harvest Medley Project, there are some clear distinctions, including: their industry partners, organizational structures, geographic reach within the state, and the vegetable components of the WI blends being developed and sold.

NOTE: Conventional Supply Chain Models

For the purpose of this report, we term "conventional supply chain" models as characterized by long-standing personal and working relationships between national food industry entities, largely dependent on the awarded contracts between buyers and sellers. The following three conventional supply chains developed over the course of the project timeline.



Conventional Supply Chain

32,199 lbs of Wisconsin Harvest Medley finished product produced, processed and sold

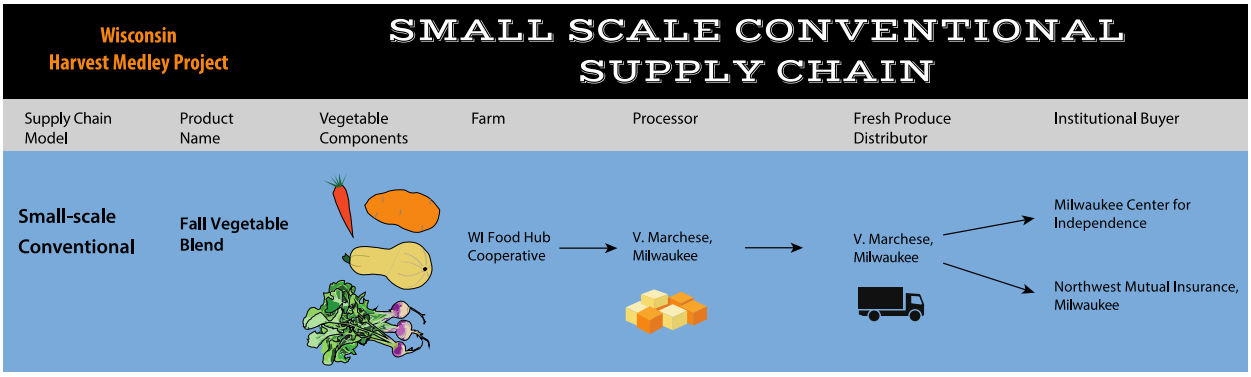
The project began working with the stakeholders originally interested in sourcing local product for the existing Harvest Medley served in Milwaukee Public Schools during the 2011-2012 school year. Growing Power was established as a partner and began production of their carrots, selling 15000 lbs. for the Harvest Medley in 2011-2012. The project team worked with the partners listed below to facilitate sales during the 2013-2014 school year. Prime vendor contracts shifted during the course of the project, which required building relationships with new distributors.

- ***Grower:*** Growing Power, an urban agriculture non-profit in Milwaukee.[3]

[3] See organization's website for more information: http://www.growingpower.org

- ***Grower Group:*** WI Food Hub Cooperative, a farmer-led cooperative owned by the producers and the Wisconsin Farmers Union.[4]
- ***Fresh produce processor:*** Maglio ReadyFresh
- ***Distributors:*** Sysco and US Foods
- ***Buyers:*** Approximately 13 school food authorities (SFAs) including Milwaukee Public Schools (MPS), and Madison Metropolitan School District (MMSD)

Small-scale Conventional Supply Chain
1,640 lbs of a spin-off vegetable blend purchased, processed and sold

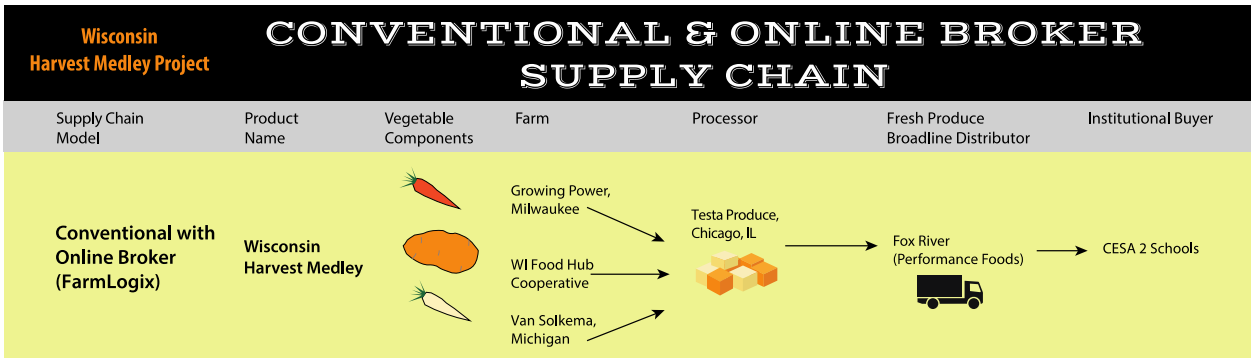


The development of a small-scale conventional supply chain occurred independently of the previous partnerships, with only minor involvement of the project team. During a meeting with representatives from V. Marchese, a fresh produce processor and distributor in Milwaukee, and after taking a tour of their state-of-the-art facility, project team members described the concept of the WI Harvest Medley and its market potential. V. Marchese subsequently took action and created their own Fall Vegetable Blend, sourced in part through the WI Food Hub Cooperative. This development shows the potential for such fresh, minimally-processed local products, and the recognized demand for them across food industry sectors.

- ***Grower Group:*** WI Food Hub Cooperative
- ***Fresh produce processor & distributor:*** V. Marchese
- ***Buyers:*** Northwest Mutual insurance and Milwaukee Center for Independence (selling to schools in Milwaukee)

Convention Supply Chain with Online Broker (FarmLogix)
4,020 lbs total raw procurement for Wisconsin Harvest Medley
960 lbs total raw procurement for FarmLogix Holiday Medley
36,000 lbs total raw procurement for Growing Power Carrot Coins

[4]For more information visit http://www.wifoodhub.com



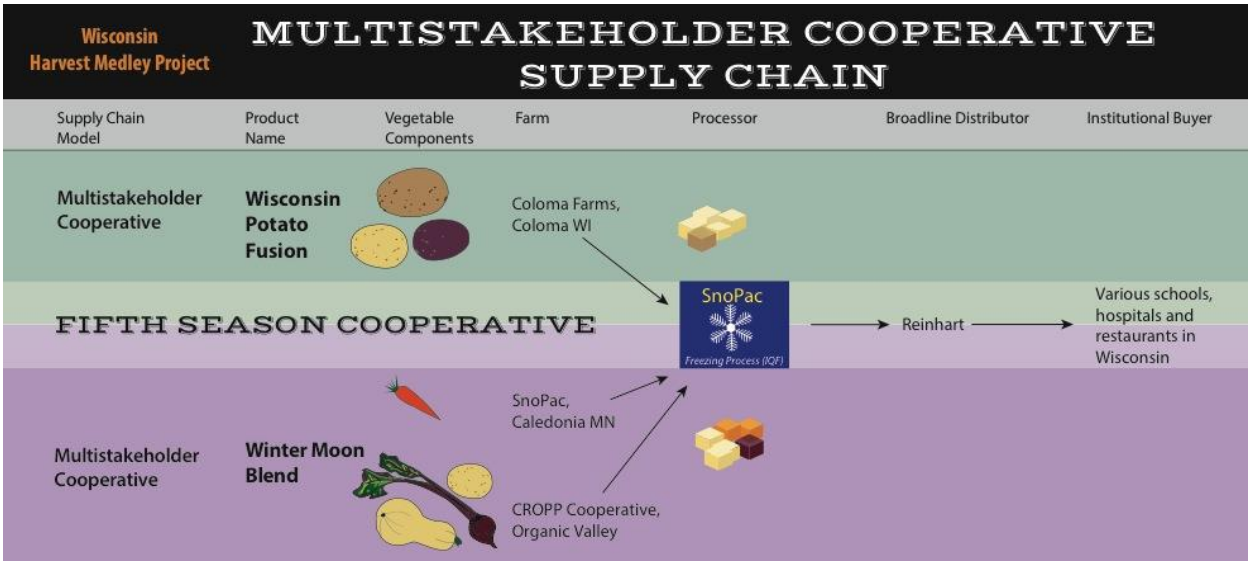
The opportunity to work with FarmLogix and the CESA 2 school cooperative buying group expanded the influence of the WI Harvest Medley. FarmLogix is a farm to plate online technology platform that overcomes logistical barriers to connect local farms to institutions (including schools). Online ordering, transportation/distribution and sustainability reporting are key inherent features for their users. They provide significant farm to school services for Chicago Public Schools and other districts in WI and elsewhere. FarmLogix works at a large scale to enable institutions to purchase locally grown produce.

FarmLogix sold the WI Harvest Medley to the CESA 2 School Cooperative Purchasing Group. The Cooperative Educational Service Agency (CESA) Purchasing cooperative program works with vendors to provide collective purchasing and distribution services for schools as well as municipalities across the state of Wisconsin. The CESA 2 cooperative buying group is the only school buying cooperative in the state that can use their collective purchasing power for food purchasing in Wisconsin, and currently includes 75 school districts. 105 schools in 16 of those school districts purchased the WI Harvest Medley through FarmLogix. Schools benefit from the discounts provided by high volume purchasing, and can apply this advantage to locally grown products through FarmLogix. In addition to producing a run of the WI Harvest Medley for 2 schools and 11 districts, FarmLogix also created and sold a similar Holiday Medley that included carrots, sweet potatoes, and butternut squash, sold to 7 school districts, 3 schools and 3 other institutional buyers.[5]

- ***Grower:*** Growing Power
- ***Grower Group:*** WI Food Hub Cooperative
- ***Fresh produce processor:*** Testa Produce (Chicago, Illinois)
- ***Distributor:*** Performance Food Group
- ***Buyers:*** WI CESA 2 Buying Coop

Multi-stakeholder Cooperative Model:
40,000 lbs total raw procurement for Wisconsin Potato Fusion
40,000 lbs total raw procurement for Winter Moon Blend

[5] See buyer list on page in the Appendix.



The Fifth Season Cooperative is a multi-stakeholder cooperative co-owned by producers, producer groups, food processors, distributors, workers, and buyers from the Driftless Region in southwest Wisconsin. The Fifth Season Coop sources and sells product from within a 150 mile radius of Viroqua WI, which includes south central and southwest Wisconsin, southeast Minnesota, and northwest Iowa. Although all product sourced by Fifth Season within the 150 mile radius is considered "local", for the purpose of this grant report only Wisconsin-grown product will be documented as "local."

The Coop produces and distributes locally grown produce, meats, dairy and value-added food products to institutional and foodservice buyers through its distribution member, Reinhart FoodService. The relationship with Reinhart is at the core of the Coop's success because it has allowed them to use existing distribution infrastructure, rather than investing in their own. This innovative model of a multi-stakeholder cooperative with a broadline distributor represented on the Board of Directors provides producers another critical set of services – warehousing, transportation, sales representatives and a developed customer base, while simultaneously providing hundreds of foodservice buyers access to their locally and sustainably grown products. The Coop also works with businesses and organizations to provide education and increased exposure to locally produced foods for their customers. This added programming helps to build knowledge of the individual producers and their practices, and builds upon the importance and benefits of a developing an economically viable and sustainable regional food system.

The Fifth Season's multi-stakeholder cooperative structure ensures that working relationships exist between key supply chain entities. Such positive working relationships can be hard to find in mainstream supply chains that are marked by the volatility of contracts and often aggressive competition. In contrast, the Coop brings everyone to the table to make decisions, for the benefit of all, and in doing so, redistributes power across the supply chain. The mission to create a sustainable, local and regional food system with fair pricing to farmers, is prioritized in their decision making, which contrasts with the market driven mainstream food supply chain.

As part of this project, the Fifth Season Coop developed its first two value-added products in a frozen, line of vegetables: the *Wisconsin Potato Fusion* and the *Winter Moon Blend* (see sell sheets and educational sheets in the Appendix). After the recipe trials for these blends, the Fifth Season Cooperative approached Sno Pac Foods and contracted for the first product runs. Sno Pac Foods is a family-owned business that uses an IQF (Individual Quick Frozen) freezing process for certified organic frozen vegetables. Sno Pac requires minimum product runs to ensure profitable operations. In this case, a 40,000 lb. minimum raw product is the smallest viable run for the facility. However, the Coop needed proof of the sales potential for the two 40,000 lb. minimum runs before authorizing. A pre-order system was set up to quantify demand for the product prior to approving the processing. Because pre-orders exposed a high level of interest among schools and other institutional buyers, the Coop moved forward with the processing of both blends (a total of 80,000 lbs. of raw product) at Sno Pac Foods in the late fall/early winter of 2013.

- ***Grower:*** Coloma Farms, Sno Pac
- ***Grower Group:*** Organic Valley/CROPP Cooperative
- ***Frozen produce processor:*** SnoPac
- ***Distributor:*** Reinhart
- ***Buyers:*** Wisconsin school districts and other institutional food service operations

Pricing

The pricing for the different vegetable blends reported by schools included the following ranges listed below. These prices only represent what the schools paid for the product, and do not provide any information on the margins added by processors and distributors, as such is proprietary information.

Table 1. Supply Chain Pricing

Supply chain model	Per serving	Per pound
Conventional	$0.30-0.50	$2.00-3.15
Conventional & Online Broker	$0.23	$1.50
Multi-stakeholder Cooperative	$0.16-20	$1.00-1.05

IV. Lessons Learned

Planning for Supply & Demand

The project team learned that increasing the volume of Wisconsin-grown produce into schools required relationship building and strategic planning across the supply chain. It was difficult to convince growers to increase production without a quantified demand for the final product. Similarly, it was difficult to promote and market a product that did not already exist or have a sales track record. At the same time, school buyers were interested in the price per serving of finished product, and growers were interested in the price per pound for their raw product. Both of these beginning and end prices were dependent on the volume, which was dependent on the demand (which was dependent on the price). Therefore, it was nearly impossible to set an accurate price for a brand new final product, which made promotional and sales activities challenging.

Processor Size & Scale

It became evident during the course of this project that a number of small to mid-scale processors in Wisconsin and the surrounding region were interested in working to develop local and organic lines. The project team worked successfully with V. Marchese, Maglios, Testa Produce, and SnoPac to process the root vegetable blends. The positive experience working with these processors shows potential for locally grown minimally-processed products in Wisconsin.

Despite the overall success with processors, the project team had difficulty finding the right *sized* processor for the Fifth Season Coop (see interim report for more details). The project team facilitated meetings with Sno Pac, a mid-scale processor located in Caledonia, MN (within 100 miles of Fifth Season coop) that focuses on organic, frozen vegetable products. Sno Pac requires a minimum run of 40,000 lbs raw product, a larger volume that the Coop initially intended to source, process and sell. The Fifth Season Coop and the project team worked hard to urge schools to pre-order the two blends (WI Potato Fusion and Winter Moon Blend) to ensure their commitment for purchasing the blends during the school year. With enough pre-orders from schools and other buyers, the Board of Directors voted in October 2014 to move forward with processing of both blends with Sno Pac.

This was a major milestone for the project and for the Fifth Season Coop, as they now have established their first two successful, branded products with plans to expand them four-fold in the next year, 2014-15. In addition, the partnership built between Fifth Season and Sno Pac also resulted in a new business relationship between Sno Pac and Reinhart. Because of the success of these frozen blends, Sno Pac may benefit from selling their own product line through Reinhart.

Seasonality

Although the blends were heavily promoted to coincide with October National Farm to School month, the Harvest Medley fresh cut product was not available until November, and the frozen blends not until December. This was in large part due to the reality of when the majority of fall root crops are ready for harvest (October) and then the additional handling time required through the processing and distribution phase. Some schools that responded to the October Farm to School Month promotional push were disappointed when product was not available until November and December. The positive side to this timing turned out to be the availability for holiday inspired menus and the fact that the season for schools to serve locally produced foods was greatly extended. The Fifth Season Coop's current frozen blends and planned line of frozen, value-added products have the potential to be available year-round. If these products are successful, they will significantly benefit the Coop's consistent cash flow and overall revenue.

Promotional Video

The WI Harvest Medley promotional video was created to reach schools with a clear and inspiring message and encourage sales. The original goal of this video was to promote the WI Harvest Medley to school nutrition directors for October Farm to School month by emphasizing that it is local, easy to prepare, and available through their distributor. The video features some key supply chain partners who describe their involvement with the project and why building a local and regional food system is important to them, including several involved producers on their farms. Footage also includes Milwaukee Public Schools serving the WI Harvest Medley and students reporting on how much they enjoyed the Medley. The video was posted on the WI School Nutrition Association's facebook page, promoted by the WI Local Food Network listserve, the WI Farm to School Newsletter, the WI Farm to School AmeriCorps Program, the Transform WI Program and a wide variety of other partner organizations and listserves.

Video website: http://www.youtube.com/watch?v=BMiDq6Y-cmM

Farmer-identified Educational Materials

The project team created educational materials for each of the blends that identified local farmers, provided nutritional information, and gave general information of how and where the vegetables were grown and processed.[6] For a traditional farm to school program that sources directly from a farmer, these educational materials are easy to create because the school is making the individual procurement decisions. For the conventional supply chain however, the processor was making the procurement decisions and sourcing from multiple farms and farmer groups. This made it very difficult to track where some product was coming from due to short turnaround times and challenges with communication.

When sourcing local product at these larger scales, it works best to have an entity that is responsible and accountable for sourcing and providing these farmer-identified educational materials. The Fifth Season Coop and FarmLogix are two examples of how this can be accomplished. Both of these entities are very familiar with producer identified educational materials, as they provide their own with each product to ensure the educational value and transparency of "producer identified" products. The conventional supply chain however, was not familiar with the concept and did not have existing communication streams to facilitate the development and dissemination of such educational components (i.e. sales reps did not have relationships with farmers), or a process to ensure the resulting materials were accurate.

Marketing of Local Products

The Fifth Season Cooperative developed two regionally identified and branded frozen vegetable blends, now trademarked products that include significant representation at the point of sales. The FarmLogix vegetable blends also had similar representation and were promoted by the company to the school buyers. In contrast, the sales for the conventional supply chain model were of an unbranded product that received less representation at the point of sales, and may have been perceived as less distinctive by buyers.

---

[6] See Appendix for educational sheets.

Changing players, changing contracts

Due to turnover in contractual partnerships in the conventional supply chain, the project team experienced challenges in building stable working relationships with key players. The change of the MPS prime vendor contract mid-project from Sysco to US Foods required establishing relationships with new partners. In addition, a strong relationship had been built with the Department of Defense (DoD) Fresh Produce vendor AJ Wholesale Produce only to find that the contract was awarded to a much larger company and subcontracts (see Interim Report for more information on AJ Wholesale Produce). This halted project efforts to offer the WI Harvest Medley through the DoD Fresh Program.[7] This uncertainty and instability contrasts with the membership and mission driven structure of the Fifth Season Cooperative model where member partners supported communication and accountability across sectors throughout the duration of the project.

Transparency and traceability

During the project timeline it was difficult to retrieve information on product origin in the conventional supply chain due to the fact that documentation systems did not involve collecting and communicating product origin to their buyers. Schools require product that is produced in the U.S., however there are no requirements for labeling of product origin, which means that tracking and labeling for "local" food is not enforced. Most major distributors track by commodity, but not by farm of origin, for example.

Although traceability capabilities are in place in the case of a food safety recall, product origin information is commonly not provided directly to schools. This information was difficult to retrieve from processors and distributors, whose organizational activities had not typically included documenting and reporting product origin. This was an extremely important lesson learned given the potential for misrepresentation of product as "local". Again, in contrast to the documentation and reporting capabilities of the conventional supply chain, the documentation and reporting systems of the FarmLogix and Fifth Season Cooperative models provided a high level of product origin and transparency for the buyer, including the regular inclusion of educational materials with each product, featuring producers and product origin.

V. Beneficiaries

The beneficiaries of this project include many stakeholders across multiple supply chains. Although there was minimal direct economic impact for 2013, many of these partners have stated that they are confident in the large economic potential in future years. The partnerships that were created have benefited all project participants, and lay the groundwork for future market expansion opportunities. Following is a sampling of information collected through phone exit interviews with project partners, which staff saw as the most effective way to gather information on how each partner benefitted from the project and potential economic impacts.

Monty Viske, Maglios ReadyFresh Monty explained that he was expecting orders for larger volumes of the product, and sold only 3,600 more of the product this year than last year.

---

[7] This program allows schools to use their federal entitlement dollars to purchase fresh fruits and vegetables. Many states are currently looking for ways to make local fruits and vegetables more affordable for schools through this program.

However he added that he thought the Harvest Medley was a great product and he would continue to produce and sell it. He strengthened his relationship with Growing Power during the process, but did not find other new partner benefits. For the sake of this project, Maglios ReadyFresh sold Harvest Medley blend through Sysco and US Foods to 13 schools, including the two biggest schools districts in the state, Milwaukee Public Schools and Madison Metropolitan School District.

Ron Balsimo Wisconsin Food Hub Cooperative (WFHC) **Sales Manager**
The WFHC is a farmer-led cooperative owned by the producers and the Wisconsin Farmer's Union, that helps local farmers by providing marketing, sales, aggregation and logistics that allow them to access wholesale markets. It was officially incorporated in October 2012 and the first general membership meeting took place in April 2013. Ron, the WFHC Sales Manager, reported that he created new valuable partnerships from the WI Harvest Medley project. The Food Hub began working with V. Marchese (fresh-cut processor in Milwaukee) with the WI Harvest Medley, and now are working with them to develop a pre-cut home-grown section for Roundy's, a large, regional retail grocery company based in Milwaukee, WI. The Coop also benefited from the relationship built with Monty at Maglios Readyfresh, providing Food Hub expanding opportunities for selling their local product to schools and other institutions. For him, working with V. Marchese was ideal because they provided trucking and logisitical services, two of their biggest challenges. Although this year the project did not have a significant economic impact for the Food Hub, they are optimistic that it will be viable in the future as demand and production capacity increase simultaneously. For the Food Hub, this project provided a clear avenue to build key relationships and supply chain partnerships.

Linda Mallers FarmLogix *Founder, President*
For Linda Mallers, Founder and President of FarmLogix, the first run of WI Harvest Medley did not provide a profit, however her company did benefit from the concept of the WI Harvest Medley product. Shortly after selling the WI Harvest Medley, they created their own fresh-cut blend, the FarmLogix Holiday Medley, for their school buyers that consisted of a similar, though different variety of local and regional vegetables. They plan to create more variations of minimally-processed, locally sourced vegetable products at larger scales, as a result of their successful experience with the WI Harvest and Holiday Medleys. FarmLogix also benefited from involvement in the project through the development of new producer relationships. For example, via the Harvest Medley project, Farmlogix added Growing Power (GP) in Milwaukee WI as a new vendor. During the project period they not only purchased carrots from GP for the blends they produced and sold to schools, but also purchased an additional 30,000 pounds of carrots for processing and sale to the Chicago Public Schools.

Bill Zimmer V. Marchese Produce *General Manager*
The local vegetable blend that V. Marchese developed was modeled after the WI Harvest Medley, and included slightly different vegetable components. They sourced product from the WI Food Hub Cooperative, developing a new relationship for locally sourced produce. According to Bill, they had success selling this product to both schools and other institutions and will continue to make similar fresh cut WI root vegetable blends in the future.

Diane Chapeta Fifth Season Cooperative *Operations Manager*
Diane Chapeta and the Fifth Season Cooperative benefitted greatly from the WI Harvest Medley project. Not only did this project provide a positive economic impact for the Coop, and give their growers a new market for seconds, but it also gave the Coop the opportunity to form a new partnership with SnoPac. According to Diane, "this relationship was priceless." Now that SnoPac is a member of the Coop, Reinhart is now distributing their whole product line, and the whole Coop is profiting. This project has set them on a track to become financially sustainable, and has opened new doors for them. Looking toward the future, the Coop will continue building a trademarked regional frozen vegetable product line, which will expand access for Wisconsin farmers to institutional markets.

Andy Diercks Coloma Farms *Owner*
For Andy Diercks, the WI Harvest Medley project provided an opportunity to be involved with farm to school programs and build new partnerships with Reinhart and SnoPac. He explained that it was a "refreshing change to work with local foods" because it is mission driven. Coloma Farms profited from the project, finding prices competitive and volume adequate. He would like to see an increase in volume for next year of 4-7 times the volume, and will definitely remain part of the project in the future.

Other Beneficiaries: ***Participating Schools***

Harvest Medley
13 schools i
Milwaukee Public Schools
Sparta
Sauk
Madison
Albany
Whitewater
Columbus
Juda
Brodhead
John Edwards
Edgar
Cambria
Beloit

Fifth Season
Wisconsin Potato Fusion
BANGOR HIGH SCHOOL
EMERSON ELEM.SCHOOL
HARRY SPENCE SCHOOL
LA CRESCENT ELEM. SCHOOL
LOGAN HIGH SCHOOL
LOGAN MIDDLE SCHOOL
MCHS-NORTHLAND, INC.

ONALASKA CTRL KIT-LUNCH
RED WING HIGH SCHOOL
SOUTHERN BLUFF SCHOOL
ST ANTHONY FOOD SERVICE
ST. GABRIEL'S CATH SCHOOL
SUNNYSIDE SCHOOL
TOMAH MEMORIAL HOSPITAL

Winter Moon Blend

BORGEN'S CAFE
BOYCEVILLE SCHOOL
CAFE D-VINE
COLFAX HEALTH & REHAB
COUNTRY WINDS MANOR
COUNTRY WINDS-EMPLOYEE
FOSNOW ADULT LIVING
KICKAPOO SCHOOL
MARKET PLACE CAFE-AM GIRL

PRAIRIE VIEW N.H. S8
REINHART FOODS-MISC CUST
RUBAIYAT
SPOONER AREA SCHOOL DIST
THE GREENS
THE RIDGE
UNIVERSITY PURCHASING
WABASHA KELLOGG TAHER

Both Vegetable Blends

ASPSETER, DON
BANGOR ELEM SCHOOL
BLUFF VIEW SCHOOL
CREST VIEW NURSING HOME
EVERGREEN ELEM SCHOOL
GUNDERSEN LUTHERAN-CAFE
HANSON, KEN
HILLSBORO HI SCH
HOLMEN HIGH SCHOOL
HOLMEN MIDDLE SCHOOL
KOSLOWSKI, TIMOTHY

LAC COURTE OREILLES CASIN
MAGGIE MAE'S
MEMORIAL HOSP. PRAIRIE S6
MENOMONIE HIGH SCHOOL
MILE BLUF MED CENT
MINERAL POINT MID-HIGH SC
MOUNT HOREB SCHOOL DIST
OUR LADY QN OF PEACE SCH
PRAIRIE VIEW ELEM SCHOOL
RICHLAND SCHOOL DIST
ROLLING HILLS REHAB S12
SAND LAKE ELEM SCHOOL
SAUK PRAIRIE MEM HOSPITAL
SPRING HILL SCHOOL
ST. ROSE'S CONVENT
TOMAH HIGH SCHOOL
UPLAND HILLS HEALTH
VIKING ELEMENTARY SCHOOL
VIROQUA HIGH SCHOOL

WEST SALEM ELEM. SCHOOL
WEST SALEM HIGH SCHOOL
WEST SALEM MIDDLE SCHOOL
WINNESHIEK MEDICAL CENTER

FarmLogix WI Harvest Medley
11 districts
2 schools

Barneveld School District
Beloit Turner School District
D.C. Everest School District
Lake Mills Area School District
Marshall Public Schools
Norwalk Ontario Wilton School District
Potosi Public School District
Slinger School District
Verona Area School District
Wasau School District

Waterloo School District
Watertown Unified School District
Wisconsin Rapids Public Schools

FarmLogix Holiday Blend
7 districts
3 schools

Deer Path Middle School
Fall River School District
Lake Mills Area School District
Marshall Public Schools
Monona Grove School District
Norwalk Ontario Wilton Schools
Peru Public School District
Potosi Public School District
School District of Jefferson
Slinger School District

Growing Power Carrots
145 schools
16 districts

CESA 2 Cooperative Buying Group
Appleton School District

VI. Additional Information

Included in this report are promotional and educational materials for each of the three blends (WI Harvest Medley, WI Potato Fusion, and Winter Moon Blend).

Video website: http://www.youtube.com/watch?v=BMiDq6Y-cmM

Celebrating Farm to School month with the

WISCONSIN ★ POTATO FUSION

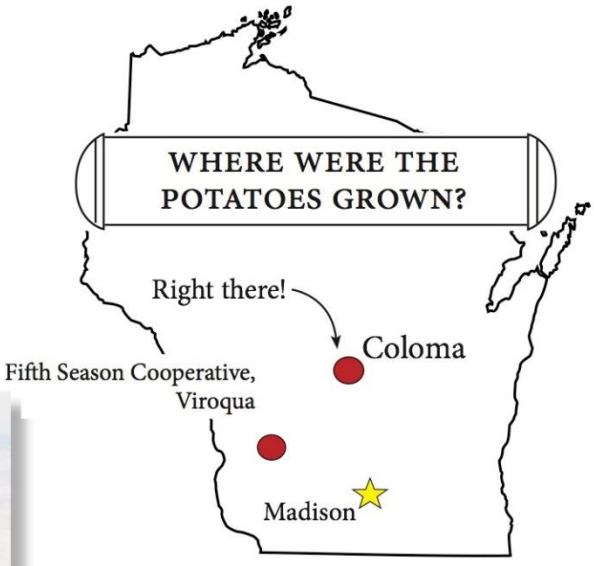
WHO'S THE FARMER?

Coloma farms is run by third and fourth generation farmers, Steve and Andy Diercks. They grow a variety of potatoes including reds, whites, yellows, and Russets. They harvest most of the potatoes in late August and early September, many of which are stored to be sold during the winter.

WISCONSIN HEALTHY GROWN POTATOES
Good for you, good for the environment.
www.healthygrown.com

Healthy Grown Potatoes are produced using strict growing practices that are good for the environment. Andy and Steve Diercks are dedicated to providing healthy grown potatoes to schools in Wisconsin.

WHERE WERE THE POTATOES GROWN?



Andy and Steve's farm is located in the Central Sands region of Wisconsin. Many farmers in this region depend on **irrigation** to grow their crops. **Irrigation** is how farmers water their plants, using big machines that spray water on their fields. Andy and Steve try extremely hard to use the least amount of water necessary to keep their potatoes growing.

Fifth Season Cooperative

The Fifth Season Cooperative in Viroqua, WI **aggregates** vegetables from many different farms. That means that they gather vegetables from many small farms to supply the large amounts needed for the Potato Fusion. Coloma Farms is one of the farms that they **aggregate** from. They work with farmers, processors, and distributors to bring you delicious locally grown vegetables!

Celebrating Farm to School month with the

WISCONSIN ★ WINTER MOON

BUTTERNUT SQUASH

Butternut squash grows on a vine and belongs to the gourd family. It contains lots of vitamin A and vitamin C and has a sweet, tasty flavor similar to a pumpkin. Did you know you can bake and eat the seeds from this squash just like pumpkin seeds?

CARROTS

Carrots are extremely nutritious and come in different colors--orange, purple, white, yellow, and red. Did you know that celery, cilantro, parsley and parsnips are all in the carrot family? Celery is from the stem of the plant, carrots are from the roots, and cilantro and parsley are from the leaves. The first carrots were grown more than 2000 years ago and were purple and yellow--the orange ones we eat today were originally grown in the Netherlands.

BEETS

Beets are one of the sweetest vegetables, with more sugar than carrots or even sweet corn! They can be red, golden, or even pick and white striped. Beets give you lots of vitamins A and C, potassium and magnesium. The part of the beet plant we eat in this blend is the root, but you can also eat the stem and leaves too.

GOLDEN POTATOES

Potatoes grow underground and are harvested by digging them up in the fall. Potatoes are a powerhouse of nutrients! They're high in potassium, iron, and protein and if you eat them with the skin on, like they are in the Potato Fusion, you also get good fiber.

NATIONAL FARM to SCHOOL MONTH

WISCONSIN NATIONAL FARM TO SCHOOL NETWORK

Beets photo: All rights reserved by The Red Hare {a mixed-media studio}

VII. Contact Info

Michael Bell
Center for Integrated Agricultural Systems
University of Wisconsin - Madison
1535 Observatory Dr
Madison, WI 53706
608-265-9930
michaelbell@wisc.edu

3) Developing IPM for rust diseases in turfgrass (FY12-003)

Report Date: September 4, 2015

I. Project Summary

Rusts of cool-season turfgrasses are caused by many species of *Puccinia* and *Uromyces*. Traditionally rust diseases were thought to be cosmetic and of little concern to turfgrass managers. Yet, relatively recently rusts have become a major problem for turfgrass sod producers, homeowners, K-12 athletic field managers, and golf course superintendents. The reason for this shift is largely unknown, but it is hypothesized that the varieties currently used in production were bred for resistance to stem rust (*Puccinia graminis*). Yet, the species we currently find associated with many cool-season turfgrasses, especially Kentucky bluegrass, is crown rust (*Puccinia coronata*). Typically breeders associated stem rust only with Kentucky bluegrass and crown rust with perennial ryegrass. However a recent survey conducted by scientists at Rutgers University demonstrated that crown rust was the most prevalent rust pathogen associated with rust in Kentucky bluegrass. Although researchers at Rutgers demonstrated that the primary rust disease of Kentucky bluegrass was crown rust, they did not outline any means to manage this devastating disease.

Kentucky bluegrass is the most common cool-season grass used for home lawns, athletic fields, and golf course roughs and is grown in large supply by turfgrass sod producers. This particular turfgrass comprises over 2/3 of the turfgrass acreage in Wisconsin, which last estimated in 1999 was 1.2 million acres in total. During the past five years, the number of samples submitted to the Turfgrass Diagnostic Lab at the University of Wisconsin-Madison diagnosed with rust has increased dramatically, indicating that rust has become more prevalent in recent years despite vastly different environmental conditions in recent summers. Rust had become so severe that sod producers in Wisconsin couldn't sell large volumes of their product and homeowners and golf course superintendents have started spraying fungicides to control the disease. Considering the vast acreage covered with Kentucky bluegrass in Wisconsin, it was necessary to investigate this disease in more detail in order to develop management strategies that reduce the risk of harm to people and the environment.

In order to achieve improved management strategies for rust in Kentucky bluegrass swards, we proposed to identify the rust species associated with Kentucky bluegrass, evaluate current germplasm for relative resistance, evaluate mixtures of turfgrass cultivars and species as a means of rust management, and to investigate the influence of nitrogen sources on rust incidence and severity.

B. This research did not built on a previously funded Specialty Crop Block Grant.

II. Project Approach

Part I: Laboratory Identification of Rust Fungi

The qPCR technique to be used for identifying the various rust species took time to develop but currently is a rapid and effective tool for identifying rust species found on turfgrass from throughout the Midwest. Rust samples are still being collected as of this report in 2015, but as of today the following tables illustrate the number of samples that have been collected and their species identification:

Table 1: Overall number of each rust species collected from 2013-Aug 31, 2015

Rust Species	Number Identified
Puccinia coronata	44
Puccinia graminis	267
Puccinia striiformis	1
P. coronata + *P. graminis*	42
N/A	90
No Rust DNA extracted	27
Total	471

Table 2: Rust species by type of grass collected from.

Grass	P. coronata	P. graminis	P. striiformis	P. coronata + P. graminis	N/A or No DNA	Total
Kentucky bluegrass	33	262	1	36	98	428
Perennial Ryegrass	8	3	0	2	7	19
Fine Fescue	1	0	0	1	0	2
Annual Ryegrass	0	0	0	0	1	1
Tall Fescue	0	1	0	0	1	2
Big blue stem	0	0	0	0	2	2
Unknown prairie grass	0	1	0	0	1	2
Creeping Charlie	0	0	0	0	1	1

Table 3: Rust species by state submitted or collected from.

State	P. coronata	P. graminis	P. striiformis	P. coronata + P. graminis	N/A or No DNA	Total
Wisconsin	28	249	1	37	99	413
Illinois	2	4	0	2	0	8
Minnesota	3	1	0	0	0	4
Ohio	4	6	0	3	0	13
Nebraska	0	0	0	0	1	1

As is clear from these tables, there is diversity in the rust population on turfgrass throughout the Midwest. This study was conducted to confirm and expand upon findings from Rutgers University that *P. coronata* could be found on Kentucky bluegrass, which until that paper was not considered likely. Our results were in agreement with those from Rutgers, indicating that Kentucky bluegrass in the Midwest can also be host to multiple rust fungi. In addition, our study also found that perennial ryegrass can be a suitable host for not only *P. coronata* but also *P. graminis*. One last point of great interest of this portion of the study is that multiple samples tested positive for both *P. coronata* and *P. graminis*. To my knowledge, neither *P. graminis* on perennial ryegrass or both *P. coronata* and *P. graminis* occurring on the same plant at the same time has previously been reported in the literature.

Part II: Field Resistance of Kentucky Bluegrass Families to Rust

In addition to the laboratory assay development and identification, field assessment of 29 different Kentucky bluegrass cultivars belonging to 7 different bluegrass families were tested. Each cultivar was visually assessed for rust on a 1-6 scale with 1 < 10% rust, 2 = 10 – 30% rust, 3 = 31 – 50% rust, 4 = 51 – 70% rust, 5 = 71 – 90% rust, and 6 > 90% rust. Field studies were set up at 3 locations (OJ Noer Turfgrass Research Facility in Verona, WI; Paul's Turf and Tree in Marshall, WI; Jasperson Sod Farm in Franksville, WI) in spring of 2013. The OJ Noer site had ample disease in 2013 but none in 2014 and none to date in 2015. Paul's Turf and Tree had consistent rust in each of the three years of the field study. The Jasperson site has not had rust develop in any of the three years of the study. The results from OJ Noer in 2013 and Paul's Turf and Tree in 2013-2015 are below:

Table 4: Rust resistance of seven different Kentucky bluegrass families at the OJ Noer Turfgrass Research and Educational Facility in Madison, WI in 2013.

Family	Estimate ± Standard Error	Letter Group[a]
Midnight	3.05 ± 0.136	A
Compact	2.71 ± 0.136	B
America	2.68 ± 0.155	B
Hybrid Blue	2.38 ± 0.317	BCD
Shamrock	2.29 ± 0.136	C
Improved Common	1.63 ± 0.317	DE
BVMG	1.50 ± 0.317	E

[a]Means separated using Fisher's LSD test (P = 0.05).

Table 5: Rust resistance of seven different Kentucky bluegrass families at Paul's Turf and Tree Farm in Marshall, WI in 2013.

Family	Estimate ± Standard Error	Letter Group[a]
Midnight	2.06 ±0.089	A
Compact	1.98 ±0.089	AB
America	1.78 ±0.105	BC
Improved Common	1.75 ±0.235	ABC
Shamrock	1.73 ±0.089	C
Hybrid Blue	1.38 ±0.235	CD
BVMG	1.00 ± 0.235	D

[a]Means separated using Fisher's LSD test (P = 0.05).

Table 6: Rust resistance of seven different Kentucky bluegrass families at Paul's Turf and Tree Farm in Marshall, WI in 2014.

Family	Estimate ± Standard Error	Letter Group[a]
Hybrid Blue	4.25 ± 0.258	A
America	2.35 ± 0.158	B
Shamrock	1.89 ± 0.148	C
Compact	1.75 ± 0.148	CD
Midnight	1.54 ± 0.148	D
Improved Common	1.00 ± 0.258	E
BVMG	1.00 ± 0.258	E

[a]Means separated using Fisher's LSD test (P = 0.05).

Table 7: Rust resistance of seven different Kentucky bluegrass families at Paul's Turf and Tree Farm in Marshall, WI in 2015.

Family	Estimate ± Standard Error	Letter Group[a]
Improved Common	2.00 ± 0.174	A
Shamrock	1.73 ± 0.070	AB
America	1.63 ± 0.081	BC
Hybrid Blue	1.50 ± 0.174	BCD
Compact	1.45 ± 0.070	CD
Midnight	1.38 ± 0.070	D
BVMG	1.00 ± 0.174	E

[a]Means separated using Fisher's LSD test (P = 0.05).

Midnight bluegrasses had the highest levels of rust in 2013 at both the OJ Noer and Paul's Turf and Tree. Midnight had comparatively less rust in both 2014 and to date in 2015, suggesting that rust resistance in Midnight bluegrasses increases over time. This is important information for sod growers, however, who would typically harvest within 2 years of seeding. If Midnight types are especially susceptible to rust in the first year following seeding, they would require additional inputs of fertilizer and pesticides to make the sod suitable for sale to customers. Planting other bluegrass families, namely America or Shamrock, may allow for sod to be sold within the first two years of seeding without experiencing significant rust development.

Part III: Rust Management Using Fungicides and Nitrogen Fertilizer

A 'rust management' field study was seeded at Lurvey Farms in Whitewater, WI in April of 2014. A mixture of cultural (balanced 10-10-10 fertilizer and urea fertilizer) and chemical (systemic vs contact fungicides and preventative vs curative applications) rust control options were evaluated on a highly susceptible cultivar of Kentucky bluegrass (Midnight). Rust was slow to develop in 2014 but it was clear by the end of the season that those plots receiving the penetrant fungicide Bayleton had much lower levels of rust than either Daconil or Heritage TL (see table below). Differences between the fertilizer regimes were less apparent, suggesting that rust development is not particularly dependent on a balanced vs unbalanced nitrogen source. Rust has yet to develop at Lurvey Farms in 2015.

Table 8: Rust severity on October 24th, 2014 on plots sprayed with either contact (Daconil WeatherStik) or penetrant (Bayleton and Heritage TL) fungicides and fertilized with either balanced (10-10-10) or unbalanced (46-0-0) fertilizer at Lurvey Farms in Whitewater, WI.

Treatment	Rust Severity ± Standard Deviation	Letter Group[a]
Non-treated control No Fungicide or Fert	3.8 ± 0.64	A
Contact Fungicide (Daconil) Non-balanced Fert (46-0-0)	2.0 ± 0.64	B-E
Penetrant Fungicide (Bayleton) Non-banaced Fert (46-0-0)	1.0 ± 0.64	E
Penetrant Fungicide (Heritage TL) Non-balanced Fert (46-0-0)	2.5 ± 0.64	A-E
Contact Fungicide (Daconil) Balanced Fert (10-10-10)	2.0 ± 0.64	B-E
Penetrant Fungicide (Bayleton) Balanced Fert (10-10-10)	1.3 ± 0.64	E
Contact Fungicide (Heritage TL) Balanced Fert (10-10-10)	2.5 ± 0.64	A-E

[a]Means separated using Tukey's HSD test (P = 0.05).

Part IV: Curative Rust Management With Fungicides and Fertilizer

An additional study was seeded on 'Midnight' Kentucky bluegrass at Paul's Turf and Tree in the spring of 2014 to determine the most effective curative management options for rust. Fungicides were applied in the fall of 2014 once significant rust had developed over the plot. The most effective fungicides for curative management of rust were clearly Bayleton and Banner MAXX, which are both from the demethylation inhibitor (DMI) class of fungicides. The balanced fertilizer treatment also significant decreased rust by the October 24th rating date.

Table 9: Rust severity on October 24th, 2014 following two applications of various curative fungicide and fertilizer treatments at Paul's Turf and Tree in Marshall, WI.

Treatment	Rust Severity ± Standard Deviation	Letter Group[a]
Non-treated Control	4.5 ± 0.70	A
Daconil WeatherStik	4.0 ± 0.70	AB
Bayleton	1.0 ± 0.70	C
Banner MAXX	1.3 ± 0.70	C
Compass	4.3 ± 0.70	A
Heritage TL	3.5 ± 0.70	AB
Urea Fertilizer (46-0-0)	3.0 ± 0.70	AB
Balanced Fertilizer (10-10-10)	2.5 ± 0.70	BC

[a]Means separated using Tukey's HSD test (P = 0.05).

Part V: Sod Industry Survey Responses

Ten questions were submitted to the Wisconsin and Illinois sod industry on March 27th, 2015 regarding the economic implications of rust management. The survey was designed and sent out once in 2015, and then again following implementation of rust management practices recommended as a result of this research. However, recommendations for integrated rust management have not yet been made to the industry because studies have either not yet been completed or they have only recently been completed. Eleven responses to the survey were received and are summarized below.

1) Has rust been a problem at your facility at any point in the last 5 years?
   Yes – 11 No – 0 Unsure – 0

2) Rust has been the most significant disease at my facility in the past 5 years.
   Strongly Agree – 4 Agree – 5 Neither Agree or Disagree – 1
   Disagree – 0 Strongly Disagree – 0

3) Rust seems to be getting worse at my facility.
   Strongly Agree – 1 Agree – 5 Neither Agree or Disagree – 3
   Disagree – 1 Strongly Disagree – 0

4) Approximately what percentage of your facility devoted to sod production has been affected by rust?
   <10% - 0 10-25% - 3 25-50% - 6 50-75% - 0 >75% - 1

5) Have you instituted any methods to control rust, such as using fungicides or altering fertilizer programs?
   Yes – 9 No – 1

6) If you answered yes to question 5, approximately how much did you spend on controlling rust in an average year?
   Responses: $5,000; $25,000; $1500; $5,000; $40/Acre; $1200; Minimal investment; Fertilizer & water & irrigation; $2,000

7) Approximately what percentage of your overall pest control budget (i.e. weed, disease, insect control) was devoted to rust control in 2014?
   Responses: 5-10%; 10%; 15%; 10%; 20%; 5%; 2%; $20,000; 5%

8) Was your program successful in controlling rust?
   Completely successful – 0 Somewhat successful – 8 No success- 1 No program - 1

9) Approximately how many acres of sod did you maintain in 2014?
   Responses: 650, 1200, 300, 100, 200, 110, 220, 400

10) What state is your facility located in?
   Responses: WI – 5; IL – 3; IN – 1; Cool-season area - 1

III. Goals and Outcomes Achieved

Most of this information is summarized above in Section II. Of the four objectives listed in the initial project proposal, two of them were completed.

- Identify the rust species associated with Kentucky bluegrass
  - Outlined in Part I above
- Evaluate current germplasm for relative rust resistance
  - Outlined in Part II above
- Evaluate mixtures of turfgrass cultivars and species as a means of rust management
  - This was not completed because the bluegrass cultivar selected for mixture with vrious rates of tall fescue was not susceptible to rust
- Investigate the influence of nitrogen sources on rust incidence and severity
  - This was not directly completed for the same reason as the previous point. However, information on urea vs a balanced fertilizer was obtained in multiple field projects as outlined above.

B. In addition to the above goals, additional field trials related to integrated management of rust were initiated (and some are still ongoing). Part III summarizes the impact of urea vs balanced fertilizer and contact vs penetrant fungicides as strategies for rust management, and Part IV summarizes strategies for curative rust management (which is how the majority of current sod producers manage rust at their sites. Both of these studies provide directly applicable results that sod producers can use to manage rust at their facilities. In addition, sod producers in Wisconsin and throughout the Midwest were surveyed on their current rust management strategies and how important rust is to their facility and the results are presented in Part V. The results from this survey provide additional rationale for why this project was completed in the first place. Once recommendations as a result of this project are implemented, the results of this survey (and potential additional surveys) can be used to document impact of this research.

IV. Beneficiaries

The primary beneficiaries are the sod growers of the Midwest, who will benefit for numerous reasons. First, they will understand that part of the reason rust is more problematic on their turf is due to an increasing ability of P. coronata to infect bluegrass. Second, they will benefit from

the knowledge that bluegrass cultivars from the Midnight family are highly susceptible to rust in the first year following seeding. This will use this information to inform breeders that they prefer cultivars from other families, which will allow them to use fewer fungicides and fertilizers for acceptable rust management. Lastly, they will benefit from additional knowledge surrounding management practices. While projects looking at species blending and nitrogen source were unsuccessful for this project, other studies investigating proper fungicide timing and product selection were more successful in providing valuable information for future integrated pest management strategies.

Other beneficiaries include turfgrass breeders, who now have additional knowledge about the types of rust infecting Kentucky bluegrass (and other turfgrasses) throughout the Midwest. This in turn provides them a more realistic view of the important pathogens present in the field, which they can incorporate into their own breeding screens.

A third beneficiary is the group of scientists who research rust disease. Turfgrass is the largest irrigated crop in the United States, and can have widespread and severe outbreaks. But the level of research into rust on turfgrasses has been almost non-existent in recent years, and it is our hope that this research contributes more broadly to the scientific literature surrounding rust diseases of cereals.

V. Lessons Learned

There were numerous lessons learned as a result of problems and delays throughout the project, many of which have been discussed in previous progress reports and earlier in this report. The most significant delays were largely the result of staffing changes. With both a PI change and a post-doc change related to this project, continuity was difficult to maintain and numerous delays related to the development of the molecular probes occurred. Developing and documenting more accurate procedures that could be easily understood by multiple people may have helped to alleviate some of the problems during the staff changes.

The most significant problems in the field studies were 1) variable rust severity from year to year and 2) the bluegrass variety selected as the susceptible variety for inclusion in planned projects on species mixing and nitrogen source turned out to be highly resistant to rust. Because of the absence of rust in these areas of the field plots, the studies investigating the mixing of tall fescue in with Kentucky bluegrass and the impact of nitrogen source on rust development were not completed. The lesson learned here was that we should have obtained more information and discussed with more people familiar in bluegrass development what cultivar would be resistant to rust and suitable for a control treatment.

VI. Additional Information

Rust tends to be most severe on turfgrass in the Midwest in August, September, and October. As a result, rust samples for identification will continue to be collected throughout the Midwest during the remainder of September and October of 2015. In addition, the various field studies discussed above that are still in place will continue to be rated through the end of October. These new results will be added to the results presented above and included in manuscripts that will be prepared for submission to peer-reviewed journals in the winter and spring of 2016. Results will also be disseminated to industry groups via trade journals, industry newsletters, and social media.

VII. Contact Info

Mark Lurvey
President
WI Sod Producers Association
P.O. Box W3411 Hwy 59
Whitewater, WI 53190
262-473-1999
lurveyma@idcnet.com

$

4) Expanding the market for CSA shares in Southern Wisconsin (FY12-004)

Report Date: December 10, 2014

I. Project Summary

A. The purpose of this project was to develop and launch creative outreach and marketing strategies to engage new members in Community Supported Agriculture (CSA) via the creation of a rural outreach marketing toolkit for farmers; workplace delivery host recruitment; and rural outreach and strategic partner development.

For 20 years CSA had been gaining in popularity in Southern WI, largely due to the existence of a coordinated coalition of growers, consumers and community partners. Coalition farms served between 10-1,500 member families, and marketed the majority of their shares in Madison or large metropolitan areas such as Chicago, Minneapolis or Milwaukee, often driving 2-4 hours to deliver their food.

Despite new farms adopting CSA each year as a model for farm viability and marketing, we had reached a plateau of CSA share sales from 2009-2011. Within the coalition, the number of CSA shares sold rose significantly between 2005 and 2009, averaging 35% growth each year, however, between 2009 and 2011, the number had increased only 10% despite the addition of 15 new farms to the coalition. Until the 2010 growing season, all FairShare CSA Coalition farms had reported sold-out shares annually. In 2011, 38% of farms did not sell out of available shares leaving over 1,000 shares unsold; an estimated value of $450,000 in specialty crop income not realized by Wisconsin CSA farmers.

There was clear evidence of the need for an infusion of new, creative marketing to take CSA information from the core membership of existing CSA members to a wider, broader audience of mainstream families.

B. This project did not build on a previous SCBG.

II. Project Approach

We successfully developed and piloted three strategies to build the market for CSA in Wisconsin.

Workplace CSA

Workplace CSA toolkit – In fall 2012, FairShare staff researched national workplace CSA programs and interviewed FairShare farmers and experienced workplace CSA coordinators to learn best practices for creating a robust workplace CSA program. We then compiled a draft workplace CSA toolkit that contained documents to assist companies in setting up their programs, so that when they contacted the Coalition, we had more to give them than the name of a farm. The toolkit now contains: a workplace CSA FAQ, a suggested implementation timeline, detailed general how-to steps, incentive suggestions, a price comparison of share contents as compared to the cost of the same organic food on the same day at all the major grocery stores in

Madison, a survey template, graphic templates, veggie cookbook suggestions, and newsletter articles.

We sent the documents to all companies who contacted us for workplace CSA throughout 2013 and 2014 (more than 40 businesses). Some of those companies worked with FairShare to set up their programs; others took the info and ran with it on their own.

In November 2014, we held a workplace CSA debrief with our piloting companies and plan to use their lessons learned to further update the toolkit. We will add graphics and formally release the toolkit via our website in January 2015. We will amend this report with the final toolkit when it's complete.

Collaboration with Aprilaire/Research Products - Beginning in Fall 2012, FairShare formed a strategic partnership with Bill Herman, HR director, and Emily Moenck, wellness coordinator, at Aprilaire/Research Products in Madison. Both were passionate, experienced CSA members in their personal lives, and their goal was to imbed workplace CSA within their company's broader wellness program as a key driver in improving employee nutrition. They joined FairShare as our initial pilot company, and together, we laid out a timeline, created a communications plan, and devised incentives for their employees, including payroll deduction (in addition to their health plan's CSA rebate). In winter 2013, FairShare staff gave several introductory CSA presentations to Aprilaire/Research Products employees, along with their partnering farmer, and the company marketed CSA to their employees over a 6-week period leading up to sign-ups. Their 2013 participation rate was a stellar 26%. In the 2014 season, despite a disappointing experience with their farm the previous season and needing to deal with the poor word of mouth and transitioning to a new farm in 2014, their Madison sign-up rate was still high, at 24%. They also expanded CSA to their Poynette facility.

Aprilaire/Research Products Participation Rates

Year	Location	Eligible Employees	# Signed Up	Sign-Up Percentage
2013	Madison	167	52	26%
2014	Madison	197	47	24%
2014	Poynette	100	6	6%

As Aprilaire/Research Products deployed different tactics and we watched what worked well, we were able to tweak our toolkit documents. We also created a Google Group for workplace CSA organizers to share their experiences and challenges. In addition, Aprilaire/Research Products presented with us at the WI Local Food Network's conference in January 2014 and we featured their work at the 2013 and 2014 Workplace CSA Meet and Greets for new workplace organizers (7 companies sent representatives to the 2013 Meet and Greet; all of them went on to create workplace CSA programs in 2014 and to join our project as piloting companies). Emily Moenck has also acted as a mentor to other wellness/HR professionals.

Overall FairShare work with workplace CSA:
2013 season – Worked with 1 pilot company, met with 6 additional companies (5 started programs) and provided limited assistance to 12 additional companies via email and phone calls.

2014 season – Provided extensive support to 14 pilot companies: 737 employees were involved in CSA through 14 workplaces in 2014 and purchased $256,076 in shares. 100% of companies rated their experience with their farm as "very good" or "excellent."
Employee Sign-Up Rates: Madison area average: 13.6% ; non-Madison average: 3.8%

2015 season – This fall, we have been working with the following companies to prepare programs for 2015: 3M in Prairie du Chien, Didion Milling in Cambria, Finley Hospital in Dubuque, Kwik Trip in LaCrosse, and First Choice Dental, Cascade Asset Management, and Turville Bay MRI & Radiation Oncology Center in Madison.

In addition, our pilot companies' plans for 2015 include:

- 2 are expanding to additional locations
- 2 are opening existing sites to the public
- 1 business is moving half their employees to a new location and isn't sure they'll have enough participants to reach the minimum for CSA deliveries to both locations, yet their farmer is committed to working with them
- 2 sites with low enrollment aren't certain they'll continue next year (LaCrosse County Health Dept. and Spacesaver)
- The remaining 7 pilot companies are planning to keep their programs pretty much the same in 2015.

Rural Outreach and Strategic Partnership Development – FairShare staff spent time in La Crosse, Viroqua, Oregon, Stoughton, Whitewater, Lake Mills, Oshkosh, and Soldiers Grove developing strategic partnerships with existing organizations, businesses and individuals interested in advancing local food initiatives in their community.

SE Dane County - In partnership with the Oregon School District, in 2013, we trialed a school-based outreach initiative and off-shoot CSA Open House. We estimate 2,500 individuals received detailed information about CSA farms serving their local community via flyers sent home in students' backpacks. However, the school-based CSA fair in 2013 was less successful with a low turnout (details in interim report), and was not replicated in 2014.
We partnered with Stoughton Hospital on their first Healthy Eating Fair in spring 2014 that was a de facto CSA Fair – 5 of our farms participated and FairShare staff gave presentations on making the most of CSA shares. The event was very well attended, as the hospital gave out several $100 CSA gift certificates as door prizes during the fair. We also tabled at the fall 2014 Stoughton Wellness Expo, which was lightly attended and primarily drew an elderly crowd. FairShare's large cycling fundraiser, Bike the Barns, in September 2013, started in Evansville and traveled through Stoughton and Brodhead, and was covered in the Evansville and Stoughton papers.

Jefferson County - In Whitewater, we developed a pilot farm-to-table dinner event to build on local farm and restaurant relationships and reach new local audiences with the message of CSA. Template outreach and promotional materials were developed and one dinner was hosted at The Black Sheep in Whitewater in partnership with two local farms. We held a second farm-to-table dinner in 2014 at the Edgewater Supper Club in Jefferson with the same two farms. We also

worked with Water House Foods in Lake Mills in November 2013 on a month-long promotion of CSA. A FairShare outreach volunteer also postered across Jefferson County and met with representatives at Jefferson County food pantries regarding FairShare's assistance program, Partner Shares. In addition, we partnered with Spacesaver in Ft. Atkinson as one of our pilot workplace CSA companies in 2014.

La Crosse - In fall 2013, FairShare staff connected with a nutritionist at the La Crosse County Health Department who introduced us to her workplace partners. We were able to start new workplace CSA programs at the University of Wisconsin-La Crosse campus and at Trane for the 2014 season. We supported existing programs at the La Crosse County Health Department and Mayo Clinic Health System, and laid the groundwork for a new program at KwikTrip's headquarters for 2015. We plan to offer a Workplace CSA Meet & Greet in the La Crosse area in winter 2015. Staff volunteered in summer 2013 and 2014 to precept Viterbo University dietetic students on CSA research specific to La Crosse; we attended Kwik Trip's employee fair to table for CSA in May 2014; tabled at the La Crosse Earth Day fair in April 2013 and 2014; and recruited Viterbo students to do CSA tabling at the Cameron Park Farmers Market in summer 2014. We also attended the first-ever CSA fair sponsored by the People's Food Co-op in La Crosse in January 2014, along with 5 of our farms that deliver to La Crosse. We also attended the initial meeting of the Coulee Food System Coalition in March 2013.

There is definite momentum for CSA in the La Crosse area with several CSA articles in the La Crosse Tribune and a new local-food publication by the Hilllview Urban Agriculture Center: "The La Crosse Area's Growing Experience," in which CSA is featured prominently (see article and our ad in section VI). In addition, Mayo Health Tradition Health Plan offers a $100 Healthy Eating rebate applicable to CSA shares – the only CSA rebate we know of outside of Madison. Since 7 of our farms have drop sites in LaCrosse and are located nearby, it is important to build on these new relationships and continue to outreach in this city.

Vernon and Crawford Counties - The committee of CSA farmers serving Crawford, Vernon and La Crosse counties determined the best way to proceed in building the market in their rural areas was to increase media coverage of CSA-focused events, and to initiate programs that bring more individuals to existing CSA farms to raise awareness and familiarity. Bike the Barns West was held June 30, 2013 and June 29, 2014; it visited 4 of our farms and attracted 200 riders total over the two years. The ride was widely covered in the local media, and will be replicated again in 2015.

One of our 2014 pilot workplace CSA companies was North Crawford School District, to our knowledge, the first school offering CSA to teachers, staff and families with a "school year" CSA share. FairShare staff met several times with their organizer and tabled at the Spring It On! Fitness event in Soldiers Grove in April 2014. FairShare staff attended MUNCH, a local food fair with 46 vendors, sponsored by the Fifth Season Co-op and held at the Viroqua Food Enterprise Center in February 2014.

Dubuque, Iowa - At this time, we are exploring the concept of CSA veggie prescriptions with Mercy Medical Center and workplace CSA at Finley Hospital in Dubuque, with additional

outreach through the Dubuque Wellness Coalition. We are also trying to develop new workplace CSA sites in Dubuque.

Farmer rural outreach toolkit and marketing – A draft farmer outreach toolkit was developed in winter 2013 and circulated to 48 FairShare farms to assist with local market presentations and farmer-initiated outreach to their farm community. At that time, the toolkit included 7 documents developed in response to requests for assistance in specific areas from FairShare farms gathered at the December 2012 annual meeting. We learned via our 2013 annual survey that 4 farms used the draft toolkit. We fleshed out the toolkit in response to more farmer feedback at the December 2013 annual meeting, then mailed all 49 farms a jump drive loaded with the toolkit in January 2014, in time for spring marketing. The toolkit now includes 21 files: the coalition's Farm Policy Manual, a customizable PowerPoint presentation template with instructions; Partner Shares info, graphics, publicity and media tools, general info on the value of CSA, and resources for farm websites. (See a complete list of files in Section VI.)

Also in response to our farmers' requests, we created graphic endorsement seals as a branding tool for farm websites and publicity materials – a popular addition to overall Coalition marketing. Farmers are using the seals on their websites and linking to the "About Our Farms" page on FairShare's website.

FairShare also coordinated a group T-shirt buy in February 2014. We hired a graphic designer to create three different CSA designs to which farms could add their logos. Eight farms participated in the buy and ordered 221 shirts. We plan to offer the buy again in 2015.

**At the start of this project, FairShare CSA Coalition had two non-specialty crop CSA members which made up less than 4% of its clients base. To ensure that no grant funds were used to pay for non-specialty crop beneficiaries, 4% of every expense billed to the grant was paid out of another funding source. The focus of all materials created was to promote specialty crop CSAs.

III. Goals and Outcomes Achieved

Workplace CSA

Goal: 5 businesses attend farmer/workplace meet and greet in Southern WI and receive logistical assistance in setting up workplace deliver sites, connecting with local farms and recruiting exmployee members; 2 businesses establish creative employee incentive programs.

Actual: Overall, the workplace CSA component of our project was very successful. We blew past our goal to outreach to 5 new workplace sites for 2014 and to assist with the establishment of at least one new workplace incentive or delivery site. We worked closely with 14 new sites in 2014 (see chart). We held Workplace CSA Meet and Greets for workplace CSA organizers in 2013 and 2014 (rather than meet ups between organizers and farmers. We introduced farmers and businesses, but typically did this one-on-one.)

> "FairShare was instrumental in WHEDA offering a Workplace CSA and in the successful roll-out of our program for our first year. Without FairShare, we wouldn't have even

thought about offering a Workplace CSA. Staff helped facilitate Lunch-n-Learn info sessions to drive enrollment, and how-to-use-your share and preservation sessions during the CSA season." ~ WHEDA

As for establishing new incentives, all of the businesses in 2014 used incentives. Among those offered were payroll deduction, free CSA cookbooks for enrollees, "share a share" programs for employees who wanted to try CSA for a week and, for 2015, we are working with a new company, First Choice Dental in Madison, considering a cash grant for employees who sign up for CSA (on top of their company health plan's CSA rebate).

Unusual champions

- *Government agencies* - Dane County Executive Joe Parisi offered workplace CSA at two county offices in 2014, utilizing 4 Dane County FairShare farms, and plans to expand the program to more sites in 2015. His office released a press release touting workplace CSAs (see Section VI) and has since publicly spoken about workplace CSA as an exciting new model for local food distribution and outreach. His support has made it easier to "sell" CSA at government offices where employees are concerned CSA would violate non-solicitation policies.
- *Schools as a delivery mechanism for CSA* - The North Crawford School District is piloting CSA in a very rural county (total pop. 16,397). The Madison Metropolitan School District headquarters offered CSA in 2014 and is considering expanding it to other school district facilities and possibly to schools.

New locations **-** When working with large companies with multiple locations, farms enjoy the potential benefit of easy expansion as the business adds new locations in subsequent years. For example:

Summit Credit Union has additional locations in Cottage Grove, Stoughton, Westport, Lake Mills, Beaver Dam, Baraboo, Portage, and Waukesha. They offered CSA at 2 locations in Madison this year and plan to add up to 2 more in 2015, eventually offering public drop sites at all of their locations.

Baker Tilly has offices in Janesville, Appleton, and Milwaukee, in addition to their Madison office. 2014 was a trial year; they are not planning to expand to other sites in 2015, but are considering it for 2016.

Wider outreach **-** FairShare staff have fielded workplace CSA info requests from across the country, including North Carolina, Colorado, Virginia, New York, Massachusetts and Oregon. In 2014, FairShare's workplace CSA initiatives were covered by WI Public Radio, WI State Journal, and the national food blog, Civil Eats (see articles in Section VI).

Strategic Partnerships and Outreach

While our work in LaCrosse was very effective, we feel the work in Jefferson County – despite good farm partners – was less impactful. There is overall less momentum for CSA and local food in Jefferson County, but it is still worth pursuing outreach there. Connecting with a local

champion/partner was crucial to us in getting our foot in the door in LaCrosse; we have not yet developed similar support for our work in Jefferson County.
Goal: Six local outreach events will be held in local farm communities (2 in year one and 4 in year two).

Actual:
2013 – Bike the Barns Driftless (Vernon and Crawford County); Oregon CSA Fair (Dane County), Water House Foods CSA promotion (Jefferson County); Farm-to-Table Dinner in Whitewater (Jefferson County); tabling with our farmers at the Earth Fair in La Crosse

2014 – Bike the Barns Driftless, MUNCH (Viroqua), Stoughton Healthy Eating Fair (Dane County), Farm-to-Table Dinner in Jefferson (Jefferson County), CSA Fair at the People's Food Co-op, tabling at the Earth Fair, ongoing CSA tabling at the Cameron Park Farmers Market, all in La Crosse

Goal: Develop creative mass media marketing campaign to engage new audiences in Community Supported Agriculture.
Actual: The original grant proposal contained a PR plan and rollout in collaboration with 270 degrees; that component was not funded. We did our best to generate grassroots publicity (see compilation of articles in Section VI).

Ice Age Trail Alliance volunteer work parties statewide - We began collaborating with the Ice Age Trail Alliance on a pilot project to supply fresh local food from our farms to feed volunteers at their 5-day volunteer trail building event in October 2014 near Roxbury. It went well; we co-promoted and FairShare staff attended the celebratory dinner to give a presentation on CSA. In 2015, we plan to feed more crews on Alliance projects across Southern Wisconsin. While this does not amount to a lot in sales, it could contribute to outreach as the Alliance draws volunteers from rural areas near the project sites.

Rural outreach through the farmer communications toolkit
Goal: One local marketing toolkit will be developed including sample press releases, introductory presentations, fliers, informative brochures, etc.
Actual: The toolkit contains 21 files that cover all of the above topics.

Goal: 25% of farmers will indicate using one of more of the toolkit materials in 2013 and 40% in 2014. Farmer surveys will be conducted in December of each calendar year using Google forms.

Actual: According to the 2013 FairShare annual survey of 46 farmers, only 4, or 8.7 percent, of surveyed farms downloaded and used the toolkit files; these farms together estimated they used the toolkit to reach 740 people. But 40 out of 46 farms in the January 2014 survey, or 87 percent, answered "yes" to "Are you interested in using our farmer toolkit to help you with outreach in the future?" We believe sending the files through the mail on a jump drive, after holding a session to introduce the files in December 2013, increased the likelihood that the tools were used in 2014. But we won't know the extent of toolkit use until we get back our 2014 annual survey, which goes out to farmers in January 2015. We have seen the endorsement seals on many of our farms' websites, so we suspect the toolkit use will be much higher for 2014.

We chose not to use Google docs for a separate survey, in favor of adding toolkit questions to the farmer annual survey. Perhaps we should have included evaluation postcards when we sent out the toolkits – self-addressed stamped postcards on which famers could have penciled in where and how they used the toolkit, audience numbers, and a space to submit suggestions. As we give jump drives to the 9 new farms joining the Coalition for 2015, we can experiment with the postcards.

IV. Beneficiaries

Our overarching goal with this project is to increase the sale of specialty crop CSA shares and to sell those to more mainstream families. FairShare's 2013 sales data showed an 18% drop from 2012 to 2013 (a staggering statistic and perhaps an anomaly); we won't know the sales totals for 2013-2014 until spring 2015. What we *do* know is that the sites we've worked with have added first-time CSA members to the fold. From site coordinator surveys, we've learned that between 75%-85% of workplace CSA participants are new to CSA. This means workplace CSA is a means of reaching more mainstream eaters, a key goal of this grant.

In 2014 alone, 714 people were involved in CSA via the 14 pilot workplace partners, with share sales of $256,076. Farms reported adding the equivalent of 6 full-time seasonal positions and spent $20,500 in infrastructure improvements (this figures is actually higher as one farm with significant workplace CSA sales did not list a dollar amount for their purchases). New workplace CSA sites were significantly more impactful for smaller farms, as evidenced by new workplace sites equaling a high percentage of their total CSA sales (see High Meadow Farm and Elderberry Hill Farm in chart). Twelve out of 49 FairShare farms worked with at least one company in the pilot -- 24% of Coalition farms.

The people who sign up for CSA aren't the only ones getting the CSA message; *it's everyone at the companies given the option of signing up for CSA*. In 2014, more than 10,570 employees learned about CSA through their workplace.

Farm Name	Infrastructure Addition	New hires	Workplaces	Empl. Part.	Shares	Amount	% of CSA revenue
Campo di Bella Mt. Horeb			City County Building. (Madison)	4	4	$1,707	8%
Driftless Organics Soldiers Grove			North Crawford School District (Soldiers Grove)	16	8	$2,680	< 1 %
Elderberry Hill Farm Waunakee		1 part-time	VA Hospital (Madison) Dane Cty Human Services Building (Madison)	37 41	26 30	$11,000 $12,500	Total: $23,500 46%
Equinox Community Farm, Waunakee			City County Building. (Madison)	15	10	$4,330	4.5%
Good Earth Farm, Oak Field			Winnebago County Health Dept (Oshkosh)	12	10	$5,000	4%
High Meadow Farm, Johnson Creek	New irrigation well, $10,000	1 full-time, 1 part-time	Summit (2 locations in Madison) Baker Tilly (Madison) **Spacesaver (Ft. Atkinson)**	50 39 14	39 30 14	$18,600 $13,200 $5400	Total: $37,200 50%
Keewaydin Farms, Viola			Duluth Trading Co. (Belleville)	13	6	$6,476	9%
Old Oak Family Farm, Bangor			LaCrosse Cty Health Dept.	13	9	$4,425	7%

Ridgeland Harvest, Viroqua	"New" old truck, $2,500		University of WI – LaCrosse Trane (LaCrosse)	52 17	42 14	$21,165 $6,425	Total: $27,590 14%
Small Family CSA Farm, Le Farge	New delivery van, $6,000	More worker shares; no new paid laborers	University of WI - LaCrosse	25	25	$13,625	12%
Sprouting Acres, Stoughton		2 part-time	Madison Metropolitan School District	51	25	$8,520	10%
Tipi Produce, Evansville			BonTon (Milwaukee)	51	33	$17,523	4.5%
VT Valley Community Farm, Blue Mounds			City County Bldg (Madison)	40	36	$18,200	1.9%
Westridge Produce, Blue River	New rain flow water wheel, transplanter, $2,000	1 full-time, 2 part-time	Sanimatic (Madison)	14	9	$4,950	7%
Wholesome Harvest, Jefferson	Farmer writes: "New tractor, new field equipment, smaller items, but hard to attribute how much is because of workplace CSA"	2 part-time	Aprilaire (aka Research Products) – (Madison) Madison Metropolitan Sewerage District WHEDA – (Madison) Meriter (5 locations) – (Madison)	55 18 44 126		$17,000 $7,000 $12,500 $43,850	Total: $80,350 17%
TOTAL	$20,500+	6 FTE		714		$256,076	Avg: 13.4%

Farmer comments:

"FairShare gave several presentations at the Dane County Dept of Human Services and the VA Hospital that helped answer employees' questions about how a CSA functions. The professional presentations and enthusiastic support added legitimacy to our CSA program."
~ Elderberry Hill

"FairShare's biggest contribution from our farm's point of view has been the word of mouth/marketing they can achieve beyond what we can. They seem to know who to speak with and where to look, which brings potential workplaces to our farm."
~ Wholesome Harvest

"FairShare is very helpful in the education that they provide to the workplace, and all of the leg work they do to meet with workplace coordinators." ~ Old Oak Family Farm

"The beginning stages are always hard. FairShare helps with taking the first step and approaching the site, as well as explaining how the CSA program works, so that we can just come aboard and provide the site with our products." ~ Westridge Produce

CSA as a community building tool at businesses – We learned of an unexpected positive benefit of workplace CSA. We repeatedly hear that administrators like the way CSA brings together employees from different departments and raises employee morale. Experienced members mentor the CSA newbies, employees swap veggies and share recipes, and it's easy for employees

to find someone to take over their box when they go on vacation. **As compared to the relative isolation of picking up a share at a neighborhood site, we believe employees are receiving more support, and are enjoying being CSA members more, by experiencing CSA as part of their work community**. This could impact CSA satisfaction and retention rates long-term. We'll know more in spring 2015 when our 14 piloting businesses share their spring sign-up rates for Year 2, and we compare the average workplace retention rate vs. the average retention rate for the farms.

Ease of partnering – In the right communities and with committed champions, local food/CSA is an easy sell. People are excited about the work being accomplished by FairShare and in Dane County in general, and want to learn how to replicate it in their areas.

V. Lessons Learned

Selecting where to focus - Looking at a map or population stats will only get you so far. You can't ignore culture, awareness, or momentum when choosing where to expand outreach. In the future, we need to consider requests fielded by our office, potential champions we meet from around the state who could be allies, *plus* farmer feedback when selecting where to invest staff time and energy.

Coordinating outreach with farmers - We need new models for how to coordinate with our farmer partners. We are currently working closely with two farms, Small Family CSA Farm and Two Onion Farm, to develop workplace CSA sites and new drop sites in DuBuque and Prairie du Chien. We work collaboratively weekly via free conference calls and Google Docs. The farmers have a lot of experience in this area as they have been trying to grow their shares in this region for years. It's a great combination to add a staffer to the mix, to make the initial asks as a non-profit organization.

Travel expenses and leveraging volunteers - While one-on-one meetings are invaluable in building relationships, the cost and time commitment of travel are prohibitive. As much as possible, we piggybacked travel – for example, meeting with our workplace CSA partners while in LaCrosse for the MOSES conference in 2014 – but we should have included funding for travel in our budget. Developing relationships with passionate outreach volunteers local to the areas we're working in has helped leverage our efforts, especially in La Crosse. Work early on in new areas to develop an outreach team of volunteers recruited from colleges, sustainability groups, or groups such as Slow Food; ask farmers to suggest members who might want to volunteer. Form the team in the beginning and create a networking/PR plan.

Long distance support vs. "local" support - Madison-area companies ranked FairShare's assistance in their workplace CSA program development as very satisfied to excellent. But in the LaCrosse area, all workplaces rated it as average. This reflected the difficulty in serving our far-flung partners. We need to arrange for more local support for workplaces outside of the Madison area. For example, in Madison, FairShare staff gave "How to Make the Most of Your Share" presentations in summer 2014 and facilitated food preservation workshops with a Master Food Preserver. We could have found equivalent locally-based volunteers to help at outlying

workplaces; or planned to give presentations ourselves if we could have stacked them all to occur over a day or two.

Cold contacts vs. personal relationships – We called and emailed dozens of companies to find ones interested in starting workplace CSA programs. We were much more successful (and efficient!) when we were introduced to an HR professional by a trusted community member. Only 31 percent of our pilot workplace CSA organizers were HR or wellness professionals; workplace CSA organizers can be anyone at the company passionate about CSA. Farm members can be great advocates for CSA and the catalysts for workplace CSA initiatives at their workplace.

Starting from the ground up – The importance of working from the grassroots, up! We learned you can't come into a new community as an unknown entity and put on an event about a topic people are unfamiliar with and expect a good turnout. You have to start from the ground up -- forming new relationships, introducing the topic of CSA, building interest, *and then* putting on your event.

Workplace CSA Partners – Two of our partnering businesses are sponsoring our organization and sending volunteers to help at our events – an added bonus!

VI. Additional Information

Workplace CSA Toolkit files (draft) compiled in one PDF and attached separately; available online at:
http://www.csacoalition.org/?p=15188

2013 and 2014 press regarding rural outreach and CSA compiled in one PDF and attached separately; available online at:

https://db.tt/kl1g6W2c

Farmer Communications Toolkit Contents file list (below)

Guide to FairShare's
Farmer Communication Toolkit

Hang onto your jump drive, bring it to the Annual Meeting in December, and we'll update your drive. The drives are 2GB; they can hold A LOT. Please contact Julie Garrett at (608) 226-0300 or julie@csacoalition.org. We welcome your feedback on the toolkit!

Farm Policy Manual

Presentations

- Farmer Toolkit PowerPoint – customizable PowerPoint – just drop in the info about your farms and shares
- How to Use the Farmer Toolkit PP

Partner Shares

- Partner Shares messaging for your website, brochures and more

Graphics

- Cookbook cover images (for selling via your website or order form)
- FairShare logos
- Customizable Lunch and Learn/Presentation Flyer
- "Sign Up for CSA" graphic
- FairShare Endorsement Seal

Publicity/Media

- How to Get Free Publicity for Your Farm
- CSA Intro Article for HR and Wellness Newsletters
- How to Write a Press Release
- CSA Fact Sheet
- Customizable press release for your local media

General Info on the Value of CSA

- 10 reasons to buy local
- 16 reasons to join CSA
- Farm Labor

For Farm Websites

-10 Ways to be a Good Farm Member
-CSA Menu Planning Resources
-History of CSA
- Is the CSA Model Right for You
- What to Expect as a CSA Member

VII. Contact Info

Chris Brockel
FairShare CSA Coalition
303 S. Paterson Street #1B
Madison, WI 53703
608-226-0300
chris@csacoalition.org

5) Cultivating alternative apple pollinators (FY12-005)

Report Date: February 25, 2015

I. Project Summary

Apples are a pollinator-dependent, specialty crop grown throughout much of Wisconsin. Historically, apple growers have relied on managed, non-native honey bees to meet their pollination needs. However, as honey bees become more expensive and difficult to obtain, the relative importance of native, wild pollinators increases. Wisconsin is home to over 400 species of native, wild bees, many of which are known to be effective pollinators of other crops. Preliminary results show that adequate apple pollination can be obtained with native, wild bees alone, but that pollination rates depend on the on-farm abundance of these wild bees.

Wild bee abundance and diversity may in turn be affected by on-farm management decisions and thus in part dependent on the actions of growers. In addition, the landscape around each farm may also affect the resources available to wild bees and thus affect their diversity and abundance within the farm. Our previous results suggested that wild bee abundance and diversity are positively impacted by wooded and diverse habitats surrounding an orchard. In this project, we continued to measure the pollination contributions of native, wild bees to apples and assessed how this contribution varied over different growing seasons and weather conditions. We also continued to evaluate the effects of pesticides, and began to assess how pesticide use and landscape features interact to impact wild bee abundance and diversity. The project additionally aimed to increase growers' awareness and knowledge of wild bees through the development of outreach materials and presentations. **The specific objectives of this research were to 1) continue to measure the pollination contribution of wild, native bees to apples and the season-to-season variability in this contribution, 2) continue to evaluate pesticide impacts on bees, with a focus on the influence of natural habitat as a refuge from pesticide exposure 3) begin to examine how pesticide exposure increases bees' susceptibility to diseases and parasites.**

Overall, the outcomes of this research will enable growers to make better decisions regarding their need for managed pollinators and will enhance their ability to take management actions that conserve wild bees for pollination. The sustainability of apple growing throughout Wisconsin can increase with a greater dependence on wild bees as pollinators.

B. This research built on the previously funded project in FY2011, "Cultivating alternative apple pollinators: Enhancing the sustainability of apple production through conservation and use of wild bees". The objectives of that project were 1) To determine the extent to which native, wild bees provide pollination services to apples and to assess whether full pollination can be achieved with wild bees alone, 2) To determine how agricultural management affects native, wild bees. Specifically, to examine the effects of pesticide use and apple blossom density on wild bees and levels of apple pollination, and 3) To characterize the floral resources used by wild bees that pollinate apples.

Our results from the previously funded project showed that 1) Orchards with higher native, wild bee species richness had higher apple fruit set, but that managed honey bees did not increase apple fruit set, 2) There were no significant differences in bumble bee colony growth, health, or reproductive output at organic compared to conventional orchards, and 3) Wild bee species richness within the orchard was positively related to the diversity of the landscape surrounding the orchard, indicating that diverse landscapes provide a more abundant and diverse supply of flowers to support a diverse wild bee community.

This research built on the previously funded project by 1) Continuing to examine if wild bees alone can provide adequate apple pollination across multiple years and varying weather conditions, 2) Exploring differences in foraging behaviors between wild bees and honey bees in order to explain and predict their efficacy as apple pollinators, 3) Developing orchard toxicity scores from growers' spray records over a 3-year period and examining the relationship between these toxicity scores and wild bee abundance and diversity, as well as bumble bee colony growth and reproductive output. This research therefore collected additional years of data in order to strengthen and support our conclusions, and furthermore explored new aspects of bee foraging behavior, pollinator efficacy, and the effects of pesticides on bees that expanded upon our previous findings.

II. Project Approach

Objective 1: To continue to document the overall contribution that wild bees make to pollination and the season-to-season variability in this contribution.

Activities and tasks performed: In 2013, in order to assess the contribution of honey bees versus wild bees to apple pollination, we selected twelve orchards using managed honey bees for pollination and seven orchards with no managed honey bees on the farm property**. Project partner Wisconsin Apple Growers Association assisted in selecting the participating orchards.** At each orchard, we measured fruit set as the proportion of flowers per tree that became fruit on each of ten trees. Additionally, in order to assess the dependence of apples on animal pollinators, we measured fruit set within fine mesh bags made from bridal veil, which is impermeable to even the smallest insects, on each of the ten trees per orchard. In order to measure bee abundance and diversity at each orchard, we sampled both wild bees and honey bees during the apple bloom period (May 2013) using bee traps elevated in the apple canopy. All bees were processed and identified to species.

In 2014, in order to assess the pollinator efficacy of honey bees versus wild bees, we examined three aspects of foraging behaviour that determine bees' ability to effectively pollinate apples: floral preferences, resource collection (nectar only vs. pollen), and cross-tree movement. To assess floral preferences, we observed bee visitation rates to apples and competing dandelions, which bloomed at the same time in May 2014, within five orchards in south-central Wisconsin. We compared the preferences of honey bees to the preferences of wild bees. We additionally captured 26 honey bees and 33 wild bees at these same five orchards and recorded whether or not the captured bees had pollen in their scopae (pollen carrying device) as an indication of active pollen collection. Bees actively collecting pollen are more likely to contribute to pollination as compared to bees that collect only nectar. Finally, at the Peninsula Agriculture

Research Station, we observed the foraging patterns of honey bees and wild bees by recording the number of sequential visits an individual bee made to the same tree, as well as sequential visits made to trees within the same row. Since apples require the transfer of pollen between trees of different varieties, bees that make repeated visits to flowers on the same tree, or to flowers on neighboring trees of the same variety, are less likely to cross-pollinate compared to bees that frequently move among trees and across tree rows.

Significant results:

Combining data collected across three years, including 2011-2013, we found that the use of managed honey bees does not increase apple fruit set (apple fruit set did not significantly differ between orchards with and without honey bees ($F_{1,28} = 0.09$, $P = 0.77$, Figure 1)). On average, apple fruit set was 13% on branches open to animal pollinators, but only 0.9% on branches closed to animal pollinators, indicating that apples are highly dependent on pollinators. While apple fruit set did not increase with the use of managed honey bees, the abundance of honey bees ($P = 0.13$), or the abundance of wild bees ($P = 0.30$), apple fruit set increased significantly with the species richness of wild bees found in the orchard during bloom ($P = 0.003$, Figure 2).

Honey bees showed a significant preference for apple blossoms over dandelion blossoms, while wild bees showed a significant preference for dandelions over apples ($F_{1,83} = 4.4$, $P = 0.04$, Figure 3). The wild bees observed visiting both dandelions and apples included mining bees *Andrena spp*., and sweat bees *Lasioglossum spp*. However, wild bees were significantly more likely to collect pollen (77%) as compared to honey bees (40%) (Chi Square = 7.85, df = 1, $P = 0.005$). Wild bees, in particular mining bees and sweat bees, also made significantly fewer sequential visits to a tree before moving to a different tree as compared to honey bees ($t_{78} = -4.66$, $P < 0.0001$, Fig. 4).

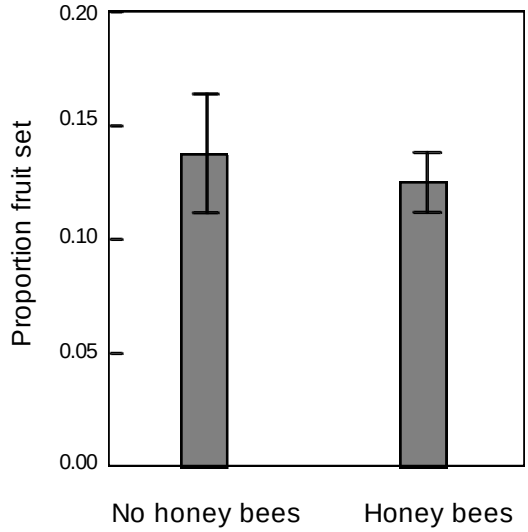


Figure 1. Proportion fruit set at orchards with and without honey bees measured over 3 years, 2011-2013, at orchards in southern Wisconsin.

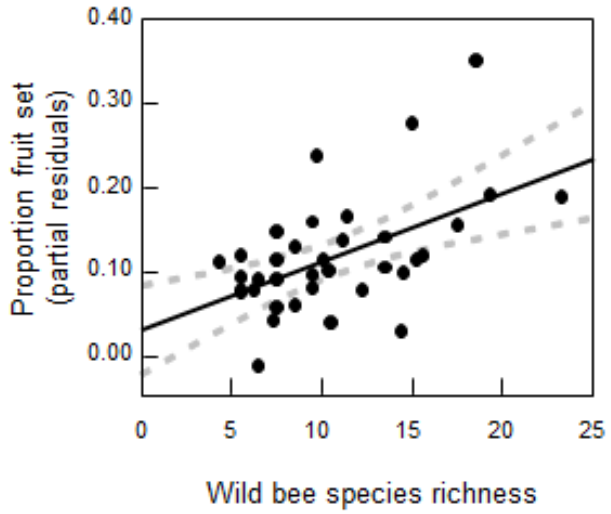


Figure 2. The effect of wild bee species richness on proportion fruit set, after accounting for frost damage, measured over two years, 2012 – 2013, at orchards in southern Wisconsin.

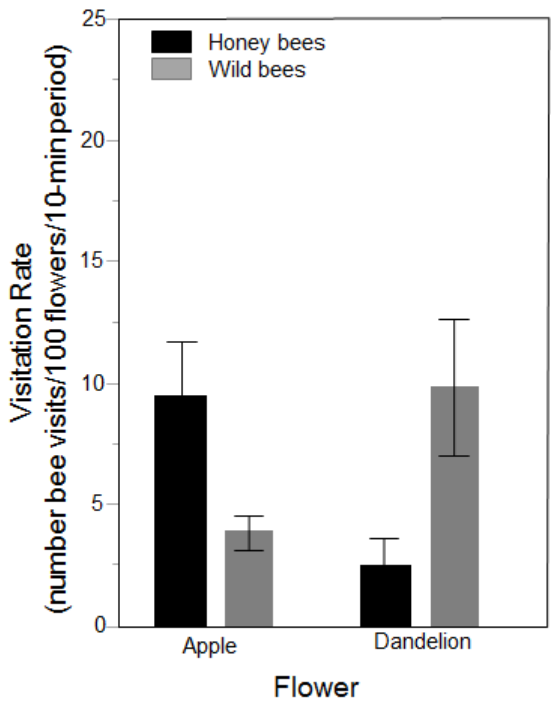


Figure 3. Visitation rates made by honey bees and wild bees (including *Andrena spp*. and *Lasioglossum spp*.) to apple flowers and understory dandelion flowers, which bloomed at the same time during May 2014. Observations of visitation rates were conducted at five apple orchards in southern Wisconsin.

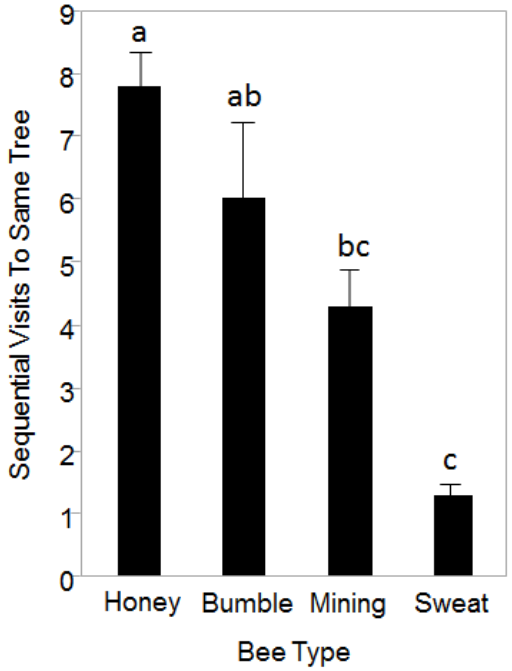


Figure 4. The number of repeated, sequential visits to flowers on a single tree made by individual bees belonging to four different taxonomic groups: honey bees *Apis mellifera*, bumble bees *Bombus spp*., mining bees *Andrena spp*., and sweat bees *Lasioglossum spp*. Significant differences among groups are noted with different letters.

<u>Conclusions and recommendations:</u>

We conclude that the majority of apple farmers in Wisconsin can rely solely on wild bees for pollination and do not need to manage or rent honey bees. Managed honey bees do not increase apple fruit set, either because all orchards have enough wild bees such that adding managed honey bees results in no further increase, or because honey bees are ineffective pollinators.

We found some significant differences in the foraging behaviors between honey bees and wild bees that suggest honey bees are ineffective pollinators. Honey bees frequently collect only nectar, thereby removing and depositing less pollen as compared to wild bees, the majority of which actively collect pollen. Additionally, honey bees tend to forage systematically, making repeated visits to a single tree and moving along tree rows. Wild bees, on the other hand, make few sequential visits to a tree before moving to a different tree, and do not frequently move along single-variety tree rows. Therefore, wild bees are more likely to cross-pollinate between trees of different varieties.

However, we did find that wild bees prefer dandelions over apples while honey bees prefer apple blossoms. Therefore, growers should consider mowing dandelions during apple bloom in order to reduce floral competition. As most bees are generalists, their foraging behaviors can change with the relative availability of different flowers. If dandelions are removed during apple bloom, wild bee visits to apple flowers may increase.

Finally, since wild bee species richness was the most significant factor positively affecting apple fruit set, growers should take actions to conserve the wild bee community. Previous results found that landscape diversity surrounding the orchard positively affected wild bee species richness within the orchard. Therefore, by maintaining a diversity of land-cover types around the orchard, including woodlands, open grasslands, as well as agriculture and urban habitat, growers may be able to conserve a species rich wild bee community.

Objective 2: Continue to evaluate pesticide impacts on bees, with a focus on the influence of natural habitat as a refuge from pesticide exposure

Activities and tasks performed: In 2013, we selected nine organic orchards (using only certified organic pesticides) and thirteen conventional orchards (practicing a range of pest management intensity) in order to study the effects of pesticides on bees. At all orchards, we sampled wild bees during the apple bloom period using elevated bee bowl traps. All bees were pinned, processed and identified to species. We additionally collected spray records from all orchards and developed season-long toxicity scores for each orchard. These toxicity scores multiplied the "bee score" listed in the Environmental Impact Quotient database (Kovach et al 1992) by the application rate for every pesticide applied in the orchard (including fungicides, herbicides and insecticides) and summed across the entire growing season. We then analyzed the relationship between orchards' toxicity scores and wild bee abundance and species richness.

Additionally, within each orchard, we deployed sentinel bumble bee colonies for the 2013 growing season. Each colony was placed at the edge of the orchard bordering natural habitat (woodland, wetland, or open grassland). The colonies remained in the orchard for four months, at which time they were brought back to the lab for analysis. We measured various aspects of colony growth and reproductive output including the production of new queens, or gynes, the production of non-queens (workers and males), colony weight gain from the time of deployment to the time of collection, and average worker body size. We examined metrics of bumble bee colony growth and performance as a function of orchard toxicity scores. We additionally analyzed the relationship between colony performance and the amount of natural habitat in the surrounding landscape.

Significant results:
Conventionally managed orchards had significantly higher toxicity scores (8,953 ± 987) compared to organic and no-input orchards (3,901 ± 1119) (t_{46} = -3.38, P = 0.002), though there was high variability in the toxicity scores of both groups. There was no significant relationship between the abundance and species richness of all wild bees captured within orchards during bloom and orchard toxicity scores ($F_{1,35}$= 0.01, P = 0.91; $F_{1,37}$= 0.10, P= 0.76, respectively). However, orchards with higher toxicity scores had significantly fewer small-bodied bees ($F_{1,44}$= 6.0, P =0.02; $F_{1,39}$= 6.4, P =0.02, respectively, Figure 5).

At orchards with high toxicity scores, sentinel bumble bee colonies also produced fewer bumble bee workers and males ($F_{1,12}$=6.4, P =0.03, Figure 6). However, there was no significant relationship between orchard toxicity scores and the production of new queens ($F_{1,20}$=0.06, P =0.81), or colony weight gain ($F_{1,17}$=0.10, P =0.76). Additionally, there was no significant effect of the amount of natural habitat surrounding the orchard on the production of workers and males

($F_{1,10}$=0.11, P =0.74), new queens ($F_{1,10}$=0.64, P =0.44), or colony weight gain ($F_{1,10}$=0.15, P =0.71), and there was no significant interaction between the amount of natural habitat and orchard toxicity scores for any of these bumble bee colony performance metrics ($F_{1,21}$=0.66, P =0.42; $F_{1,21}$=0.41, P =0.53; $F_{1,19}$=0.24, P =0.63, respectively), indicating that the value of natural habitat did not vary with orchard pest management intensity.

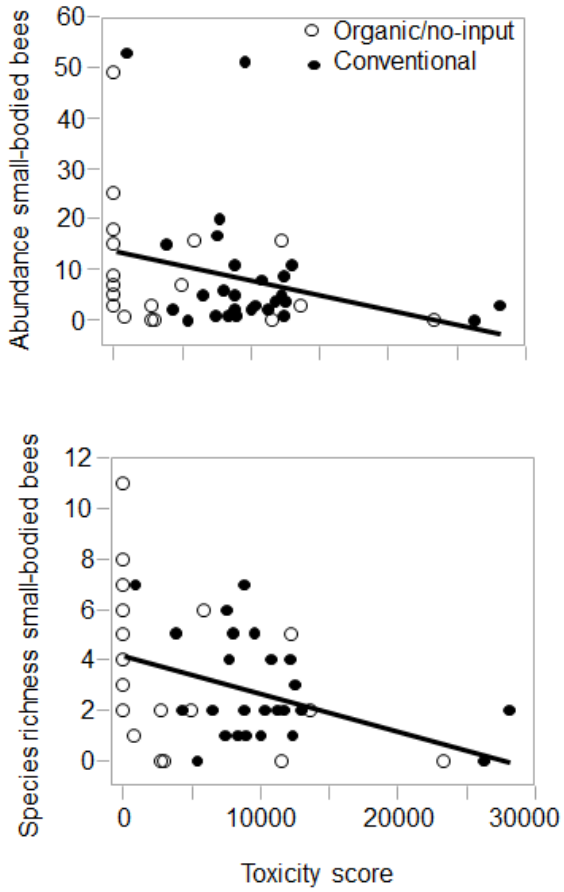


Figure 5. Relationship between orchard toxicity score and the a) abundance and b) species richness of small-bodied bees, *Lasioglossum dialictus spp*., sampled during the apple bloom period in 2010, 2012, and 2013 within orchards varying in pesticide inputs.

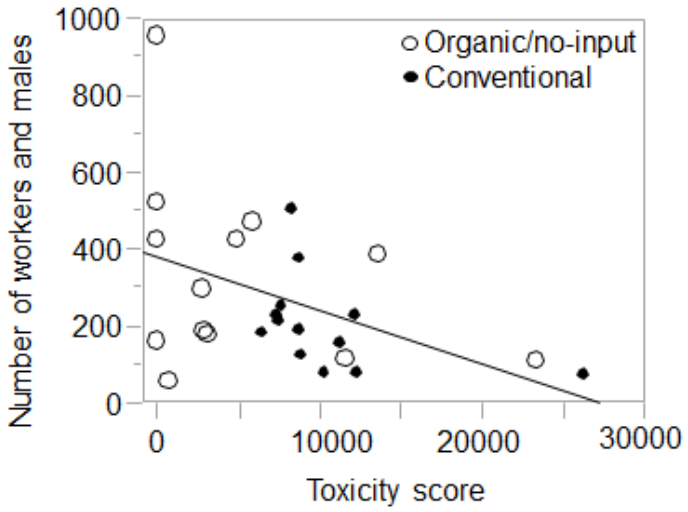


Figure 6. Relationship between orchard toxicity score and the combined number of workers and males produced by colonies of *Bombus impatiens* that were placed at orchards varying in pesticide inputs over the 2012 and 2013 growing seasons.

Conclusions and recommendations:

Orchard pest management did not significantly affect the abundance or diversity of wild bees that were active during apple bloom. Therefore, conventional orchards practicing high intensity pest management may still have a relatively high abundance and diversity of wild bees as compared to orchards practicing integrated pest management or organic pest management. The lack of a relationship between orchard toxicity scores and wild bees may be due to a few factors 1) Growers are already practicing best management practices to avoid bee exposure to pesticides, such as spraying very early or late in the day, or removing flowers in the orchard prior to pesticide application, 2) Many wild bees do not forage throughout the entire growing season, and therefore have only limited exposure to the pesticides applied during their periods of activity, and 3) Bees may be foraging outside of the orchard for much of the growing season, thereby reducing exposure to orchard pesticides.

However, we did find significant, negative effects of orchard toxicity on a few subgroups of bees. Orchards with high toxicity scores had fewer small-bodied bees, perhaps because small body size makes them more sensitive to pesticides, or because they have short foraging ranges that restrict their foraging activity to the orchard. Additionally, bumble bee colonies produced fewer workers and males, which could significantly affect colony viability and bumble bee population growth rates. Therefore, we conclude that orchard pesticide use has a strong potential to affect certain bees that are more sensitive to within-orchard pesticide applications, including small-bodied bees and social bees such as bumble bees. Growers should whenever possible use pesticides that are lower in toxicity to bees, practice integrated pest management to reduce their total number of pesticide applications, and reduce bee exposure by spraying at night and outside of bloom.

Objective 3*:* Begin to evaluate how exposure to pesticides affects wild bees' susceptibility to disease and parasites.

Activities and tasks performed:
From all bumble bee colonies collected in 2012 and 2013 (see objective 2 for method details), we measured the presence of external parasites or pests within the colony. We counted and identified all external parasites, which included beetles, moths, earwigs, ants, and wasps. We correlated the number of parasites/pests to the pesticide toxicity scores as detailed above in objective 2.

Significant results:
The most common external parasite/pest was the wax moth, which was found in the majority of colonies. No other external parasite or pest was frequent enough to statistically analyze. We found no significant effect of orchard pesticide toxicity scores on the abundance of wax moths within bumble bee colonies. Instead, wax moth abundance was significantly, positively correlated with colony size or weight ($P = 0.0002$).

Conclusions and recommendations:
We found no effects of orchard pesticide toxicity scores on the abundance or presence of external parasites within bumble bee colonies. Instead, the abundance of wax moths, the primary external parasite, was significantly related to colony size. Larger colonies are probably more attractive to parasites and pests, with larger stores of honey, as well as more larvae and wax, and may thus have higher parasite loads. Since orchards' pesticide toxicity scores had no significant effect on colony size (weight gain), they in turn had no effect on colony parasite load.

Orchard pesticide toxicity scores may have subtler or longer-term effects on bee immunity, individual bee and colony health, and population growth rates that we were unable to detect. Our study did not follow bumble bees over multiple generations, for example. Furthermore, due to the difficulty and cost of the procedures, we were unable to measure internal pathogens or parasites in bumble bees. We thus conclude that while we saw no evidence of orchard pesticide use affecting bumble bees' defense against external parasites, we still do not know how pesticides affect susceptibility to internal pathogens.

Outreach activities:

1. Results were presented at 3 grower meetings, including the 2013 and 2014 Annual Fruit and Vegetable Growers Conferences, and at the 2014 Peninsula Agriculture Research Station Fruit School.
2. Results were published in the January 2015 edition of Fresh Magazine (distributed to specialty crop farmers of Wisconsin and the Upper Midwest).
3. Individual reports were sent to all 35 apple growers that participated in the study during both the 2012 and 2013 growing seasons.
4. We developed an online pollinator identification tool designed for farmers and the general public to identify and learn about spring pollinators of crops such as apples: http://energy.wisc.edu/bee-guide/. A downloadable PDF hard-copy version of the bee guide was added to the website in response to public demand.
5. Research was also presented at scientific conferences, including the 2013 and 2014 Entomological Society of America annual conferences, and the 2013 Ecological Society of America annual conference.

6. Results from objective 1 have been published in a peer-reviewed journal: R.E. Mallinger and C. Gratton. Diversity of wild bees, but not the use of managed honey bees, increases fruit set of a pollinator-dependent crop. *Journal of Applied Ecology*. In press: http://onlinelibrary.wiley.com/doi/10.1111/1365-2664.12377/abstract

III. Goals and Outcomes Achieved

The overall goals for this research were to directly benefit apple growers throughout Wisconsin by 1) Enabling growers to make more informed decisions regarding their need for managed honey bees, thereby saving money on honey bee rentals and management costs, 2) Increasing the sustainability of apple farming through a greater reliance on wild, native bees for pollination as opposed to managed, honey bees, and 3) Providing information on the effects of orchard pest management on bees in order to help farmers make management decisions to conserve wild, native bees.

To achieve our first goal, we conducted the activities and tasks described above for objective 1. The results and conclusions obtained through these activities (see above) directly address our goal of providing information to help growers make more informed decisions re. their need for managed honey bees. Our second goal is longer-term. We have made progress on that goal by sharing our results at numerous grower and scientific conferences, and through both outreach and research publications. We have since talked to a few apple farmers that 1) have reduced or eliminated their reliance on managed honey bees and 2) put in wild bee habitat, including floral plantings and nest boxes. Furthermore, we have been asked by 3 different orchard growers to give on-farm assessments of the wild bee community and conservation recommendations. We therefore believe that substantial progress has been made towards increasing apple farming sustainability through reliance on, and conservation of, wild bees. To achieve our third goal, we conducted the activities and tasks described above for objectives 2 and 3. The research results obtained through these activities (see above) directly address the impact of orchard pest management on bees. Furthermore, our outreach activities have shared these research results with the grower community.

B. Proposed activities for objective 1:

1. Examine pollination rates at orchards with and without honeybees.
2. Correlate pollination rates with the abundance and diversity of wild, native bees as collected in bee bowl traps.
3. Determine the pollination efficacy of multiple wild bees and compare to honey bees.

Actual accomplishments for objective 1:

1. Pollination rates (fruit set) were measured and compared at orchards with and without managed honey bees in both 2012 and 2013.
2. Pollination rates (fruit set) were correlated with the abundance and diversity of wild, native bees as collected in bee bowl traps, as well as with the abundance of honey bees, in both 2012 and 2013.
3. The foraging behaviors of different wild bees were compared to honey bees in order to assess the pollinator efficacy of these bees during apple bloom 2014.

Our actual accomplishments for objective 1 closely match the proposed activities. The results and conclusions obtained through these accomplishments (see above) directly address the performance goals: 1) Enabling growers to make more informed decisions regarding their need for managed honey bees, thereby saving money on honey bee rentals and management costs, 2) Increasing the sustainability of apple farming through a greater reliance on wild, native bees for pollination as opposed to managed, honey bees.

Proposed activities objective 2:
1. Sample wild bee abundance and diversity at multiple orchards varying in pest management approaches and overall toxicity of applied pesticides.
2. Measure bumble bee colony growth, reproduction, mortality and fat content at sites with high toxicity scores (from previously collected records) but that vary in landscape structure.

Actual accomplishments for objective 2:
1. Wild bee abundance and species richness were sampled with bee bowl traps at orchards varying in pest management practices during apple bloom of 2012 and 2013.
2. Sentinel bumble bee colonies were placed at orchards, and reproductive output (number of new queens), colony growth (number of workers), and individual bee health (worker size) were measured at the end of the growing season.
3. Toxicity scores were developed for all orchards using 2012 and 2013 spray records. The percent natural habitat surrounding orchards was also measured for each orchard in 2012 and 2013.

Our actual accomplishments for objective 2 closely match the proposed activities. The results and conclusions obtained through these accomplishments (see above) directly address the performance goal: Providing information on the effects of orchard pest management on bees in order to help farmers make management decisions to conserve wild, native bees.

Proposed activities objective 3:
1. Collect bumble bees from the colonies used in 2012 and 2013 and examine the bees for infection with pathogens and parasites.

Actual accomplishments for objective 3:
1. Bumble bee colonies from 2012 and 2013 were analyzed for external parasites. The abundance and presence of external parasites within each colony were correlated with orchard toxicity scores.

The actual accomplishments for objective 3 were to meet the performance goal: Providing information on the effects of orchard pest management on bees in order to help farmers make management decisions to conserve wild, native bees. Specifically, our objective was to examine how orchard pest management affects bees' susceptibility to parasites and pathogens. While we accomplished a portion of that objective by examining external parasite loads in bee colonies (see above for results and conclusions), we were unable to measure the abundance or presence of internal pathogens in individual bees due to the difficulty and cost of identifying such pathogens.

IV. Beneficiaries

Farmers: Research results, including site specific results, were disseminated to approximately **22 apple growers** who participated in this study in 2013. Results specific to each orchard, such as the on-farm abundance and species richness of wild bees, can help growers decide whether or not to rent honey bees, potentially saving growers $700 - $7,000 ($70/hive * 1 hive/acre * 10-100 acres). Research results were also presented to **approximately 300 apple growers** at the 2013 and 2014 Wisconsin Fruit and Vegetable Conferences, and to a different group of approximately **100 fruit growers** at the 2014 Peninsula Agriculture Research Station Fruit School. These presentations have the potential to impact growers' management practices, encouraging the preservation of diverse and natural habitats for wild bees, or reducing pesticide impacts through low-toxicity sprays, integrated pest management, and reducing bee exposure. Additionally, research results and conservation recommendations were written in an article of *Fresh Magazine*, which was distributed to over **1,000 specialty crop farmers** in January 2015**.**

General public: This research also lead to the development of an online guide to identifying Wisconsin's wild bees. As of January 20, 2015, this guide has received **46,440 visits**, many of which were likely members of the general public in Wisconsin or the upper Midwest. Additionally, public presentations on wild bees, including research results from this project, and related conservation recommendations, were made to approximately **100 people** at "Wednesday Nite @ the Lab" on UW-Madison campus in March 2014, to approximately **50 people** at Kemp Natural Resources Station in Woodruff WI in July 2014, and to approximately **75 Master Gardeners** in Wood County in October 2014.

Academic community: Research presentations were made to approximately **225 (75*3) entomologists and ecologists** at the 2013 and 2014 Annual Meetings of the Entomological Society of America, and at the 2013 Annual Meeting of the Ecological Society of America. Results generated by this project were published in a peer-reviewed journal (Journal of Applied Ecology), which has received **83 tweets from 74 accounts**, 74% of whom identify as members of the general public, 20% of whom identify as scientists, and 5% of whom identify as science communicators.

V. Lessons Learned

This project generated many research results and conclusions of high interest, applicability, and economic significance to the apple grower community as well as the general public. We had many more opportunities to share our work than we initially expected due to this interest; for example, we were invited to speak at a number of grower conferences, public outreach events, and interviewed by radio and newspaper media. We were able to carry out the majority of our proposed activities for objectives 1 and 2, even including additional activities for objective 1 in the second year of the project (2014). While our results did not always match our hypotheses, particularly for objective 2, we were still able to explain our results and provide recommendations to the grower community.

We faced many challenges in conducting field research for this project. Unpredictable weather, yearly and even daily fluctuations in wild bee populations and activity, unintentional interference from growers, and unexpected costs all affected the quality and quantity of data that we were

able to collect over the years. Specifically, for objective 3, we were unable to fully carry out the proposed activities due in part to their high costs and also due to the poor quality of bee specimens that we collected at the end of the growing season. We learned that is important to anticipate such challenges, prepare for the worst, and have back-ups (more than enough replicates, extra time, multiple growing seasons, etc). We additionally learned that having a multi-year study is important. Not only does it provide a buffer in case one year of research does not go as planned, data and results are stronger if collected over multiple years and in different conditions.

VI. Additional Information

Peer-reviewed publication:

R.E. Mallinger and C. Gratton. 2015. Diversity of wild bees, but not the use of managed honey bees, increases fruit set of a pollinator-dependent crop. *Journal of Applied Ecology.* In press.

Wisconsin Wild Bee Guide:

https://energy.wisc.edu/bee-guide/

Fresh Magazine Article:

http://www.waga.org/images/freshmagazine1-15_lowres2.pdf

Media:

Native pollinators step up (2014, August 21) retrieved 20 February 2015 from http://fyi.uwex.edu/news/2014/08/21/native-pollinators-step-up/

Hundreds of Native Bee Species Can Also Pollinate Crops (2014, July 27) retrieved 20 February 2015 from http://wxpr.org/post/hundreds-native-bee-species-can-also-pollinate-crops

What's the buzz? Online bee guide features Wisconsin pollinators (2013, November 15) retrieved 23 January 2015 from http://phys.org/news/2013-11-online-bee-features-wisconsin-pollinators.html

Online guide provides the A-Bee-C's of bee identification (2013, November 21) retrieved 23 January 2015 from http://www.thegrower.com/news/Online-guide-provides-the-A-Bee-Cs-of-bee-identification-232879041.html

VII. Contact Info

Anna Maenner
Executive Director
Wisconsin Apple Growers Association
2011 Canal Road
Waterloo, WI 53594
920-478-3852
anna@acmadmin.com

6) Refined pest management strategies for ginseng (FY12-006)

Report Date: August 31, 2014

1) Project Summary

The primary focus of the project was to reduce the overall amount of pesticides (fungicides/insecticides) applied to ginseng each year that are identified by FQPA as high risk while introducing newly registered chemistries to growers. This goal was to be reached through three objectives: 1.) Implement reduced-risk, pest management programs that reduce the amount of pesticides applied to ginseng, 2.) Incorporate at least one newly-registered product into their pest management programs by the completion of the study, and 3.) Investigate the potential for increased disease and insect resistance in ginseng while using vermicompost and anaerobic digestate solids mulch. Several new fungicides effective against ginseng pathogens have been registered in recent years, however the growers were not familiar with these new products and their effectiveness. Introducing growers to these new fungicides and disseminating important information (new pesticide registrations, disease/insect updates) to growers were specific needs in this industry.

2) Project Approach

To determine the effectiveness of newly registered or soon to be registered fungicides, field trials were placed at grower cooperators' ginseng gardens in Wisconsin in 2013 and 2014. Growers are becoming more aware of the newly registered fungicides, however, due to the high disease pressure observed in 2013, the efficacy of these products were questioned. One trial was conducted to determine the effectiveness of biopesticides for the control of root rot pathogens on ginseng seedlings. This trial included comparisons of industry standards and biopesticides applied alone and rotational programs (Tables 1 & 2). A trial was conducted on 3-year-old ginseng gardens to determine if applications based on environmental conditions could reduce the number of applications applied over a growing season while still providing adequate protection from Alternaria blight (Table 3). The overall goal of using environmental data to trigger fungicide applications is to reduce the amount of applications when disease pressure is at is lowest and hence lower the overall amount of pesticides applied per acre per year. A greenhouse trial was conducted to determine the effectiveness of drench applications of a newly registered, reduced-risk fungicide when compared to industry standards (Table 4).

On August 9, 2013 ~80 growers attended the annual Ginseng Research Field Day. All of the fungicide trials described in this report were highlighted by Dr. Hausbeck and growers were able to observe the results first-hand. An explanation of Disease Severity Values (DSVs) and the equipment used to monitor the environment were presented to growers. North Central Regional IR-4 Coordinator Dr. Satoru Miyazaki updated growers on the status of product registration and current projects. At the luncheon growers filled out and returned the pesticide use survey.

The results of this research were presented at the winter ginseng growers' meeting held in Wausau, WI on March 22nd, 2014. Over 150 growers and industry representatives attended the

all day meeting and break out sessions were available for the Hmong grower community (interpreter provided). Along with research results, growers were given information on currently labeled products and sprayer technologies.

3) Goals and Outcomes Achieved

To achieve the project goals, biocontrol products were tested against industry standard fungicides for their ability to control root rot pathogens of ginseng. This study was conducted at a ginseng garden provided by a cooperator in Marathon County, WI on ginseng seedlings grown under 80% shade-cloth. Beds were 4 ft wide with 1 ft between beds. Treatment blocks consisted of a 10-ft bed with a 2-ft buffer on each end. Treatments were replicated four times in a randomized complete block design. Weed control and fertilization were made according to commercial production standards. Treatments were initiated on 29 May when ~80% of the plants had emerged from the straw mulch. Labeled products were applied based on label instructions, and experimental products were applied based on registrant recommendations. Captan 80WDG was applied with a CO_2 backpack boom sprayer equipped with four T-Jet 8006VS flat fan nozzles spaced 18 in. apart, operating at 30 psi, and delivering 150 gal/A. Ridomil Gold G was applied with a SOLO manual granular applicator. Tenet, Serenade Soil, and Actinovate were applied as a drench using a watering can at a volume 700 gallons per acre. Treatments were reapplied every 14-days until August 28th. Plant foliage was observed for symptoms of disease every 14-days and roots were sampled monthly to determine root rot prevalence within the treatment blocks. Roots (10/plot) were impartially selected in June, August, and September to observe root health. To determine the pathogens present on the roots, tissue was isolated in June and September onto amended water agar and observed for pathogens. Data was subjected to analysis of variance using SAS and statistical differences were compared using the Fisher's Least Significant Differences test (P=0.05).

Although plants were observed through June and July, symptoms were not observed on the foliage until August. The untreated control beds had an average of 12.8 seedlings with disease symptoms on the foliage while the treatment with the least amount of symptoms, Ridomil Gold G alternated with Actinovate, averaged 2.3. Significant differences were not observed between the severity of the symptoms between any treatments. Significant yield differences between treatments were also not observed at the end of the season. When the roots were observed for disease symptoms, differences were not observed until the final rating (25 Sep). It should be noted that the Ridomil Gold G treatment resulted in the highest yield (g) also had the lowest root disease severity rating (1.2). Ridomil Gold G, applied alone or in a rotation with Actinovate AG, were the only two treatments that resulted in statistically lower disease severity compared to the untreated control. Although data analysis is still underway, early results show that Pythium spp. (33% of all isolations) and Fusarium spp. (15%) were prevalent within the treatment block.

Tables 1-2. Evaluation of biocontrol products, and industry standard fungicides for the control of root rot pathogen on ginseng seedlings, 2013.

Treatment and rate[z] applied at 14-day intervals	Avg. # plants with foliar symptoms	Foliage symptom severity[y]	Avg. weight/10 seedlings (g)
	15 Aug	15 Aug	25 Sep
Untreated control	12.8 ab[x]	2.0 ab	7.7
Actinovate AG 12 oz	7.5 ab	2.0 ab	9.0
Tenet WP 2.2 lb	9.3 ab	2.3 ab	8.6
Serenade Soil 6 qt	20.0 b	2.8 b	9.9
Captan 80WDG 2.5 lb	10.5 ab	2.3 ab	9.5
Ridomil Gold G 15 lb[w]	6.0 ab	2.3 ab	10.4
Ridomil Gold G 15 lb alt. Captan 80WDG 2.5 lb	7.0 ab	2.0 ab	8.6
Ridomil Gold G 15 lb alt. Actinovate AG 12 oz	2.3 a	1.8 a	9.9
Ridomil Gold G 15 lb alt. Tenet WP 2.2 lb	7.3 ab	2.0 ab	8.7
Ridomil Gold G 15 lb alt. Serenade Soil 6 qt	8.5 ab	2.3 ab	9.2
Ridomil Gold G 15 lb alt. Actinovate AG 12 oz alt. Tenet WP 2.2 lb alt. Serenade Soil 6 qt	6.0 ab	2.0 ab	10.2

Treatment and rate[z] applied at 14-day intervals	Root disease severity[y]		
	13 Aug	25 Sep	
Untreated control	1.3	1.9	c
Actinovate AG 12 oz	1.2	1.7	abc
Tenet WP 2.2 lb	1.3	1.9	bc
Serenade Soil 6 qt	1.4	1.4	abc
Captan 80WDG 2.5 lb	1.1	1.5	abc
Ridomil Gold G 15 lb[w]	1.4	1.2	a
Ridomil Gold G 15 lb alt. Captan 80WDG 2.5 lb	1.1	1.7	abc
Ridomil Gold G 15 lb alt. Actinovate AG 12 oz	1.2	1.3	ab
Ridomil Gold G 15 lb alt. Tenet WP 2.2 lb	1.3	1.5	abc
Ridomil Gold G 15 lb alt. Serenade Soil 6 qt	1.0	2.0	c
Ridomil Gold G 15 lb alt. Actinovate AG 12 oz alt. Tenet WP 2.2 lb alt. Serenade Soil 6 qt	1.2	1.5	abc

[z]Application method and volume differ by treatments. Actinovate AG, Tenet WP, and Serenade Soil were applied as a drench volume of 700 gal/acre. Captan 80WDG was applied as a high volume spray (150 gal/acre) and Ridomil Gold G was applied as a granular application.
[y]Severity rating is 1-5, 1=healthy, 2=discoloring/some wilting, 3=moderate wilting/plant death, 4=moderate plant death observed, 5=Large areas of plant death.
[x]Column means with a letter in common are not significantly different (*P*=0.05; Fisher's LSD).
[w]First applications of Ridomil Gold G were applied at 15 lb/acre, subsequent applications were applied at 10 lb/acre.

[y]Root disease severity rating is 1 to 5; 1=healthy/no blemishes, 2=minor blemishes, 3=moderate sized lesions, 4=large necrotic lesions, 5=root severely compromised.

The results in Table 3 show the early results from the 2014 forecasting trial located at a grower cooperators' farm located in Marathon County, WI. The application schedule of rotating the protectant fungicide chlorothalonil with reduced risk products/newly-registered fungicides was designed to limit the repeated applications of B2 carcinogens, such as mancozeb (Dithane DF). Although the 10 and 15 DSV treatments limited infection compared to the untreated control, infection in these plots were at levels unacceptable to growers and could result in increased infection in the garden the following growing season.

Table 3. Evaluation of TOM-CAST disease forecaster for the control of Alternaria blight on three-year-old ginseng, 2014.

Springbrook (2-year-old) Treatment and rate per 100 gal		Schedule	Incidence (No. infected plants)				Disease severity			
			6/12		6/19		6/12		6/19	
1	Untreated	--	49.2	a	193.8	a	5.2	a	5.8	a
2	Bravo WeatherStik SC 2 pt alt. Endura 70WG 4.5 oz alt. Quadris 500F 15.5 fl oz alt. Omega 62.5 1.5 pt alt. Switch WDG 14 oz	7 days	4.3	b	5.3	c	1.8	ab	2.0	b
3		10 days	4.0	b	5.0	c	1.8	ab	2.0	b
4		10 DSVs	9.7	b	18.2	bc	2.0	b	2.0	b
5		15 DSVs	13.0	b	41.5	b	2.2	a	2.2	b

Often, to get reliable data for the control of root rot pathogens of ginseng, trials must be conducted in a controlled greenhouse environment. Stratified ginseng seeds were mixed in silica sand and stored at 38ºF until germination. Germinated seeds were hand planted into 72-cell flats containing sterilized silica sand. Once enough seedlings emerged, they were carefully removed from the sand and observed for any disease symptoms. Any seedlings showing root discoloration were discarded. Inoculum was prepared by growing *C. destructans* on potato dextrose agar for 8 weeks. The upper layer of the agar was removed, macerated in water, and diluted to a concentration of 2.9 x 10^7 spores/fl oz. The bare-rooted plants were then dipped into the spore solution for 10 sec. and planted in 24-cell packs containing a soilless medium (Baccto Professional Planting Mix, Michigan Peat Company, Houston, TX) on 17 May. Eight plants per treatment were placed into a completely randomized design. Fungicides were applied as a drench to the inoculated potted ginseng plants at a volume of 4 fl oz/9 in.^{2} on 17, 24 and 31 May. A disease severity rating (1=no disease symptoms, 2=chlorosis/minor wilting, 3=moderate wilting, 4=severe wilting, 5=plant death) and death (%) were noted 22, 29 May and 6 Jun.

Disease severity was moderate in this trial with the untreated control inoculated plants averaging a plant health rating of 3.1 (1=healthy, 5=dead). The reduced risk fungicide Fontelis was especially effective and resulted in plant health ratings better or equal to the current industry standard products, Cannonball, Topsin, and Captan. Phytotoxicity was no observed on any of the treated plants in this trial.

Table 4. Evaluation of a newly registered reduced-risk fungicide and industry standard fungicides for the control of cylindrocarpon root rot of ginseng seedlings, 2013.

Treatment and rate/100 gal, applied at 7-day intervals	Plant health*		
	5/22	5/29	6/6
Untreated uninoculated	1.0 a**	1.0 a	1.0 a
Untreated inoculated	1.3 ab	2.4 c	3.1 d
Fontelis 1.67SC 16 fl oz	1.1 a	1.5 abc	1.8 ab
Fontelis 1.67SC 24 fl oz	1.0 a	1.3 ab	1.5 ab
Topsin SC 16 fl oz	1.5 ab	1.9 abc	2.8 cd
Captan 80WDG 2 lb	1.8 b	2.0 bc	2.4 bcd
Cannonball 50WP 8 oz	1.0 a	1.8 abc	1.6 ab
Quadris SC 15.4 fl oz	1.1 a	1.4 abc	1.6 ab

*Rated on a scale of 1-5, where 1=healthy, 2=chlorosis, 3=minor wilting, 4=severe wilting and 5=plant death.
**Column means with a letter in common are not significantly different (Fisher's LSD; *P*=0.05).

Three emails were sent to growers throughout early portion of 2014 growing season. One email, titled 'Glower Alert' was a sent to warn ginseng growers that Alternaira blight pressure was unusually high early in the 2014 growing season. A second email was titled 'Phytophthora Foliar Blight Alert' and was sent to growers after we observed high numbers of infected plants in gardens during field trial evaluations. A third email was sent the following day explaining to growers why Phytophthora blight was observed at such high levels and also recommended some cultural control methods that growers could use to reduce infection in their gardens. Also available to growers at the Ginseng Board of Wisconsin website in 2014 were the DSVs from two areas of Marathon County. DSVs are calculated on a 0 to 4 scale; 0=environmental conditions not favorable for disease, 4=conditions very favorable for disease development. The DSV data can be used by growers to modify their fungicide application intervals or to apply their most effective products when disease is most likely to develop. During past Ginseng Field Research Days we have explained to growers how to interpret this data and how to use it to adjust their fungicide applications.

At the 2014 Spring Grower Meeting, posters, titled 'Common Diseases of Ginseng' were distributed to growers as reference guide to help with diagnosing the most common disease issues they might observed in their own garden.

At the 2013 Ginseng Research Field Day, surveys were distributed to growers regarding their pesticide use in 2013, if the new products for Alternaria blight control were implemented into their spray program, and their general satisfaction with the current disease management recommendations. The survey response was excellent with 48 growers returning the finished forms. See the table below for the survey response data. Of the two 100+ acre growers who responded to the survey, both had applied newly registered, reduced-risk fungicides Omega and Fontelis. The one 51-100 acre ginseng grower had also applied newly registered fungicides Omega, Switch, and Fontelis. Of the growers that farm 5-10 acres of ginseng, 44% had applied either Switch or Omega in 2013, an increase from 0% surveyed in 2012. The segment of ginseng growers questioned with the smallest farms, <5 acres, had also incorporated Switch and Omega into their programs, with 29% of either product used. It should be noted that >90% of the smaller growers in the 10 acre or less range had incorporated a lower risk product, such as Quadris, Cabrio, or Endura, into their spray program. There did not appear to be a correlation with the amount of years growing ginseng and whether Switch or Omega were used.

IV. Lessons Learned

Due to the high disease pressure, 2013 trial results did not confirm the effectiveness of a 10 DSV spray threshold as evidenced by the data. Preliminary data collected in the first half of 2014 appeared to reaffirm the 2013 results. Future trials will include more aggressive spray programs to limit infection early in the growing season. Also, due to the extreme disease pressure in 2013, the overall amount of pesticides used, based on survey results, did not appear to be lower compared to previous years. For small ginseng growers (<5 acres) cost was the most important reason, and the second most important reason for 5-10 acre growers for not including a new product into their program. It should be noted that length of time growing ginseng did not appear to correlate to the use of new fungicides as the two largest growers surveyed, both with 30+ years in the industry, used almost all labeled products in 2013.

V. Beneficiaries

The beneficiaries of this project were the ginseng growers and the environment at large. The returned surveys, along with the attached trial results, show that growers are continuing to implement the newly-registered, reduced-risk fungicides. With seed prices at ~$100 per lb., the application of effective fungicides can save growers up to $1 million from the loss of seed due to Alternaria blight. If growers applied two applications of either Switch or Omega in place of Dithane, for example, the amount of mancozeb applied to the environment would be reduced by roughly 4,400 lbs. This is not only a decrease in the amount of B2 carcinogen applied to ground, but also a decrease in worker exposure for the pesticide applicators. We feel that we have shown growers over the past three years, that although these new products are more expensive, they are also more effective and just as safe on the ginseng as the standards they have relied on for years.

VI. Additional Information

Figure 1. Dr. Hausbeck talking to growers about the trial results at the 2013 Ginseng Field Day.

Ginseng Board of Wisconsin Newsletter Articles:

Hausbeck, M. 2013. Notes for Managing Diseases This Spring. Wisconsin Ginseng Reporter, April, page 3

Plant Disease Management Reports:

Townes, A.L., Harlan, B.R., and Hausbeck, M.K. 2014. Evaluation of fungicides to control Alternaria blight on ginseng, 2013. PDMR 8:V301.

Townes, A.L., Harlan, B.R., and Hausbeck, M.K. 2014. Evaluation of fungicides to control Alternaria blight on ginseng, 2013. PDMR 8:V302.

Workshops/Tours:

2013 Ginseng Research Field Day, research trials tour at grower-cooperators' farms, 9 Aug, Wausau WI (~100 attendees).

2014 Ginseng Winter Research Meeting, presentation of 2013 trial results and information on spraying fungicides more effectively. A breakout group for Hmong growers, that included an interpreter, was also organized at the site (~120 attendees).

Presentations:

'Program for Blight and Root Rot Protection' M.K. Hausbeck, Ginseng Winter Growers' Meeting and Hmong Breakout Session, Wausau, WI, 22 Mar 2014.

'Tips and Tricks for Applying Fungicides' B.R. Harlan and M.K. Hausbeck, Ginseng Winter Growers' Meeting and Hmong Breakout Session, Wausau, WI, 22 Mar 2014.

'Fungicide Safety, Debudding, and Seed Testing and Treatments, M.K. Hausbeck and B. Harlan, Ginseng Winter Growers' Meeting, Wausau, WI, 22 Mar 2014.

'Know the Label and Know the Law' M.K. Hausbeck, J. Heil, and B. Harlan, Ginseng Winter Growers' Meeting, Wausau, WI, 22 Mar 2014.

‘How weather influences Alternaria blight, A. Townes, M. Hausbeck, and B. Harlan, Ginseng Winter Growers’ Meeting, Wausau, WI, 22 Mar 2014.

‘Plant clean seed to ensure top quality and yield,’ M. Hausbeck and A. Townes, Ginseng Winter Growers’ Meeting, Wausau, WI, 22 Mar 2014.

VII. Contact Info

Joe Heil
President
Ginseng Board of Wisconsin
668 Maratech Ave
Marathan, WI 54448
715 443-2444
ginseng@ginsengboard.com

7) Pest and disease forcasting for onion and carrot (FY12-007)

Report Date: 7/11/2014

I. Project Summary

A. Vegetable crops grown on muck soils in Wisconsin include onion and carrot, 2 specialty crops of significant acreage and combined farm gate value of $14 million in 2011. This total value doubled from 2010 to 2011, due to an increase of $2 million for carrot and $3.5 million for onion. The significant increase was due, in part, to elevated losses resulting from erratic environmental conditions in 2010; conditions not experienced in 2011. Above average precipitation promoted the incidence and severity of several aggressive foliar diseases including Alternaria and Cercospora leaf blight in carrot and Botrytis and Downy Mildew in onion. Aster yellows of carrot is also favored by abundant rainfall, as lush growth is attractive to feeding by the vector, the aster leafhopper. Environmental conditions greatly influence these key foliar diseases of carrot and onion. Anticipation of heightened disease risk through identification and monitoring of critical environmental factors, such as precipitation and temperature, can enhance management by optimizing timing of pesticide applications. Our proposed research aims to mitigate disease and insect risk through optimization and integration of forecasting models to trigger protectant applications of pesticides in Wisconsin. To extend information to producers, this pest and pathogen forecasting suite will be made available on a weekly basis in a static form in the Vegetable Crop Updates newsletter which is also available at the UW-Vegetable Pathology website, and will be a topic of presentation and discussion at various educational conference in 2013. A BioIPM production manual will be created for onion and will serve as a companion document to the existing carrot manual. Both documents will further enhance management recommendations in the two muck crops. We intend this project to be a multi-year effort with the long range goal of offering links to real time forecasting information with geographic specificity for Wisconsin.

B. This project (FY12) was not previously funded with the SCBGP.

II. Project Approach

Our research and extension project aimed to mitigate vegetable disease and pest risk statewide by developing and validating disease and insect forecasting models to trigger the application of protectant pesticides using remotely sensed and forecasted weather data. The pathogen and pest forecasts were available to vegetable producers in the UWEX-Vegetable Crop Updates newsletters and at the UW-Vegetable Pathology website beginning in June of 2013 and remain available to the current time in evolving formats. The utility and initial validation of the disease forecasts has been presented at educational conferences, including the Midwest Food Processors Research Meetings; the International Carrot Conference held in Madison, WI, Monona Terrace, August 2013; and the University of Wisconsin Extension & Wisconsin Potato and Vegetable Growers Association Grower Educational Conferences held in Stevens Point, Holiday Inn February 2013 and 2014. An onion BioIPM production manual is under development and will serve as a companion document to the existing carrot manual. This was a new project request

which did not build off of past WI SCBG funding. We are finalizing an internet-based graphical user interface that growers can access to view disease and pest forecasts specific to their farm for multiple crops and pests. The link to the website which is in progress is: http://vdifn.net/app_dev.php.

Database creation. We built the general infrastructure to automatically download weather data that can be used to implement numerous weather-based pest and disease models (***i.e. TOM-CAST, DOWNCAST, BLITECAST, ALH***). The infrastructure was developed to accommodate application to an internet-based GUI that growers can access to view disease and pest forecasts specific to their farm. This work was conducted for 1) research purposes, to provide predictions that can be validated, and 2) management purposes, to inform crop management for WI muck growers.

Computers housed at the UW-Madison are currently ingesting gridded weather predictions from the North American Meso-scale weather model (NAM 12km) on a daily basis from the National Weather Service (NWS). Weather data are being organized and uploaded to SQL relational database that has been created to house the forecasted weather predictions and disease and pest forecasts. Current computer code for data organization and utilization has been adapted to the gridded data structure and a new filing system was created to facilitate rapid data loading.

Model implementation. Computer code that implements the TOM-CAST, BLIGHT-ALERT, and ALH models based on the NAM 12km weather model has been written in a modular form to facilitate our ability to debug individual models. The running of the disease and pest models has been automated so that the models are updated daily following the download of the weather data.

Model validation and optimization. To optimize the large scale pest and disease forecasts, model predictions that have been calculated using NWS weather data, specific to field location, were compared to model predictions that have been calculated using field-observed data. Regression analysis was used to determine if there is a discrepancy between the action thresholds calculated using NWS weather data and those using field-based weather data. In time, a correction factor will be developed so that model predictions made over large geographic areas can be (mathematically) mapped to field-level predictions. Similar to Objective 1, AUDPC and yield data from each of the research plots will be collected and analyzed to determine if the TOM-CAST model, driven by NWS weather data, is effective at controlling disease.

Updates in model validation: Carrot foliar disease forecasting. (Amanda Gevens, Steve Jordan, and Kenneth Frost, Department of Plant Pathology, University of Wisconsin, Madison, WI 53706).

Research Overview. Alternaria leaf blight, caused by the fungus *Alternaria dauci*, and Cercospora leaf spot, caused by the fungus *Cercospora carotae*, infect leaves and petioles of carrot and are the most prevalent foliar diseases of carrot worldwide. These foliar blight pathogens reduce yield by limiting the plant's photosynthetic capacity and by weakening the petioles needed for mechanical harvest. Typically, carrots are harvested by implements that loosen the soil and simultaneously grasp the foliage while lifting the roots out of the soil; blighted petioles break when gripped by the mechanical harvester and carrots are left in the soil.

Environmental conditions greatly influence the occurrence and progression of these foliar diseases of carrot and the anticipation of heightened disease risk through the identification and monitoring of critical environmental factors, such as, relative humidity and temperature, can enhance disease management by optimizing the timing of fungicide applications. However, implementation of the weather-based models is difficult because, typically, each field requires a customized forecast that is dependent on disease severity, weather conditions, and fungicide program, factors that are field-specific. A goal of this research is to provide a set of generalized recommendations for managing foliar diseases of carrot that can be used for the majority of WI fields without the need for grower investment in weather stations.

Mean Temp (C)	**Leaf-wetting time (hr) required to produce daily disease severity values (S) of:**				
	0	**1**	**2**	**3**	**4**
13-17	0-6	7-15	16-20	21+	
18-20	0-3	4-8	9-15	16-22	23+
21-25	0-2	3-5	6-12	13-20	21+
26-29	0-3	4-8	9-15	16-22	23+

Table 1) TOM-CAST model logic for scoring a daily severity value. Under the current scheme, a fungicide application would be recommended after the accumulation of 20 severity values over consecutive days.

Methods. ***Weather data and modified TOM-CAST model.*** Computers housed in the Dept. of Plant pathology at UW-Madison ingested daily gridded weather predictions from the North American Meso-scale weather model (NAM 12km) from the National Weather Service (NWS). Weather data were organized and uploaded to a relational database created to house the forecasted weather predictions and disease forecasts. Computer code was written to organize and utilize the gridded data and a filing system was created to facilitate rapid data loading. Computer code was written to implement a modified version of the TOM-CAST model (Table 1) based on the NAM 12km weather predictions. The running of this disease model was automated so that risk predictions were updated daily following the download of the weather data. This model assumes that air temperature and relative humidity (i.e. a surrogate for leaf wetness) are the two primary weather factors that lead to disease occurrence/or progression. The model scores a severity value for each day based combinations of relative humidity and temperature and accumulates the severity values either from crop emergence or the last fungicide application. The accumulation of 20 disease severity values triggers a fungicide application.

Results. Model predictions are currently output daily for research purposes and we have been posting static figures of DSV forecasts for Wisconsin at the vegetable pathology website (see <http://www.plantpath.wisc.edu/wivegdis/> for updates). General infrastructure improvements to improve grower accessibility are ongoing and include, 1) updating the computing hardware that currently ingest, house, and calculate the weather-based disease forecasts, 2) updating the computer software that is currently used for database management and 3) continued development of applications (i.e. writing the computer programs) for the GUI that growers can use to access the weather database directly from their home computers.

Table 2) Experimental treatments, at the Hancock, WI location, used to evaluate the TOM-CAST model based on in-field weather data and NAM 12km weather data.

Trt	Program	Initiation	Initiation	Fungicide Apps.	Rate	Field EIQ[1]
1	UTC	NA	-	-	-	-
2	Calendar	First Symptom	July 17	6	2.0 pint / acre	242
3	In-field DSV	First Symptom	July 17	6	2.0 pint / acre	242
4	In-field DSV	Calendar	July 17	4	2.0 pint / acre	162
5	NAM-based DSV	First Symptom	Aug 7	4	2.0 pint / acre	162
6	NAM-based DSV	Calendar	Aug 7	3	2.0 pint / acre	121

2013 field evaluation. In 2013, the modified TOM-AST model was being evaluated in field trials for the management of *A. dauci* and *C. carotae*, respectively. Research plots were established at the UW-Hancock Agricultural Research Station and on a commercial farm in a randomized complete block design with four replicates. Plots were scouted for disease from mid-July to early September and experiments at both locations contained a standard calendar-based fungicide program (Table 2).

Experimental treatments were established based on fungicide application 1) initiation – fungicide programs were initiated based on the number of days after emergence or the occurrence of the first disease symptom and 2) interval – fungicides were applied according to DSV accumulations calculated based on in-field weather stations or calculated using the NAM 12 km weather model. Bravo Weather Stik was the sole fungicide used in these experiments and was applied at 2 pints per acre when an application was prescribed. ***Results.*** In 2013, we experienced low foliar disease pressure at both experimental locations. This resulted in similar disease control among all fungicide treatments (Figure 1); at Hancock, all fungicide programs performed significantly better than the untreated control and there was no difference in foliar disease control among fungicide programs. Additionally, there were no differences in yield among fungicide programs (F=1.99; d.f. = 5,18; P = 0.15). Thus, at Hancock, WI, all fungicide programs provided the same foliar disease control – those with fewer applications provided equivalent control. For the experiment conducted on-farm, no differences in yield (F=0.94; d.f. = 5,18; P = 0.48) nor disease severity (F=0.79; d.f. = 5,18; P = 0.57) were observed among fungicide programs.

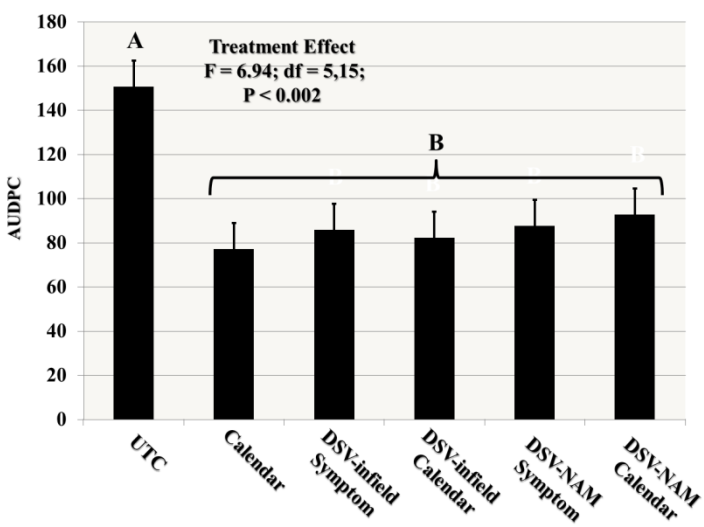


Figure 1) Average area under the disease progress curve (AUDPC) for experimental treatments at Hancock, WI in 2013.

Future work. ***Model validation and optimization.*** To optimize the large scale pest and disease forecasts, model predictions that have been calculated using NWS weather data, specific to field location, will be compared to model predictions that have been calculated using field-observed data. Regression analysis will be used to determine if there is a discrepancy between the action thresholds calculated using NWS weather data and those using field-based weather data. Finally, a correction factor will be developed so that model predictions made over large geographic areas can be (mathematically) mapped to field-level predictions. ***GUI development and information dissemination.*** Currently, efforts are being focused on the development of an internet-based graphical user interface to automate the functionality of the database and to make disease forecasts available to vegetable growers in WI. Stay tuned as there may be a web application coming on-line in the Fall of 2014 <http://www.plantpath.wisc.edu/wivegdis/>.

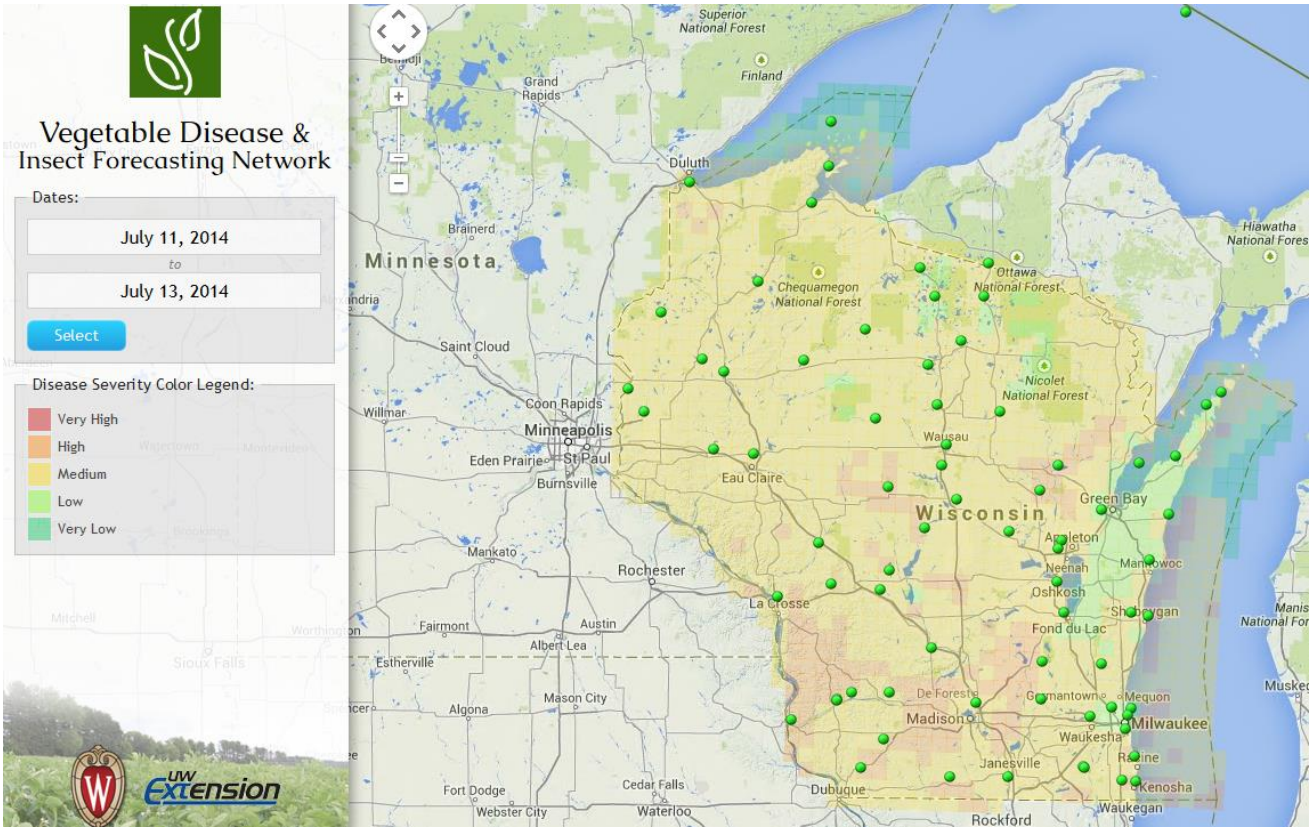
Discussion. Disease forecasting systems that inform the timing of fungicide application based on environmental conditions may be useful for managing pathogens that cause foliar diseases of carrot. A typical fungicide program in Wisconsin is initiated when disease symptoms are first detected by scouting and subsequent fungicide applications typically follow a calendar-based spray schedule. However, fungicide reapplication may not be necessary if environmental conditions do not favor disease progression; the severity of disease epidemics largely depends on environmental conditions, dictated primarily by wind and weather patterns. Thus, the application of fungicide informed by a weather-based disease forecasting system could control disease while reducing the number of pesticide applications, thereby improving profitability for vegetable growers and reducing environmental impact. The implementation of the weather-based models to inform spray programs requires a customized forecast for each field that is based on disease severity, weather conditions, and fungicide program, factors that are field-specific. The primary goal of our research is to provide a decision tool for the management of carrot foliar diseases that can be used for the majority of fields and doesn't require grower investment in a weather station for each field.

Acknowledgements. Many thanks to Paul Miller Farms of Hancock, WI for setting up the carrot field trials at the UW-Hancock Agricultural Research Station (HARS) in 2013. We appreciate the crop management efforts of the UW-HARS staff, specifically, Glenn Carlson and Paul Sytsma. Funding for this project was provided, in part, by the WI Specialty Crop Block Grant project entitled "Implementing pest and disease forecasting for enhanced management of vegetable crops grown on muck soils" in addition to support from the Wisconsin Potato and Vegetable Growers Association, the Wisconsin Fresh Market Vegetable Growers Association, and the Midwest Food Processors Association.

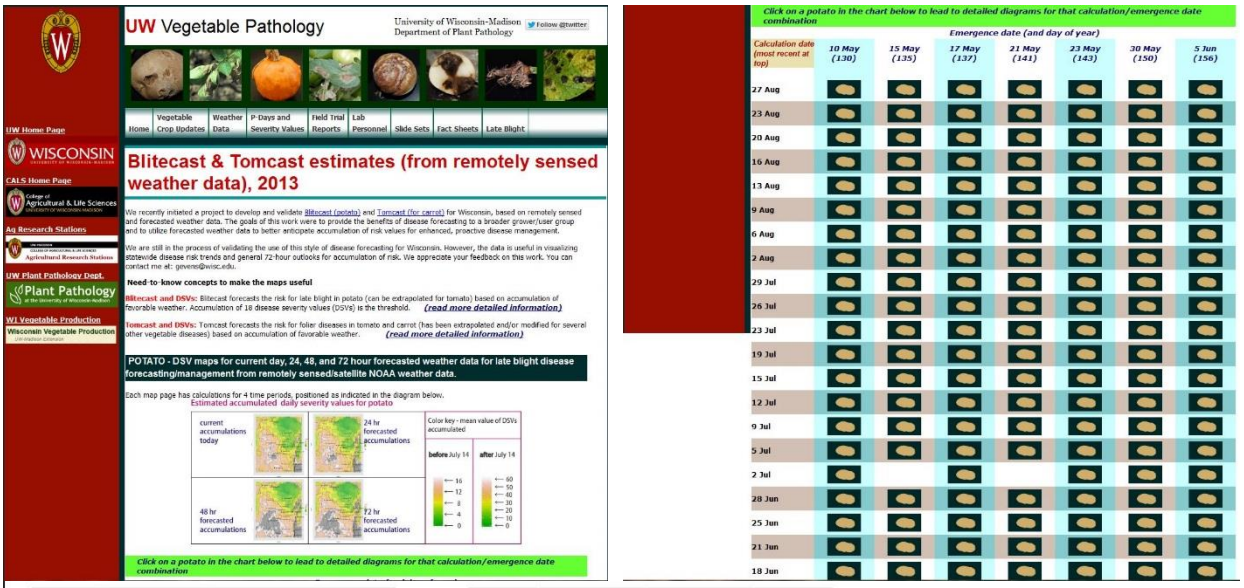
Model accessibility and GUI creation. For research purposes, model predictions can currently be output daily although this functionality requires manual manipulation and export of data files. In cooperation with the UW-Division of Information and Technology, an internet-based GUI will be created to automate the functionality of the database. This GUI will be made available to vegetable growers in the state of Wisconsin to be used as a tool to better manage their crops. This website will be linked to the UW Vegetable Pathology and Entomology websites.

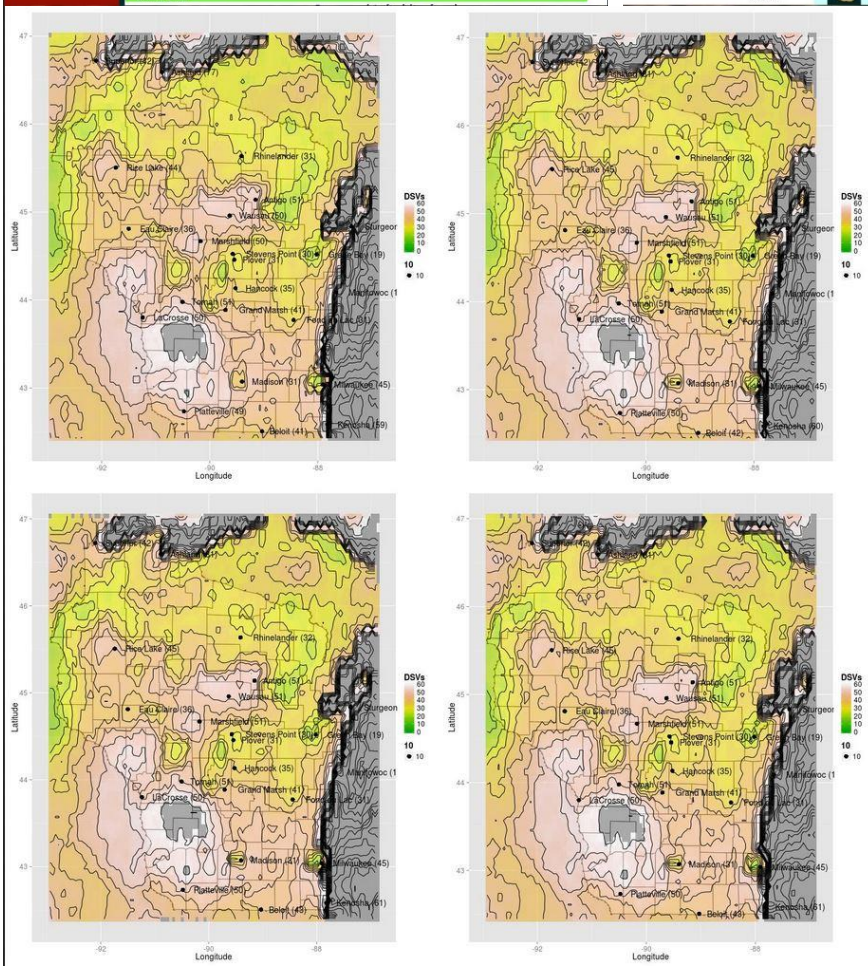
Image below depicts a screen capture of the current progress of our disease and insect forecasting network website (11 July 2014). Presently, our GUI specialist is developing

individual interfaces for each of the disease/insect models and, as seen in the screen capture below, growers/consultants/scientists will be able to enter in the date range of interest in generating relevant and regionally specific forecasts for enhanced disease and pest management.



Images below are screen captures of currently available information at the UW-Vegetable Pathology website in static form. Growers were able to access this information as it was generated in Summer 2013.





Heat maps of Disease Severity Value accumulations for Wisconsin, 2013. Maps were generated for weather already occurred, weather forecasted for 24 hours in future, 48 hours in future, and 72 hours in future.

III. Goals and Outcomes Achieved

A. Activities performed in order to achieve the performance goals and measurable outcomes for the project were previously described in report section entitled, "Project Approach." While our outcome measures were long term and included change in practice post-adoption of new integrated pest/disease management forecasting tools, our progress in the FY12 WI SCBG was significant in that we developed the infrastructure for generating and presenting disease and pest forecasting information for researchers/consultant/grower access. The infrastructure and resulting tools will be further validated and deployed for research and commercially. The end results of the application of forecasting tools will be evaluated in subsequent years of related work. (some of which is funded through a 2013 Specialty Crop Block Grant).

B.

1. **Advance adoption of a modified TOM-CAST disease forecasting model into commercial carrot production & evaluate disease forecasting models for foliar diseases**

We advanced adoption of the Tom-Cast disease forecasting model for commercial carrot production and we conducted one year of in-field model validation in carrot in Central Wisconsin in both a research field (Hancock Ag Research Station) and in a commercial field (Gumz Muck Farm, Endeavor, WI). Results of this work are detailed in above section entitled, "Project Approach."

2. **Build a functional model of aster yellows forecasting for research purposes**

A functional model of aster yellows forecasting was built for research purposes. However, the 'next steps' required the creation of infrastructure for data organization and manipulation – which we developed in our FY12 project. A relational database was created in Microsoft Access for such purposes. The automation of direct data downloads from NOAA were developed by contacting researchers at the Satellite and Information Service. Current code for data analysis and prediction was adapted to a new data structure and new filing system was established to facilitate rapid data loading and analysis export. Eventually, it may be necessary to rewrite the R code to be compiled in another computer language, such as C ++, to speed up processing in the future.

3. **Develop and disseminate extension material to producers**

Extension materials were developed and shared with producers/consultants/fellow researchers. The specific details are provided in above section entitled, "Project Approach."

IV. Beneficiaries

Of the 4300 acres of carrots grown in WI in 2012 (4200 acres in 2013) greater than 60% of the acreage is managed with crop consulting expertise which readily draws upon UWEX research-based resources to enhance disease and pest identification and integrated management. At roughly a $7 million farm gate value per recent year, our work influences an estimated $4.2 million of carrot value in the state of WI. The balance of the acreage is variably managed, but we have noted that several smaller scale producers have begun to utilize UWEX disease and pest forecasting tools to aid in pesticide use decision-making.

In our 2013 carrot field trial, we could not statistically differentiate disease control between calendar-based or disease forecasted foliar fungicide applications (with data from either in-field weather stations or NAM-based weather data). While this is just one year of trial, the data suggests that NWS and NAM data (which is more readily accessible and economical) can be utilized to aid in effective timing of fungicide applications for foliar disease control in carrot in Wisconsin. On average, a single weather station cost is $2000/each field in addition to maintenance and labor required for set up, monitoring, data downloading, and processing. Our NAM-based tool requires none of these additional expenses.

The core purpose of this proposal was to address the sustainability of muck vegetable crop production in WI through enhanced production practices. Sustainability goals included 1) reduction in foliar-applied pesticides to limit cost, environmental impact, and exposure to farm workers, and 2) enhanced economic return by keeping input costs down and quality and revenue up vegetable crops. We saw a maintenance of at least 95% of acreage and productivity from 2011 through 2013 which was a success. In fact, in 2012, a significant increase in productivity was noted across WI in carrot – which indicated additional successes and areas for potential industry expansion.

V. Lessons Learned

Project staff performed goals of the project in a timely manner. Our main challenge was in identifying an appropriately trained and interested Graphical User Interface specialist to work with our specific and many needs. We found UW resources for GUI support to be cost prohibitive and less time efficient than a non-UW contractor. Growers appreciated the 'easy IPM' mission of our work, as individual in-field weather stations are rarely feasible for operations with large acreage of multiple vegetable and agronomic crops. As such, we found easy collaboration with multiple muck crop producers in Central Wisconsin. One of the final objectives of our work – development of a BioIPM manual for onion – is the only component that we feel is a bit delayed in production at termination of the project. The reason for this delay is that the document requires input from multiple specialists across at least 4 disciplines. We currently have the outline for the document based on format from our carrot and other companion vegetable BioIPM manuals, but we have not finalized revisions for publication and release.

VI. Additional Information

Publications:

2012

Webster, B.J., Jordan, S.A., Gevens, A.J. 2012. Evaluation of fungicide treatments and application schedule on foliar blight of carrot, 2011. Plant Disease Management Reports 6:V115. Online publication.

Gevens, A.J. 2012. Early Blight and Late Blight Forecasting and Disease Updates, Cucurbit Downy Mildew Updates, Carrot Foliar Leaf Blights. *University of Wisconsin Extension, Wisconsin Crop Manager,* Vegetable Crop Update #17. July 18, 2012. (Spanish Version Available). Online.

2013

Gevens, A.J., Webster, B.J., Jordan, S.A., Frost, K.E., Groves, R.L. 2013. Carrot disease forecasting and management. University of Wisconsin Extension & Wisconsin Potato and Vegetable Growers Association Grower Education Conference. Holiday Inn, Stevens Point, WI. Online Proceedings.

Frost, K.E., Gevens, A.J., Groves, R.L. 2013. Economics of aster yellows management. University of Wisconsin Extension & Wisconsin Potato and Vegetable Growers Association Grower Education Conference. Holiday Inn Convention Center, Stevens Point, WI. (Online Proceedings).

Jordan, S.A., Frost, K., Gevens, A.J. 2013. Controlling carrot foliar diseases with reduced risk fungicide programs. International Carrot Conference, Monona Terrace, Madison, WI, August 2013; North Central Divisional American Phytopathological Society Meeting, Manhattan, KS, June 2013.

Frost, K.E., Groves, R.L., and A.J. Gevens. 2013. Toward an adaptive management strategy for the control of aster yellows in Wisconsin carrot [proceedings]. 36th International Carrot Conference, Madison, WI, August 15-16, 2013.

Frost, K.E., Groves, R.L., and A.J. Gevens. 2013. The development of a web-based tool for carrot disease forecasting [proceedings]. 36th International Carrot Conference, Madison, WI, August 15-16, 2013.

Jordan, S.A., Frost, K.E., and A.J. Gevens. 2013. Investigating performance of reduced risk fungicides of foliar disease control in carrot [proceedings]. 36th International Carrot Conference, Madison, WI, August 15-16, 2013.

Gevens, A.J., Jordan, S.A., Webster, B.J., Frost, K.E., Groves, R.L. 2013. Carrot Disease Forecasting and Management. University of Wisconsin Extension & Wisconsin Potato and Vegetable Growers Association Grower Education Conference. Muck Crop Meeting. Holiday Inn Conference Center, Stevens Point, WI. February 6.

Jordan, S.A., Gevens, A.J**.** 2013. Evaluation of fungicide treatments and application schedule on foliar blight of carrot, 2012. Plant Disease Management Reports. 7:V099.

Gevens, A.J. 2013. Vegetable disease update: DSVs/Blitecast, P-Days for Early Blight, Basil Downy Mildew, and Carrot foliar disease control. *Wisconsin Crop Manager*, Vegetable Crop Update #7. June 8, 2013. (Spanish Version Available)

2014

Frost, K., Gevens, A.J., Groves, R.L. 2014. Feasibility of alternative management strategies for the control of aster yellows in Wisconsin carrot. In *Carrot Country*. Columbia Publishing & Design, Yakima, WA. Summer 2014, p. 8-11.

Frost, K.E., Groves, R.L., Jordan, S.A., Gevens, A.J. 2014. The development of a web-based tool for carrot disease forecasting. Poster Abstract. University of Wisconsin Extension & Wisconsin Potato and Vegetable Growers Association Grower Education Conference. Holiday Inn Convention Center, Stevens Point, WI. (Online Proceedings).

Frost, K.E., Gevens, A.J. 2014. Timing and selection of effective fungicides for disease control in carrots. Central Wisconsin Processing Crops Meeting. Plover, WI. March 5. 40 attendees.

Frost, K.E., Jordan, S.A., Groves, R.L., Gevens, A.J. 2014. A novel forecasting approach for foliar disease management in processing crops. University of Wisconsin Extension & Wisconsin Potato and Vegetable Growers Association Grower Education Conference. Wisconsin Muck Meeting. Holiday Inn Convention Center. Stevens Point, WI. February 5. 30 attendees.

VII. Contact Info:

Tamas Houlihan
Acting Executive Director
Wisconsin Potato and Vegetable Growers Association
P.O. Box 327
Antigo, WI 54409
715-623-7683
thoulihan@wisconsinpotatoes.com

8) GAP/GHP cost share (FY12-008)

Report Date: December 17, 2014

I. Project Summary

The purpose of this project was to provide food safety assistance to Wisconsin-based specialty crop producers and processors, and to promote the Good Agricultural Practices / Good Handling Practices ("GAP/GHP") certification program. The DATCP Bureau of Trade Practices – Fruit & Vegetable Inspection Unit is authorized by USDA Agricultural Marketing Service ("AMS") to certify farms and facilities under the GAP/GHP program. The central part of the certification process is an on-site audit. This grant provided funds to make these audits (and therefore, certification) financially accessible to more producers and processors, thereby creating new market opportunities for Wisconsin producers. Many large chain stores require food safety certification at the farm level.

The GAP/GHP requirements are governed by AMS. AMS establishes the standards and trains the state inspectors who are certified to conduct the audits. USDA also mandates that the price of the audit is $92.00 per hour plus an overhead fee of $50.00. Under this grant agreement, the Fruit & Vegetable Inspection Unit's audit clients paid $23.00 per hour (25%) and the grant covered the remaining $69.00 per hour (75%).

In addition, a portion of this grant was originally budgeted to help defray the cost of having Fruit & Vegetable Inspection Unit Auditors provide free workshops and training seminars for growers (about 15% of the project budget). These seminars were typically organized by trade organizations for their members or by processing facilities for their suppliers. They provided an opportunity for growers to learn about the GAP/GHP requirements before submitting to the audit and, therefore, more efficiently obtain certification. However, no funds were requested under this activity because we experienced greater demand for audits than anticipated. The entire grant was exhausted to fund the 75% cost share for the audits described above. The DATCP Fruit and Vegetable Inspection Unit provided these workshops and seminars through other funding sources.

Another portion of this grant was originally budgeted to help cover the costs of Fruit & Vegetable Inspection Unit Auditor's credentials with AMS. AMS requires each auditor to complete continuing education and to attend an annual on-line class to review standards. The budget in the grant application included funds to cover a portion of Fruit and Vegetable Inspection Unit employee's time while they completed these requirements. But again, funds originally budgeted for this purpose were diverted to the cost share audits described above (about 1.5% of project budget).

B. The Fruit & Vegetable Inspection Unit received similar grants in previous fiscal years. The work done under this project was a continuation of previous projects. More growers continue to express interest in getting certified so we partnered with new groups to provide workshops for growers.

II. Project Approach

The Fruit & Vegetable Inspection Unit conducted a total of 125 GAP/GHP audits under this grant program. Of these, 94 were "Standard" GAP/GHP audits and 31 were Harmonized GAP/GHP. Many of these audits would not have been possible without this grant. Most of the businesses audited were

growers but there were also some packing & distribution facilities. The growers were from all over Wisconsin.

The Fruit & Vegetable Inspection Unit offered a total of 10 free workshops, seminars or training classes for growers. These 10 sessions represent a total of 65.5 hours by Fruit and Vegetable Inspection Unit's Auditors. These workshops were typically arranged by grower trade organizations, businesses that buy the growers' products, and a county extension agent. These workshops are an excellent opportunity for growers to learn what will be expected should they continue to seek GAP/GHP certification.

III. Goals and Outcomes Achieved

A. The overall goal of this project was to have more growers obtain GAP/GHP certification. Activities conducted by the Fruit & Vegetable Inspection Unit to achieve this goal include conducting audits at reduced cost to growers (thanks to this grant), providing free workshops and training sessions to make sure that audit candidates understand before the audit what will be expected of them, and ensure that the unit has a well-trained and qualified auditors available to conduct the audits and workshops. While the grant request including funding for all three of these activities (audits, training for growers, and training for staff), only the first was actually funded during this audit period. There was higher than anticipated demand for audit services, so the Fruit & Vegetable Inspection Unit used all available grant funds to provide as many cost-share audits as possible.

B. The program conducted 125 GAP/GHP audits under this grant period (not including the 24 audits that will be submitted for reimbursement under the FY13 grant period -- the two grants overlap each other). This is a significant increase in the 75 that were conducted during the FY11 grant period, 76 during the FY10 grant period, and 55 during the FY09 grant period.

The program's two auditors spent a total of 65.5 hours offering workshops and training sessions to growers and other interested parties. During the FY2011 grant period, the total was 56 hours.

The goal of this project is to increase the number of growers who obtain USDA's GAP/GHP certification. The increase in the number of audits (76 to 125) represent a percentage increase of 66%. This is much higher than the roughly 20% that we had anticipated.

IV. Beneficiaries

The most direct beneficiaries of this program are the growers who were able to use the cost share grant to help cover the cost of their GAP/GHP audits. Pursuant to AMS standards, the Fruit & Vegetable Inspection Unit must charge $92 per hour for audit services. However, thanks to this grant, the unit is able to charge the growers only 25% of the service, and then charge the remainder to the grant. This obviously is a large cost reduction for growers. Wisconsin has about 1600 fresh market vegetable growers as well as commercial scale growers who are potential beneficiaries of this project. As word continues to spread about the workshops and cost-sharing, more and more producers will become certified.

Buyers of specialty crops also benefit from the program. Many buyers now require their suppliers to be GAP/GHP certified. This grant allows more growers to obtain that certification, thereby improving buyers’ ability to obtain crops.

V. Lessons Learned

New for this grant period (FY12), the grant included a cap on the amount that could be deferred from the grower to the grant. As always, the $92 per hour audit cost was split with 75% being paid by the grant and 25% being paid by the audited grower. However, if the total audit time exceeded 8 hours, the grower was required to pay the entire $92 per hour for any time above eight hours. This means that the effective cost-share reimbursement under the grant was $552 per audit (8 hours X $92 X 75%). Of the 125 audits performed under this grant, ten of them exceed the limit. Generally, the businesses whose audits exceeded eight hours were either large operations or not so well prepared operations. Either way, the upper limit left more grant money available to smaller or more efficient operations.

While the standardized GAP/GHP audits have been around for a while, the Harmonized GAP/GHP is relatively new. We were somewhat surprised by the amount of extra work required (both billable audit hours and administrative tasks). The Fruit and Vegetable Inspection Unit will spend the off-season preparing to more efficiently conduct these audits and process the paperwork.

VI. Additional Information

None

VII. Contact Info

Jeremy McPherson
Director of Trade Practices
WDATCP
P.O. Box 8911
Madison, WI 53718
608-224-4922
jeremy.mcpherson@wi.gov

9) Developing IPM for high tunnel tomatoes (FY12-009)

Report Date: April 6, 2015

I. Project Summary

We worked toward the development of integrated pest management strategies (also known as best management practices) for tomato production in high tunnels in Wisconsin, determined integrated management for tomato leaf mold in the high tunnel, collected data to develop a biointensive IPM manual for high tunnel tomato production in Wisconsin, and we coordinated educational opportunities with UWEX to disseminate our findings.

High tunnel construction for season extension and conservation of lands in agricultural production has greatly increased in Wisconsin over the past 4 years as a result of the federal National Resources Conservation Service (NRCS) Environmental Quality Incentives Program (EQIP) program. The EQIP program has supported production of seasonal polyethylene covered structures (termed high tunnels) to extend the growing season with the goals of improving plant, soil, and air quality, reducing nutrient and pesticide transport, and reducing energy use through local consumption. Tomato is a high value specialty crop and one of the most commonly grown vegetable crops in Wisconsin high tunnels. Environmental conditions within the high tunnel are different than in open-field and require customized production recommendations that have, to date, come from extrapolation from field trials and from high tunnel research of other regions. The most common disease on high tunnel tomatoes is leaf mold, which is easily diagnosed and can potentially limit photosynthetic capacity, yet little information is available on yield and quality impact of the pathogen. We proposed the investigation of integrated pest management practices on Wisconsin high tunnel tomatoes through scouting and surveys. On-farm assessments of conventional production systems comparing standard grower practices with practices employing reduced risk insecticides and fungicides, as well as varietal comparisons to standard 'Mountain Fresh' were conducted.

While we had intended to compare two conventional production systems to characterize management under high and low inputs, we learned that there were not clearly established approaches that we could categorize as such. Further, insect pressures were very low with no standard treatment programs, and fertility programs were varied by grower, region, and media types. Our objectives were slightly altered to address these realizations in this one year project.

B. This was the first year of a muli-year project

II. Project Approach

Surveying high tunnel tomato growers in Wisconsin to identify extension and disease control needs – to develop best management or integrated pest management practices

K. M. Cleveland and A.J. Gevens, University of Wisconsin-Madison Plant Pathology

Over the last several years in Wisconsin, the construction of high tunnels (HTs) for season extension of locally-grown produce has greatly increased. Tomato is a high value specialty crop

and is one of the most commonly grown HT crops. Different environmental conditions prevail in a HT than in an open-field setting, requiring unique management. Many recommendations, to date, have come from open-field trials and research from other regions. To assess the production and disease information needs of Wisconsin HT growers, a survey was conducted with questions ranging from cultural practices, pest and disease concerns to interests in informational tools. Just under 70% of growers have been growing tomatoes in HTs for <5 years, with just over 60% of these growers raising 100+ - plants. Over 30% of the growers identified pest and disease management concerns as particular current challenges. Of disease troubles, over 45% of grower specified problems with the tomato leaf mold fungus, *Fulvia fulva*. Most growers (85%) would find if valuable to have additional web tools for pest and disease control, and 77% indicated interest in a leaf mold management or forecasting tool that alerted growers to when preventative fungicides would need to be applied. Results indicated that a majority of HT tomato growers are relatively new, they are growing a substantial number of tomato plants, and they are in need of further production and specific disease management information.

Introduction

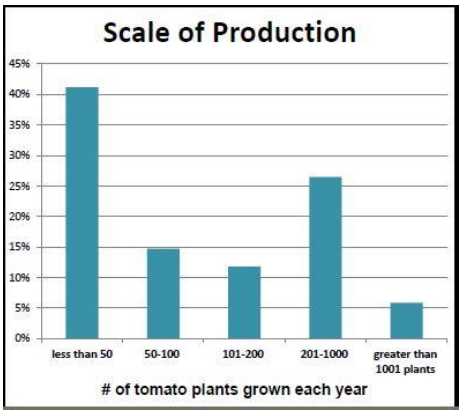
High tunnel (HT) construction for season extension and added market value of tomato production has increased in Wisconsin in recent years. HTs offer environmental conditions unique from field conditions requiring specific management recommendations to optimize yield and quality. To best understand and address information needs, we applied a production survey to current HT tomato producers of Wisconsin. Analysis of our production survey data, presented here, will be used to direct further research and extension efforts in HT tomato production and disease management.

Materials and Methods

A 45-minute, 57-question production survey was applied to high tunnel tomato producers at the 2014 Wisconsin Fresh Fruit and Vegetable Conference in the Wisconsin Dells, WI. Questions were administered with PowerPoint/Turning Point survey software and respondents answered with clicker devices. Categories included general production, cultural practices, fertility, disease, insect, and market/revenue material. Responses were graphed in Turning Point for display.

Results

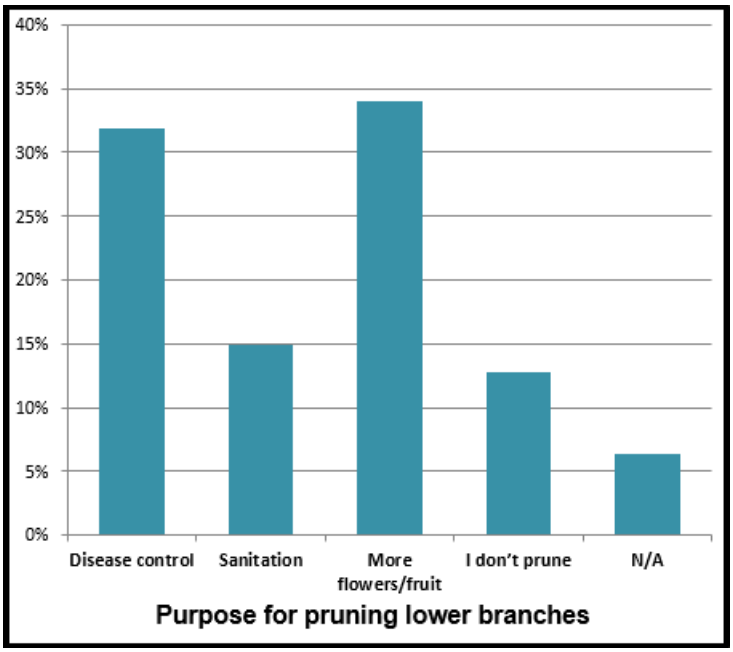
Introductory Production Results

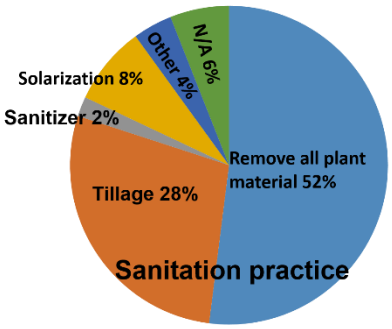


90% find it valuable for extension to offer additional web tools for high tunnels
76% have been growing tomatoes in high tunnels for 0-5 years
65% were satisfied with quality and quantity of production information currently accessible
63% of production systems are conventional
59% accessed and utilized production information from land grant institutions (of the 59% - 45% from WI, 11% from MN, 11% from MI, 2% from Penn State, and 2% from FL)

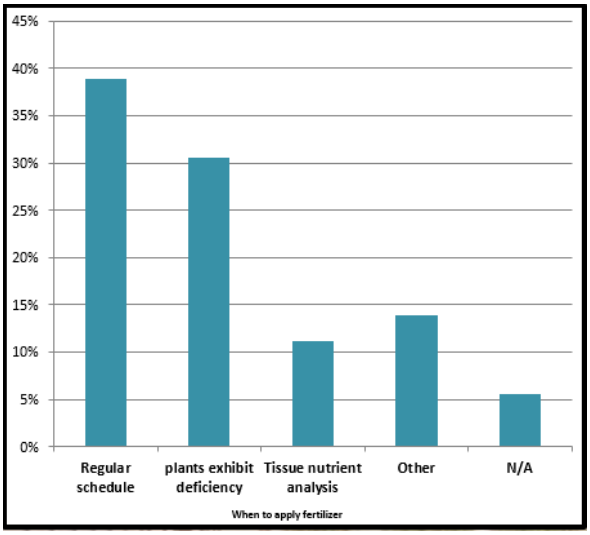
Horticultural/Planting Methods

71% space plants within rows at 18-24 in
59% space rows 36-48 in apart
69% irrigate based on crop demand
62% moderately till soil prior to planting
59% plant directly into the native soil
48% do not use cover crops
45% use landscape fabric between rows
42% rotate crops within high tunnels
34% prune for improved agronomic character



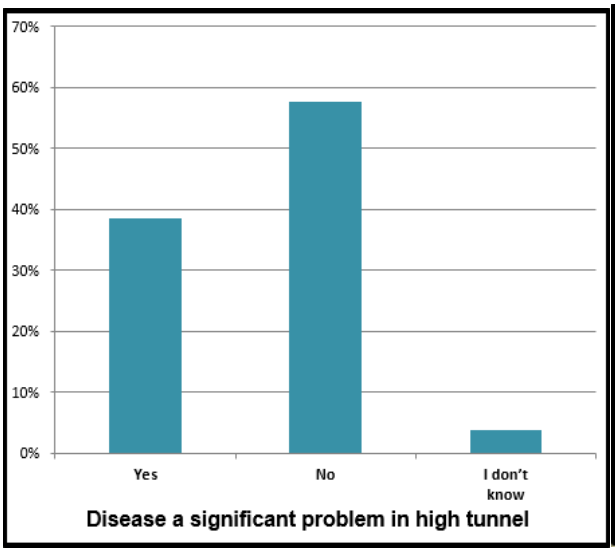


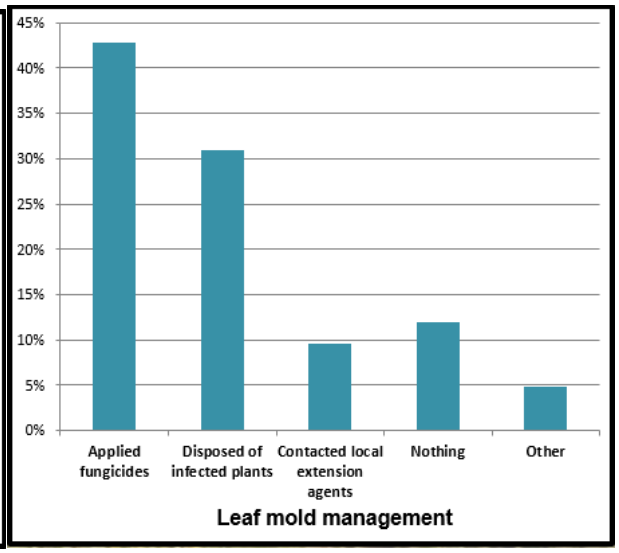
Fertility Results

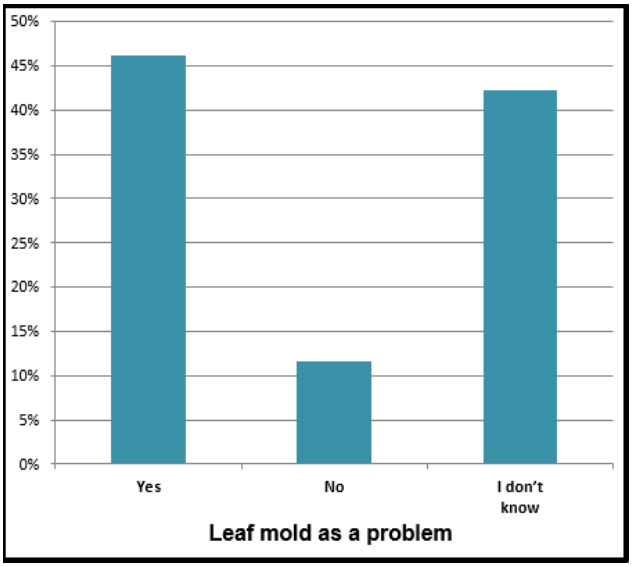


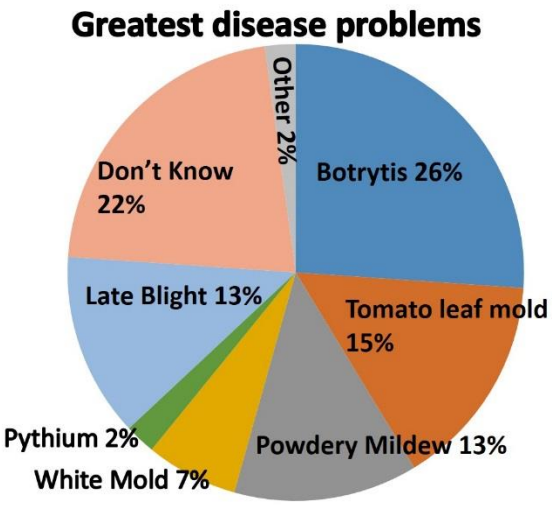
51% fertigate their tomatoes
39% fertilize tomatoes on a calendar-based schedule
32% do not feel that fertility inputs are a challenge in production; 36% do;32% are unsure

Disease Results



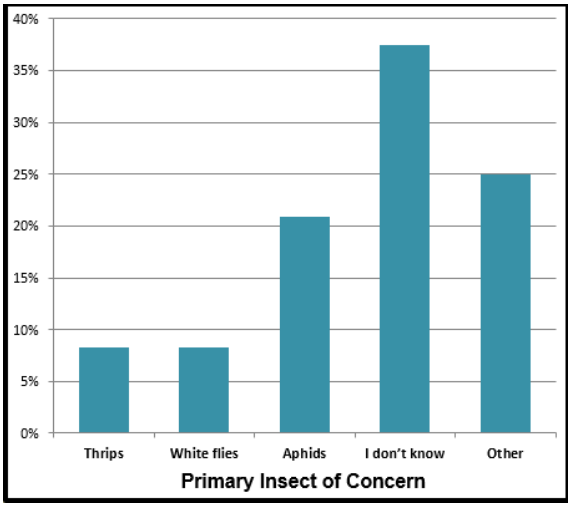






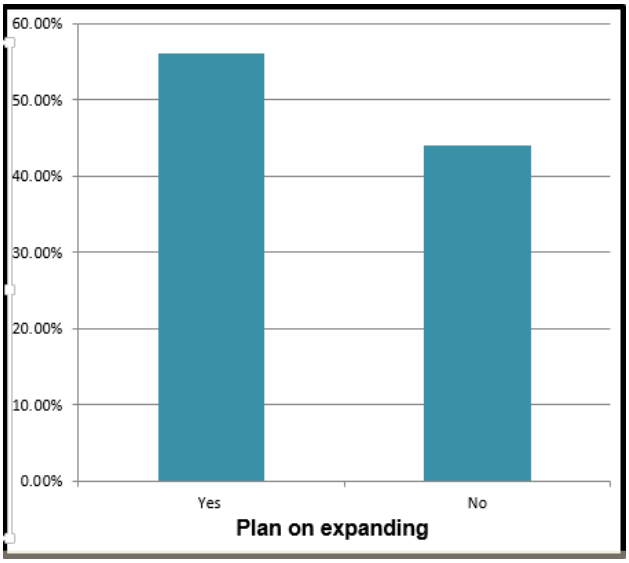
92% are interested in a tool that would alert growers of leaf mold and other diseases that need to be managed preventively
52% scout for disease every day
50% claim that tomato diseases are of greatest concern mid- and late-season

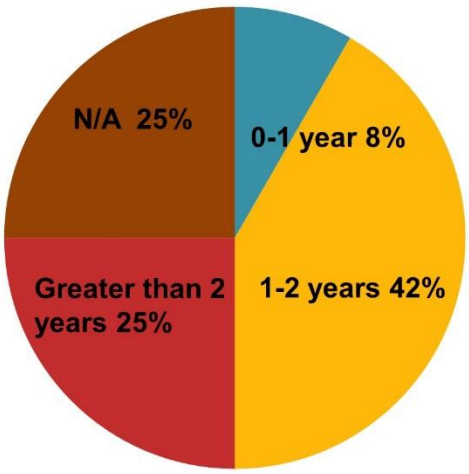
Insect and weed pest results



69% apply insecticide and/or herbicides when needed
46% do not have or encounter problems with weeds

Market and future production results





Pie chart indicates the number of years it takes to break even on the high tunnel investment. 75% of growers claim that the addition of high tunnels to their operations has added to overall revenue of the farm.

Conclusion
Most WI growers are relatively new at growing tomatoes in HTs and value web-based tools for production management guidance. Additional research-based information needs to be generated for further advancing fertility, disease, and pest concerns given that the majority of respondents indicated that they feel that they are having, or they suspect they are having, problems in these areas of production. For example, 58% of respondents claim that diseases are not a significant problem in their HTs, yet 46% claim that tomato leaf mold is a key disease problem. With greater than 50% of HT tomato producers planning on expanding, further program efforts are needed to address needs of this this growing industry.

Objective Two: Screening commonly grown high tunnel tomato varieties for leaf mold (*Fulvia fulva*) resistance to support development of integrated disease management program
K.M. Cleveland, S.A. Jordan, and A.J. Gevens, University of Wisconsin-Madison Plant Pathology.

Over the last several years in Wisconsin, the construction of high tunnels (HTs) for season extension of locally-grown produce has increased. Tomato is a high value specialty crop and is one of the most commonly grown HT crops. Different environmental conditions prevail in a HT than in an open-field setting requiring unique management. Many recommendations, to date, have been adopted from open-field trials and research from other regions. Tomato varieties commonly grown in Wisconsin HTs have susceptibility to the potentially destructive ascomycete fungus *Fulvia fulva*, which causes leaf mold. This disease can result in defoliation, reducing photosynthetic capacity of plants and leading to a reduction in productivity. Assessment of varietal response to tomato leaf mold is necessary for enhanced, integrated disease management. A 14-day-detached leaf assay was used to assess leaf mold resistance of 12 tomato varieties commonly grown in HTs to an isolate of *F. fulva* collected from Wisconsin in 2013. Varieties evaluated included determinate and indeterminate types, as well as types expressing differing phenotypic characteristics. Results indicated that there were statistical differences between several varieties in their response to *F. fulva* over 14 days. The most susceptible variety was 'Trust' with a Relative Area Under the Disease Progress Curve (RAUDPC) of 0.63. The least susceptible variety was 'Green Zebra' with a RAUDPC of 0.13. Our initial work suggested that it may be possible to enhance management of tomato leaf mold with varietal selection.

Introduction
Tomato leaf mold, caused by the pathogen *Fulvia fulva*, is one of the most common tomato diseases found in high tunnels (HT) and areas of high humidity. In general, leaves are the only plant parts affected with older tissue generally exhibiting symptoms first. However, it is possible under heavy disease pressure and favorable environmental condition that other parts of the plant may exhibit symptomatic tissue. Lesions first appear as dull yellow spots on the upper side of the leaves which may at first be restricted by leaf veins. After time lesions appear more chlorotic and may coalesce until the entire leaf is infected and killed. The lesions generally lack a distinct margin and on the abaxial side of the leaf there will be an exhibition of a greenish-brown mold that consists of asexual propagules called conidia. It is these conidia that cause the pathogen to spread to other plants. Due to the unique environmental conditions in high tunnels that are favorable for leaf mold development there is a need for developing critical control

methods. One such method is to evaluate commonly grown HT tomato varieties for disease resistance. Due to limited number of registered fungicides for HT/Greenhouse use this method will hopefully provide a valuable management tool for controlling tomato leaf mold. Varietal evaluation along with chemical and cultural practices may help aid in the proper IPM for control of *Fulvia fulva*.

Fig 1. A) A 36'X96' tomato hoop house. B) Tomatoes planted in poly-bags growing in hoop house.

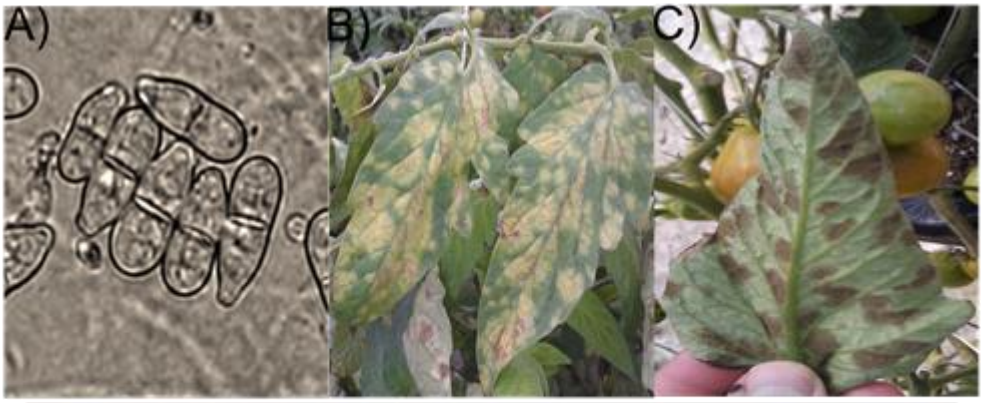


Fig 2. A) Septate asexual conidia of *Fulvia fulva*. B) Typical foliar lesions on the adaxial side of leaf. Lesions are chlorotic and often do not have well defined margins. Lesions can eventually coalesce until complete leaf necrosis. C) Sporulation of *Fulvia fulva* on the abaxial side of the leaf. Sporulation appears as greenish-brown "fuzz."

Materials and Methods

Twelve varieties of tomatoes were chosen to screen for their resistance to *Fulvia fulva*. Approximately ten plants of each variety were grown. The plants were grown at 26 degrees Celsius with a 12 hour photoperiod and fertilized with Hoaglands solution. Plants were approximately six weeks old until leaves from the second lateral branch were harvested. Leaves from each variety were placed on top of water agar in a Petri-plate. Five plates of each variety were replicated. An isolate of *Fulvia fulva* was obtained from an infected tomato leaf in a hoop house in Hancock WI. Conidia were picked and single spored. After a clean isolate was obtained it grew two weeks then was prepared for inoculum. Inoculum was prepared by using sterilized deI water into a sporulating culture of *Fulvia fulva*. The culture was gently agitated to create a conidial solution. The conidial solution was measured and adjusted to 10^6 conidia/ml. Inoculation consisted of pipetting ten microliters of conidial suspension to the middle of each leaf along the lateral vein, this guaranteed a total of 10^4 conidia per leaf. A negative control

was used for each variety. The Petri-plates of leaves were then placed randomly in a humidity chamber and incubator set to 23 degrees Celsius with a 12 hour photoperiod. The leaves were rated by measuring lesions along an x and y axis and calculating area at 0, 3, 7, and 10 days. The RAUDPC was then finally calculated for varietal comparison. This experiment was conducted two individual times.

Results

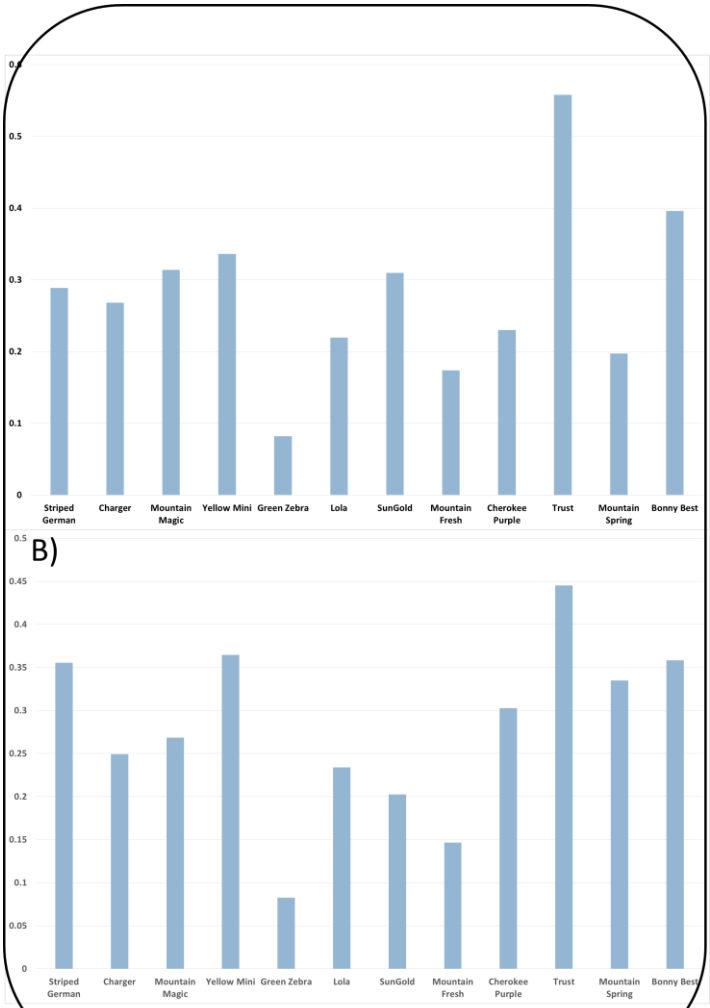
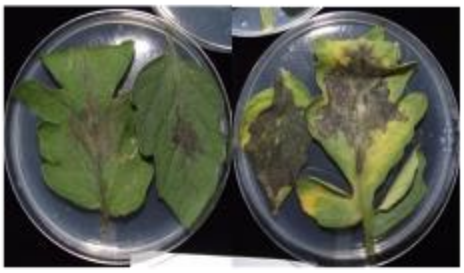


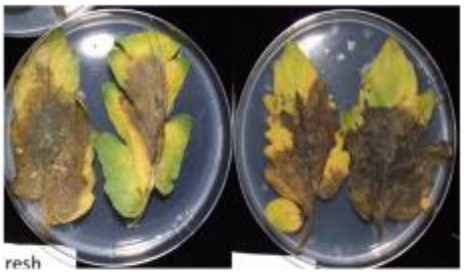
Figure 4. Average RAUDPC from *Fulvia fulva* variety trial. White letters in bars represent homogenous groups.
A) Average RAUDPC rating of varieties of experiment 1.
B) Average RAUDPC rating of varieties of experiment 2

Green Zebra-An attractive heirloom fruit, 2-4 oz., chartreuse with green stripes. A high yielding indeterminate variety with unknown disease resistance.



Lola-A round 7-9 oz. round fruit with firm texture An indeterminate variety with FFT resistance.

Mountain Fresh-An attractive flavorful red slicer that produces 8-16 oz. fruit. A determinate variety that is nematode tolerant and VFF resistant

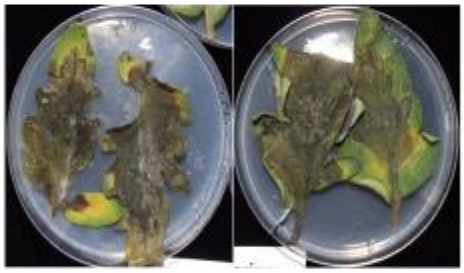


Sun Gold-A very sweet tasting bright orange colored cherry tomato,15-20 gm. An indeterminate variety that produces through the season and VFT resistant.

Cherokee Purple-A stunning deep purplish pink colored 10-12 oz. heirloom fruit. An indeterminate variety with Fusarium wilt resistance.

Mountain Magic-A bright red round salad tomato producing 2 oz. fruit. An indeterminate variety with late blight resistance and moderate early blight resistance.

Charger-An oblate crack resistant 10-14 oz. brilliant red fruit. A determinate variety with moderate gray leaf spot and TYLCV resistance along with VFFFASt resistance.

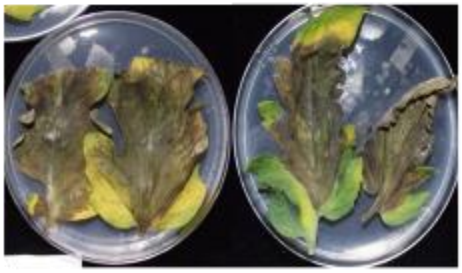


Mountain Spring-A brilliant red tomato produces 9-10 oz. fruit. A determinate variety with VFF resistance.

Bonny Best-A red round medium sized (8-10 oz) fruit that is meaty, flavorful and good for canning and slicing. An indeterminate variety with little known disease resistance.

Trust-A bright red beefsteak type tomato producing 8-10 oz. fruit. An indeterminate variety with VFFT resistance.

Striped German-A slightly flat red and yellow 12+ oz. fruit with an uneven ribbing on the shoulders. An indeterminate variety with unknown disease resistance.



Yellow Mini-A yellow sweet cherry tomato. An indeterminate variety that produces 15-20 gm. fruits and disease resistance is unknown.

Right fig 3. Pictures taken of each variety and their symptomatic responses to inoculation of *Fulvia fulva* the tomato leaf mold pathogen. A quick phenotypic summary of each tomato variety is listed next to corresponding picture.

Conclusion
Statistically there is a difference in the responses of tomato varieties to inoculation with the pathogen *Fulvia fulva*. It is likely that varietal selection can help growers in building an integrated management program for limiting tomato leaf mold. Cultivars Trust, Bonny Best and Striped German are the most susceptible to *Fulvia fulva* (Figure 4). Green Zebra and Mountain Fresh have the greatest resistance to leaf mold (Figure 4).

Objective Three: Develop a BioIntensive Integrated Pest Management (or BioIPM) guide for production of tomatoes in high tunnels for Wisconsin

Status: The BioIPM guide is in a draft format and will soon be submitted to MiMi Broeske of the UW-Nutrient and Plant Management Program for compilation and editing. The document has been co-authored by appropriate specialists within the UWEX Vegetable Production Team. We plan to make this guide available to producers as free downloadable pdfs at the UW-Potato and Vegetable Pathology website.

III. Goals and Outcomes Achieved

We achieved our project goals of contributing to approaches of integrated pest and disease management in high tunnel tomato production in Wisconsin. The approaches, activities, and results are included in the previous Section II of this report. Outcomes have included presentation of results in powerpoint presentations at the Wisconsin Fresh Fruit and Vegetable Grower Education Conference in the Wisconsin Dells in January 2015 and the Tomato and Sweet Corn School held in March 2015 in Hancock, WI. In addition, we have provided academic reports at several regional and national American Phytopathological Society meetings held in Minneapolis and Madison in 2014 and 2015.

B. We fulfilled our established goals of conducting cooperator research/outreach studies with Buchanan, Witte, and Cade in developing integrated disease management approaches targeting leaf mold, system-wide best management practices based on industry survey, and developing a Biointensive IPM production guide to share with growers and the allied industry partners. We conducted extensive grower outreach offerings during the production season as well as during winter months.

IV. Beneficiaries

The beneficiaries of this research and extension work have included current growers of tomatoes in high tunnel systems in Wisconsin, as well as those interested but not yet growing tomatoes in this system. Longer term, the information from this work will be disseminated throughout the Upper Midwestern production region as we begin to generate outreach documents online through our UWEX Vegetable Disease website and facebook venues.

V. Lessons Learned

First off, we learned that there were few to no insect pests affecting high tunnel tomato systems in Wisconsin. As such, we didn't have a standard insect management plan to include in a high

and low input system comparison. Further, there was no uniform fertility program in high tunnel tomato systems. We redirected our production research toward surveying growers to better identify standard practices and areas of production where questions were abundant. Further we focused research on disease control. In the disease work, we learned that the leaf mold fungal pathogen, *Fulvia fulva*, is not easy to work with in cultures nor as an inoculant on leaf tissues. The fungus should be handled more like one of the rust or powdery mildew fungi when considering an inoculation method. Also, we learned that the leaf mold pathogen is likely not a singular factor in causing this common disease in tomatoes grown in high tunnels in Wisconsin. Rather, there is likely a complex of relatively weak fungal pathogens that work in concert to cause leaf mold. We isolated more than one pathogenic organism in our work. And, we needed to spend time developing an appropriate inoculation method in order to conduct our variety trial and fungicide evaluation work – as we well as our leaf maturity assay. This adjustment to our work resulted in a bit of a delay in offering efficacy data producers in as timely a manner as we had initially anticipated. We also learned that coordinating a grower survey through UW-Madison's sponsored programs arm is a lengthy process. The review took us several more months than we anticipated and delayed our survey approach by about one year.

VI. Additional Information

We shared results of this work at several grower educational conferences including:

Wisconsin Fresh Fruit and Vegetable Grower Annual Meeting, Wisconsin Dells, 2014 & 2015
WFFVGA High Tunnel Tomato Spring Field Day, Hancock, WI 2014
WFFVGA Tomato and Corn Workshop, Hancock, WI 2015

Academic posters were prepared and presented at:

North Central Divisional American Phytopathological Society Meeting, Madison, WI June 2014
National American Phytopathological Society Meeting, Minneapolis, MI August 2014

VII. Contact Info

Tamas Houlihan
Executive Director
Wisconsin Potato Industry Board
P.O. Box 327
Antigo, WI 54409
715-623-7683
thoulihan@wisconsinpotatoes.com

10) Development of good manufacturing processes for the Wisconsin hop production industry (FY12-010)

Report Date: November 25, 2013

I. Project Summary

This proposal is focused on establishing proper hop processing procedures consistent with Good Manufacturing Principles expectations such as food processing facility regulations, quality control, documentation practices, and inventory management/product recall logistics. Regional hop production and processing is rapidly expanding to fill the demand of craft brewers. 95% of the hop industry is located in the Pacific Northwest and operated by very large corporations with extensive infrastructure. Craft brewers continue to turn to more local sources for their ingredients as it provides more unique identity to their product and bolsters local economy. Over the past five years regional hop production has grown from nearly zero to several hundred acres with an estimated crop value of $4M. Projections for the coming five years estimate acreage in the low thousands. High quality hop production has the potential to provide farmers with a new crop of very high value.

II. Project Approach

Recipients researched current food processing standards and adapted for use in the hop processing industry as well as drafted new guidelines to unify hop processing facilities, quality control procedures, and demonstration of quality control and food safety. A 101 page comprehensive manual resulted from this research and execution.

III. Goals and Outcomes Achieved

A.

Project Activity	Who	Timeline
Process Mapping • General inventory management requirements • General processing equipment requirements • General processing personnel requirements • General quality assurance/reporting requirements • General State processing requirements and applicability	Joseph Weger, Daniel Dettmers, Thad Moling, James Altwes	November 2012 – January 2013

Process Refinement • Inventory management architecture detailing: Receiving and tracking • Storage location tracking • Pre-processing tracking • Post-processing lot assignment • Processing equipment requirements detailing • Precautionary equipment requirements pertaining to food safety regulations • Operational flow for optimum efficiency • Material handling guidelines • Break-down, cleaning and sanitizing	Thad Molling, Joseph Wegner	February 2013-May 2013
Quality assurance and reporting requirements detailing: • Data collection based on USDA requirements • Data recording and batch association • Database best-practices • Batch vs Lot tracking • Product recall requirements	Thad Molling, Joseph Wegner	February 2013-May 2013
Governmental Requirements detailing: *(James Altwies)* • WI state CFR Chapter 70 compliance for hop processing • Risk assessment and compliance • Product classification	James Altwies	February 2013-May 2013
Personnel training requirements detailing: • Worker safety issues • Job tasks and expectations • Skill set requirements	James Altwies, Christine Molling	February 2013-May 2013
Process Drafting • Authoring a document consistent with current state format • Chapters divided according to the Process Refinement categories above	James Altwies	June - August 2013
Process Demonstration • Demonstrate execution of draft "GMP" plan during 2013 production season • Receipt of raw material • Pre-process tracking • Post-process tracking • Data management	Gorst Valley Hops	September - November 2013

• Product recall plan audit • In-process data collection and tracking • Final season audit		
Process Draft Revision	James Altwies	December 2013, Publishes January 2014

B. A comprehensive manual was produced allowing any hop processor to comply with food safety regulations, display quality control competency, and demonstrate both competence to the brewer customer base.

We have met with influential Brewers at New Glarus, Leinenkugels, and smaller regional brewers Wisconsin Breeding Company to discuss how they can base their expectations from their suppliers using the manual as a guideline. Most were specifically interested in the lot tracking and recall ability of the processor.

Three processors in Colorado, Michigan, and Connecticut are all using the manual as a base upon which to build new processing operations. Since the manual was only recently released we expect more adoption in the coming months as smaller farm based operations refine be their processes.

IV. Beneficiaries

- Growers – Hop growers rely on processing services to transform whole hop flowers into processed pellets. The appropriate equipment and procedures are quite costly and over-sized for numerous on-farm applications. Best estimates place the number of hop farmers in WI at 75-100. Additional growers from MI, IL using WI processing services are estimated at 50. The project positively impacts growers by offering a competent processing source that can confidently provide product to customers.
- Processors – Currently there are 4-5 hop processors in the WI/MI region. Some are quite sophisticated while others are struggling to establish any sort of protocols. While these numbers are small, these facilities are capable of processing thousands of pounds of hops. Since they are largely responsible for impacts on hop quality it is critical that these groups have a firm understanding and solid processes in place for their facilities. The project supplies new and current processors with a uniform system that established base-line operating procedures based on technical and business sensitive methods.
- Brewers – The customer base for local or regional hops continues to grow. As mentioned earlier, WI currently has near 70 craft breweries. Demand is far out-pacing supply and is spurring rapid hop production growth. Craft brewers are extremely conscious of ingredient quality for which they are willing to pay a premium. Locality is also important but not at the expense of quality. By providing quality hop products and confidence in processing operations, growers and processors will become a viable vendor base in the long term.
- Economic Impact – Using the projections outlined earlier, the potential hop market in the region could feasibly approach $15-$20M. At least 50% of this value could be realized

in Wisconsin. Brewers are currently pre-allocating hop products even before production begins for the season. Brewers losing confidence in the ability of local processors and growers to deliver quality products will directly reduce this income potential.

V. Lessons Learned

Detail oriented operational plans are essential for smooth, trouble-free hop processing facility operations. Many activities are taking place simultaneously and errors in material handling and data recording can happen very quickly. The processing system must be robust enough to not allow any stage in the process to be circumvented. As a result of physically executing the manual guidelines, we have refined activities to prevent any catastrophic mis-steps.

VI. Additional Information

See attached manual, ***Best Practices Guide for Hop Processing***

VII. Contact Info

James Altweiss
Gorst Valley Hops
9261 Gorst Rd
Mazomanie, WI 53560
608-334-8012
james@gorstvalleyhops.com

11) Timing of tissue analysis in cranberry (FY12-011)

Report Date: October 15, 2015

I. Project Summary

Tissue nutrient analysis is a key part to fertilizer management decisions. Since plant tissue nutrient content changes over the course of the growing season, it is important to understand these patterns and to take samples during the period of greatest stability in order to best develop nutrient management plans for the coming year, assist in sustainability goals, and maintain a healthy crop. Current recommendations are to sample tissue between August 15 and September 15 (Davenport et al., 1995). Recently introduced cultivars from Wisconsin and New Jersey have not been evaluated for their nutrient stability over the growing season. These new cultivars have been selected for a number of traits, including earliness of flowering, fruiting, and ripening, high yield, enhanced color, and rebud potential, all factors that could have an influence on the timing and degree of nutrient demand within the plant. In addition, other factors may influence the relative stability of tissue nutrient content, such as variable environmental conditions and grower practices. The goal of this project was to 1) compare the changes in tissue nutrient content change of two new varieties compared to a standard variety, and 2) evaluate these patterns of tissue nutrient stability during the season in relation to parameters such as calendar date, plant phenological stage, and growing degree day, to determine the most suitable marker for the timing of tissue sampling.

B. This research did not build on any previous Specialty Crop Block Grant

II. Project Approach

Materials and methods. To study patterns of nutrient stability, four sites were selected from the Cranmoor (3) and Tomah (1) areas that each had beds of 'Stevens' (ST), 'HyRed' (HR), and 'Crimson Queen' (CQ). One bed of each variety was sampled at each site with pooled samples taken from each third of the bed. ST beds ranged in age from 17 to 32 years, while HR and CQ bed ages each ranged from four to seven years. Over the growing seasons of 2013 and 2014 new growth (minus flowers or fruit) was sampled and sent to AgSource Cooperative Services for standard cranberry tissue analysis. Sampling was done every two weeks from early June to mid-August, then weekly until early October, for a total of 14 and 12 sample dates in each respective year. Additional data that was collected included canopy height air temperature, plant phenology/stages of growth, grower fertilizer and yield records. Results for the following nutrients have been the focus of analysis: macronutrients nitrogen (N), phosphorus (P), potassium (K), magnesium (Mg), and calcium (Ca), as well as micronutrients zinc (Zn) and copper (Cu).

Results and Discussion. Nutrient content values and patterns of change over the course of the growing season were generally similar over the two years (Figures 1-3). The pattern for each nutrient is unique, however, so attention to these patterns can help in the interpretation of test results, particularly if you have needed to sample outside of the traditionally accepted window period.

Nitrogen: Values were stable during the window (Figure 1). In 2013 values were generally lower from mid-season on because new stem tissue below the leaves was included (most nitrogen is found in leaves, as a part of the chlorophyll molecule). A period of fluctuation in values across all cultivars was seen going into the window period in 2014, but then values stabilized. The lowest values early in

the season corresponded with late bloom and fruit set for each cultivar were reached approximately one week sooner in HR and CQ than for ST.
Phosphorus: Tissue phosphorus levels were the most stable of all the nutrients. Values drop early in season and remain stable from July to October (Figure 1).
Potassium: Tissue potassium levels start high early in the season and then drop gradually, as opposed to the faster drop as with nitrogen and phosphorus (Figure 1). Steady drop continued through the window period. In 2013 there was a sharper decline and this occurred slightly earlier in HR and CQ than in ST. Deficiency does not appear to be an issue at any of these sites. Values were most stable in latter part of the window period. High potassium fertilization rates, especially late in the season, have not been shown to increase plant cold hardiness and typically results in lower calcium and magnesium by competing for exchange sites in the soil.

Magnesium: Tissues levels of magnesium peak during, or slightly after the current window period, and have the potential to have a wide range (Figure 2). Therefore, it will be important to bear this in mind when comparing values across years.
Calcium: Tissue calcium levels are lowest in the early season and do not peak until late September/early October (Figure 2). Values are notably different at the end of the window period, as opposed to the beginning of it. In both 2013 and 2014, values at these sites were notably above the upper limit of the normal range for most of the growing season.
Zinc: On most sample dates zinc tissue levels were fairly stable with low variability; however, on seemingly random dates zinc levels were both higher and highly variable (Figure 3). This may have been due to contamination on the surface of the leaves or some other cause, but test results higher than the normal range are possible at anytime in the season.
Copper: This was the only nutrient in the study that consistently had values at or below the normal range value across all cultivars (Figure 3). Values were lowest in the window period and lower in HR and CQ than in ST. In 2013, values stayed low, whereas in 2014 values rose in late September and early October. Copper deficiency is not commonly discussed in cranberry nutrition, but this may be worthy of attention. In most plant species, the most common symptom of deficiency is yellowing in young leaves. This occurs due to the essential role that copper plays in enzyme function during photosythesis (Havlin et.al., 2014). Copper in the form of Cu^{2+} is strongly bound to organic matter in the soil.

Comparison of calendar date, growing degree days, and phenology: Alternatives to considering the timing of changes or unexpected values in tissue nutrient content by calendar date is by either phenology (growth stage) or growing degree days. This would be useful if there are changes that are driven more independently by another factor, like temperature, rather than time. For the two years of this study, growing degree days were not accumulated at rates or totals different enough (Figure 4) to result in different patterns of nutrient content change (data not shown). Although HR and CQ flower, fruit, and ripen earlier than ST, only small differences in the timing of content change of nutrients such as nitrogen, phosphorus, and magnesium were noticeable in mid to late June (bloom to fruit set), as well as in August and September (fruit ripening).

Grower management and crop production: Despite the fact that the HR and CQ beds for this study were much younger than the ST beds, the values and patterns of tissue nutrient content change were similar. Grower records of applied fertilizer (Figure 5) and yield (Figure 6) show that these consistencies occur even though there are differences in grower management and crop production. These growers tend to apply as much or more nitrogen and phosphorus to HR and CQ than to ST. In 2014 there was a wide range of approach to the amount of potassium to apply to all beds (average of 223 lbs/a at Site A to 69 lbs/a at Site D). Yields of ST were more consistent than those of HR or CQ,

an indication that the management of these new cultivars is still a work in progress. Despite the differences in predictability, tissue nutrient content levels and their patterns were largely consistent across cultivars and between sites.

Conclusions.

- As with Stevens, the current sampling window of August 15 to September 15 is the best time frame for the newer cultivars of HyRed and Crimson Queen.
- The tissue nutrient content stability of several nutrients, such as nitrogen, phosphorus, and potassium, appear to be more stable in the latter portion of this window (early September).
- Growing degree days and phenology do not appear to be better gauges of tissue nutrient content change than calendar date.

Literature cited.

Davenport, J., C. DeMoranville, J. Hart, K. Patten, L. Peterson, T. Planer, A. Poole, T. Roper, and J. Smith. 1995. Cranberry Tissue Testing for Producing Beds in North America. Oregon State University Extension Bulletin EM 8610.

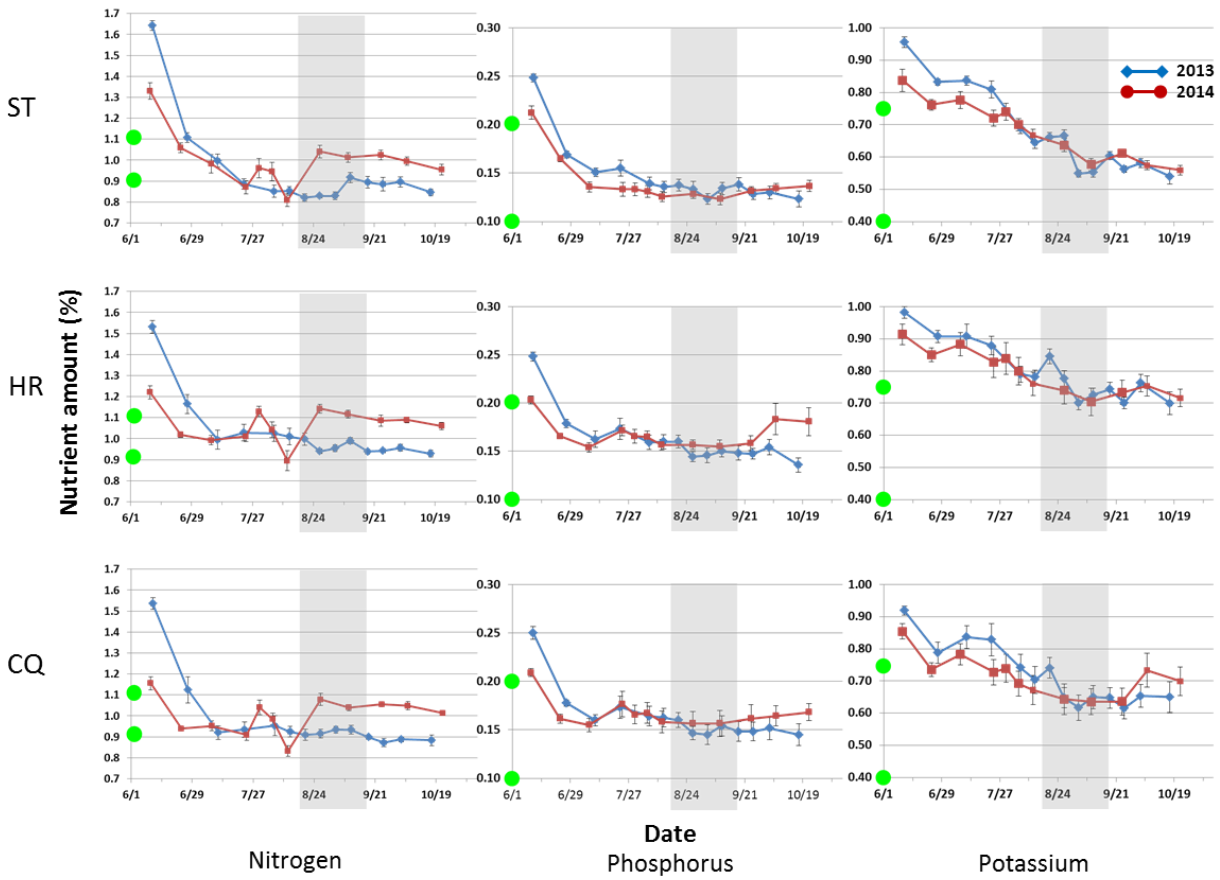


Figure 1. Nitrogen, phosphorus, and potassium tissue content for uprights sampled from four central Wisconsin cranberry marshes in 2013 and 2014. Green dots signify normal range for nutrient. Error bars show the standard error of the mean (n=12). The current mid-August to mid-September sampling window is highlighted in gray.

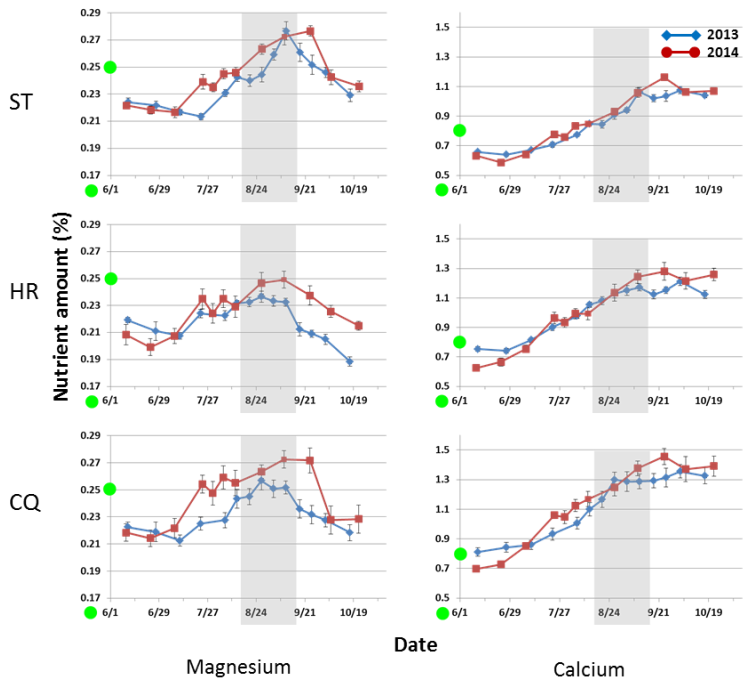


Figure 2. Magnesium and calcium tissue content for uprights sampled from four central Wisconsin cranberry marshes in 2013 and 2014. Green dots signify normal range for nutrient (lower points of range for magnesium = 0.15%; for calcium = 0.3%). Error bars show the standard error of the mean (n=12). The current mid-August to mid-

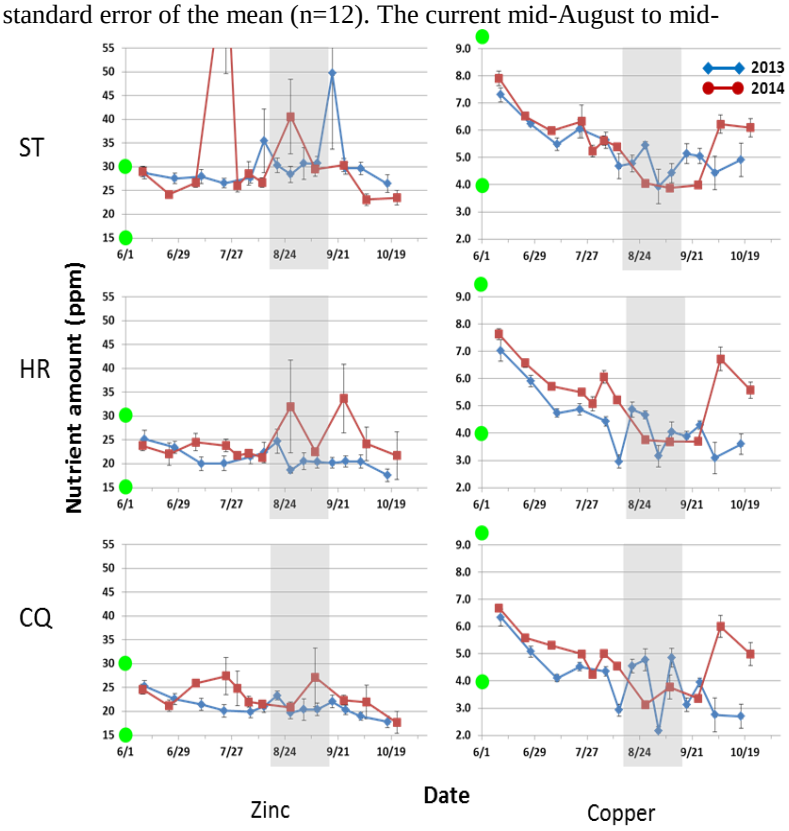


Figure 3. Zinc and copper tissue content for uprights sampled from four central Wisconsin cranberry marshes in 2013 and 2014. Green dots signify normal range for nutrient (upper point of range for copper = 10 ppm). Error bars show the standard error of the mean (n=12). The current mid-August to mid-September sampling window is highlighted in gray.

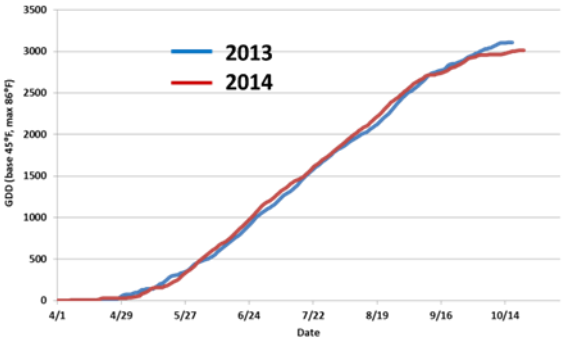


Figure 4. Accumulation of growing degree days (GDD) for Cranmoor/Tomah, Wisconsin area for 2013 and 2014 using canopy-height temperatures from four sites. Daily values calculated from maximum and minimum temperatures, and base and upper limits of

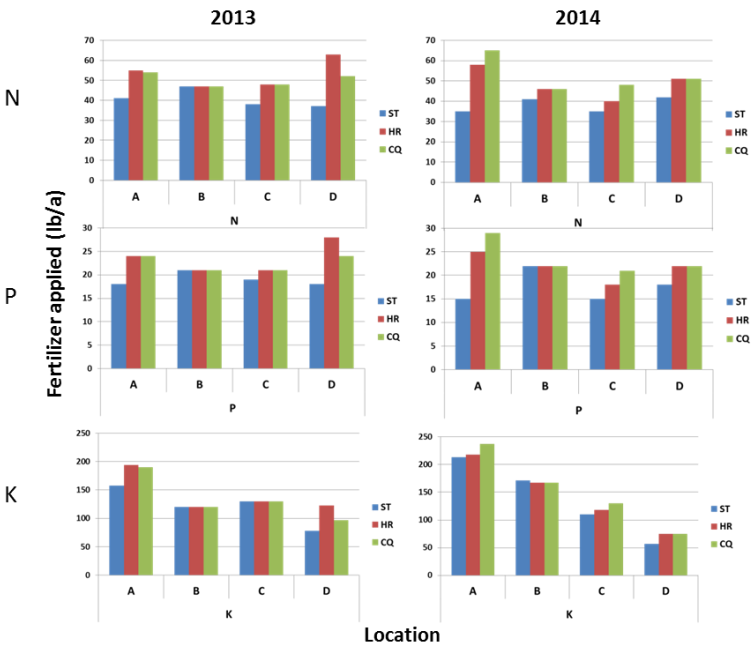


Figure 5. Annual fertilizer amounts of nitrogen (N), phosphorus (P), and potassium (K) applied to beds of Stevens (ST), HyRed (HR), and Crimson Queen (CQ) at grower sites A-D in 2013 and 2014.

III. Goals and Outcomes Achieved

Patterns of nutrient content change over the course of the growing season was established through this study. Since 2013 and 2014 were similar environmentally, the growing degree day accumulation was too similar to be able to discern the potential contribution of this factor on cranberry tissue nutrient content change. Differences in phenological stage changes across the cultivars were timed too closely to discern differences potentially attributable to this factor.

Updates and results were orally presented at the 2014 and 2015 Wisconsin State Cranberry Growers Association Cranberry School winter meetings. In addition, a poster presentation was made at the 2015 North American Cranberry Research and Extension Workers Conference. A manuscript is being

prepared for publication in a peer-reviewed journal. Growers will be surveyed during the clicker-question session at the 2016 Cranberry School regarding any impact on their tissue sampling strategies for these and other new cultivars.

B. Key baseline information toward developing the relationship between environmental and developmental factors with nutrient content change has been achieved with this study. Additional data in the future will provide a useful comparison to this baseline. The original goal was for adoption of any recommendations by at least 80% of the growers. These results led to the conclusion that the current sampling time window for cranberry upright tissue nutrient analysis, August 15 to September 15, is an appropriate one for the newer varieties of Crimson Queen and HyRed. Therefore, no adjustment to current practice is recommended at this time. Many nutrients, such as nitrogen, are more stable later in this window, so growers may choose to wait to perform their sampling. The current conclusions from this work was presented to approximately 300 cranberry growers at the WSCGA Cranberry School in January, 2015.

IV. Beneficiaries

The 260+ cranberry growers of Wisconsin are the main beneficiaries of this project's completion. It is recommended for all growers to sample for tissue nutrient content from at least some of their beds every year, so as to be able to make the best informed fertilizer decisions for the following growing season.

V. Lessons Learned

By completing this project we learned that this type of data collection, while expensive, is relatively easy to achieve and can yield highly valuable data. Future work on additional aspects of tissue nutrient content changes and grower nutrient management decisions could readily incorporate this methodology.

VI. Additional Information

None

VII. Contact Info

Beth Ann Workmaster
Researcher – Dept. of Horticulture
University of Wisconsin - Madison
273 Moore Hall-Plant Sciences
1575 Linden Dr
Madison, WI 53706 715-623-7683
thoulihan@wisconsinpotatoes.com

12) Neonicotinoid use patterns in Central Sands (FY12-012)

Report Date: November 1, 2015

I. Project Summary

Most insecticides used for control of Colorado potato beetle (CPB) in the Northeast and Midwest US have failed because of resistance that has developed in populations of this problematic insect. Increasingly, growers rely heavily on a single class of insecticides called the neonicotinoids (i.e.: imidacloprid, thiamethoxam, clothianadin, dinotefuran) for control of CPB (NASS 2006). Imidacloprid resistance first appeared in NY in 1997, and is now common in the northeast and appeared in the Michigan in 2004 and in Wisconsin in 2007. Growers in these regions of the US are experiencing serious control problems, including multiple locations in Maine, Michigan, and Wisconsin. This erosion of control with the neonicotinoids threatens the continued effectiveness of current CPB control programs and may seriously alter the economics of potato production. We now also know that the neonicotinoids have been detected in groundwater samples since 2008. The explanations for how these contaminations have occurred is unclear, and the association with particular use patterns of these water-soluble insecticides is of critical importance for the state and the region requiring further investigation for more practical and long-term CPB control.

In the field, insecticide resistance can initially be observed as only a minor reduction in the observed level of control. It is often only until resistance has become genetically fixed in the population when we begin to see full-scale field failures. In the laboratory, resistance is typically measured with a bioassay as an increase in the dose (LD50) or concentration (LC50) of the toxin required to kill 50% of the test population. Over the 2009-2011 production seasons, our laboratory conducted surveys to measure the insensitivity among populations of CPB to the neonicotinoid class of insecticides in Wisconsin. Measured responses were assessed for selected, in-state populations and compared directly to a highly susceptible, reference control strain of CPB obtained from a laboratory colony in New Jersey. It is important to note that sites were not selected at random across these areas. A portion of candidate populations evaluated in this survey were selected with the prior knowledge that some were difficult to control with neonicotinoid tools.

Another important observation surrounding the emergence of neonicotinoid resistance and widespread use is the recently reported detections of the neonicotinoid insecticides in Wisconsin's groundwater resources. A 2005, Wisconsin Department of Agriculture, Trade and Consumer Protection (DATCP) report indicated that approximately 13 million pounds of pesticides are applied to major agricultural crops in Wisconsin each year, including over 8.5 million pounds of herbicides, 315,000 pounds of insecticides, one million pounds of fungicides, and 3 million pounds of other chemicals (this last category applied mainly to potatoes). The report also showed that herbicides were used on 92% of carrots for processing, 99% of potatoes, 98% of cucumbers for processing, 88% of soybeans, 97% of field corn, 89% of snap beans for processing, 87% of sweet corn, and 84% of green peas for processing. Insecticides were used on 97% of potatoes, 96% of carrots, and 88% of apples. Fungicides were used on 99% of potatoes, 88% of carrots, and 89% of apples. Under Wisconsin's groundwater law, the Department of Natural Resources (DNR) adopts numerical standards for contaminants in groundwater. The DNR can then adopt an enforcement standard and a lower preventive action limit for any contaminant. These standards are contained in Wisconsin Administrative Code chapter NR 140 and standards are based on public health recommendations. Importantly, WI DATCP regulates pesticide use in Wisconsin and reports and reviews groundwater

monitoring data, and acts to prevent pesticide contamination of groundwater. In 2008, DATCP began testing for the neonicotinoid class of insecticides in private groundwater test wells in the state (**Table 1**). In the first year of testing, concentrations of thiamethoxam were observed in 9 separate well samples, but none were considered above acceptable levels as there were no current enforcement standards for this active ingredient.

Table 1. Groundwater detections of thiamethoxam (neonicotinoid insecticide) in Wisconsin private wells (2008-09).

Well Location	Date(s)	Thiamethoxam Concentration Range (ppb)[1]
Private well near Lone Rock	6/23/09 & 6/9/09	0.693-1.26
Private Well near Arena	6/23/08	0.656
Private well near Edgerton	11/2/09	1.61
Monitoring well Adams County	2008 and 2009*	0.82-8.93
Monitoring well Grant County	4/7/08	1.25
Monitoring well Iowa County	2008 and 2009*	0.784-2.04
Monitoring well Iowa County	2008 and 2009*	0.671-2.85
Monitoring well Sauk County	2008 and 2009*	1.47-3.66
Monitoring well Waushara County	8/19/08 & 12/1/08	0.638-0.704

B. A version of this project was originally submitted for funding to the Wisconsin Department of Agriculture, Trade and Consumer Protection's, USDA, Specialty Crops Block Grant Program in the funding cycle of 2011. In the previous submission, a principal focus of the project focused on characterization of CPB insecticide resistance to the neonicotinoid class (IRAC, Group 4A) and biochemical mechanisms of resistance (e.g. target-site, cytochrome P450, and lipid excretion). Editorial reviews of the previous submission were favorable and the project was listed as, "fund if available". However, insufficient funds were available in 2011, and the project was not supported. Over the 12 months following the original submission, new information had emerged describing the environmental consequences of the now widespread, neonicotinoid use in several cropping systems in the Central Sands Eco-Region of Wisconsin. In turn, a focus of this research proposal was then centered on determining the extent of insecticide resistance in populations of the Colorado potato beetle, the relationship of current insecticide use patterns on the in-plant concentrations of neonicotinoid insecticides, and ways to describe both the spatial extent of groundwater contaminants and further limit the potential for groundwater contamination in the Central Sands.

II. Project Approach

Objective 1. *Continued assessment of CPB insensitivity to neonicotinoid insecticides within Wisconsin.*

In each year of these investigations, correspondence was maintained with University and Extension personnel, consultants, agrichemical representatives, and growers to identify and send in suspect populations for testing representing: 1) potato seed production, 2) commercial potato production, and 3) sites where CPB populations were showing some level of insensitivity. Over the term of this proposal (2011-14), resistance monitoring was performed on a select number of fields in Wisconsin

where neonicotinoid insensitivity is reportedly high. In particular, we collected adult beetles from among 5 separate field locations in Wisconsin (**Table 2**).

Table 2. Parameter estimates of measured neonicotinoid (imidacloprid) resistance among five Colorado potato beetle populations in Wisconsin.

Population	Year[1]	N[2]	Slope(SEM)[3]	LC_{50} (PPM)	95% CI	Resistance Ratio[4]
Arlington	2011	600	3.13(0.33)	0.027	(0.028-0.34)	NA
Hancock	2011	525	1.47(0.11)	0.48	(0.4-0.6)	17.77
systemic-1	2011	425	1.63(0.14)	0.72	(0.59-0.87)	26.66
systemic-2	2011	524	1.9(0.27)	0.62	(0.41-0.94)	22.96
systemic-3	2011	500	2.03(0.73)	0.73	(0.51-1.04)	27.03
Arlington	2013	400	2.23(.25)	0.09	(.08-.12)	NA
Hancock	2013	300	0.73(.23)	0.91	(.49-4.30)	10.11
systemic-1	2013	350	0.69(.26)	1.83	(.21-12.36)	18.18
systemic-2	2013	350	1.49(.37)	1.10	(.58-1.61)	11.11
systemic-3	2013	350	2.08(.30)	1.20	(.94-1.57)	12.12
Arlington	2014	500	0.55(.12)	4.72	(1.57-10.74)	NA
Hancock	2014	500	0.80(.09)	8.69	(5.00-15.19)	1.84
systemic-1	2014	500	1.05(1.0)	12.81	(8.73-19.96)	2.71
systemic-2	2014	500	0.71(.09)	43.67	(23.60-109.27)	9.25
systemic-3	2014	500	0.66(.09)	52.68	(25.31-154.56)	11.16

[1]Sample year of testing
[2]Number of adult insects evaluated in topical bioassays
[3]Slope and associated standard errors associated with regressions of probit mortality and log dose
[4]Estimated resistance ratios calculated as the ratio of test population to the reference control strain (Arlington) populations.

Briefly, adult beetles were collected and returned to the UW-Madison campus where bioassays were performed immediately to establish resistance levels. Adult bioassays were performed by treatments with a topical application of technical grade insecticide dissolved in acetone, 120 beetles/dose (4 replicates of 30 beetles/replicate), 5 doses causing between 0 and 100% mortality, plus 30 beetles treated only with acetone. Measured responses are assessed and compared directly to a highly susceptible, reference control strain of CPB obtained from the Arlington Agricultural Research Station.

Objective 2. *Determine the relationship of insecticide use patterns and in-plant insecticide concentrations and further determine the influence of insecticide use on neonicotinoid leaching*.

Leaching experiments were conducted 6 km east of Coloma, Wisconsin at a commercial potato farm. Experiments were planted in two different fields approximately 0.5 km apart on 20 May and 11 May over the two years of the study. A randomized complete block design with four insecticide delivery treatments and an untreated control was established using the potato cultivar, 'Russet Burbank'. Plots were 0.067 ha in size and planted at a rate of one seed piece per 0.3 m with 0.76 m spacing between rows. Each year, experiments were nested within a different ~32 ha commercial potato field, and maintained under commercial management practices by the producer, with the exception of

insecticide inputs. All other inputs and production strategies (e.g. tillage, fumigation, fertility, and disease management) were conducted by the producer with equipment and products consistent with the broader industry. Prior to planting in each season, a tension plate lysimeter (25.4 x 25.4 x 25.4 cm) was buried at a depth of 75 cm below field level. Lysimeters were constructed of stainless steel with a porous stainless steel plate affixed to the top to allow water to flow into the collection basin over each sampling interval. Experimental blocks were connected with 9.5 mm copper tubing to a primary manifold and equipped with a vacuum gauge. A predefined, fixed suction was maintained under regulated vacuum at 107±17 kPa (15.5±2.5 lb per in2) with a twin diaphragm vacuum pump (model UN035.3 TTP, KnF, Trenton, NJ) and a 76 L portable air tank. Each treatment block was equipped with a data-logging rain gauge (Spectrum Technologies, Inc. model # 3554WD1) recording daily water inputs at a five minute interval. Data was offloaded with Specware 9 Basic software (Spectrum Technologies, Inc., Plainfield, IL, USA) and aggregated into daily irrigation or rain event totals using the aggregate and dcast function in R (package: plyr).

Thiamethoxam treatments (Platinum® 75SG, Syngenta, Greensboro, NC) were selected to represent a common, soil-applied insecticide in potato. A second formulation of thiamethoxam was selected to represent a common pre-plant insecticide seed treatment in potato (Cruiser 5FS, Syngenta, Greensboro, NC). Commercially formulated insecticides were applied at maximum labeled rates for in-furrow (140 g thiamethoxam ha-1) and seed treatment (112 g thiamethoxam ha-1 at planting density of 1,793 kg seed ha-1) for potato. A CO2 pressurized, backpack sprayer with a single nozzle boom was used to deliver an application volume of 94 liters per hectare at 207 kPa through a single, extended range, flat-fan nozzle (TeeJet XR80015VS, Spraying Systems, Wheaton, IL) for in-furrow applications. Spray applications were directed onto seed pieces in the furrow at a speed of one meter per second and furrows were immediately closed following application. A novel soil application method, impregnated copolymer granules, was included as another treatment in an attempt to stabilize applied insecticide in the soil. Polyacrylamide horticultural copolymer granules (JCD-024SM, JRM Chemical, Cleveland, OH) were impregnated at an application rate of 16 kg per hectare. Thiamethoxam (0.834 g, Platinum® 75SG) was initially diluted in 250 mL of deionized water and 100 µL of blue food coloring was incorporated into solution to ensure uniform mixing (brilliant blue FCF). Insecticide solutions were mixed with 75 g polyacrylamide then stirred until the liquid was absorbed and a uniform color was observed. Impregnated granules were vacuum dried in the absence of light for 24 hours at 20°C. Treated granules were divided into even quantities per row and evenly distributed into the two center rows for each treatment respectively. Additionally as an alternate delivery method, a single series of two, foliar treatments of thiamethoxam (Actara® 25WG, Syngenta, Greensboro, NC) was were applied using a CO2 pressurized backpack sprayer delivering an application volume of 187.1 liters per hectare at 207 kPa through four, extended range flat-fan nozzles (TeeJet XR80015VS, Spraying Systems, Wheaton, IL) spaced at 45.2 cm.

Lysimeter leachate was sampled bi-monthly beginning in June and concluding in October over two years. Total leachate volume was recorded for each plot. A 500 mL subsample was taken from each plot into a 0.5 L glass vessel and immediately placed on ice and refrigerated at 4-6°C in the laboratory prior to analysis. Bi-monthly samples were homogenized into a 400 mL monthly sample as percent volume per volume dependent on total catch measured in the field. Neonicotinoid residues from monthly water samples were extracted using automated solid phase extraction (AutoTrace SPE workstation, Zymark, Hopkinton, MA) with LiChrolut® EN SPE columns (Merk KGaA, Darmstadt, Germany). Sample extracts were analyzed using a Waters 2690 HPLC/Micromass Quattro LC MS/MS (Waters Corporation, Milford, MA). All thiamethoxam residues were identified, quantified, and confirmed by liquid chromatography mass spectrometry (LC/MS) by the Wisconsin Department of Agriculture Trade and Consumer Protection-Bureau of Laboratory Services.

To determine the impact of different insecticide delivery treatments on thiamethoxam leachate detected over time, we reported the mean concentration over a period of several months (**Fig. 1**).

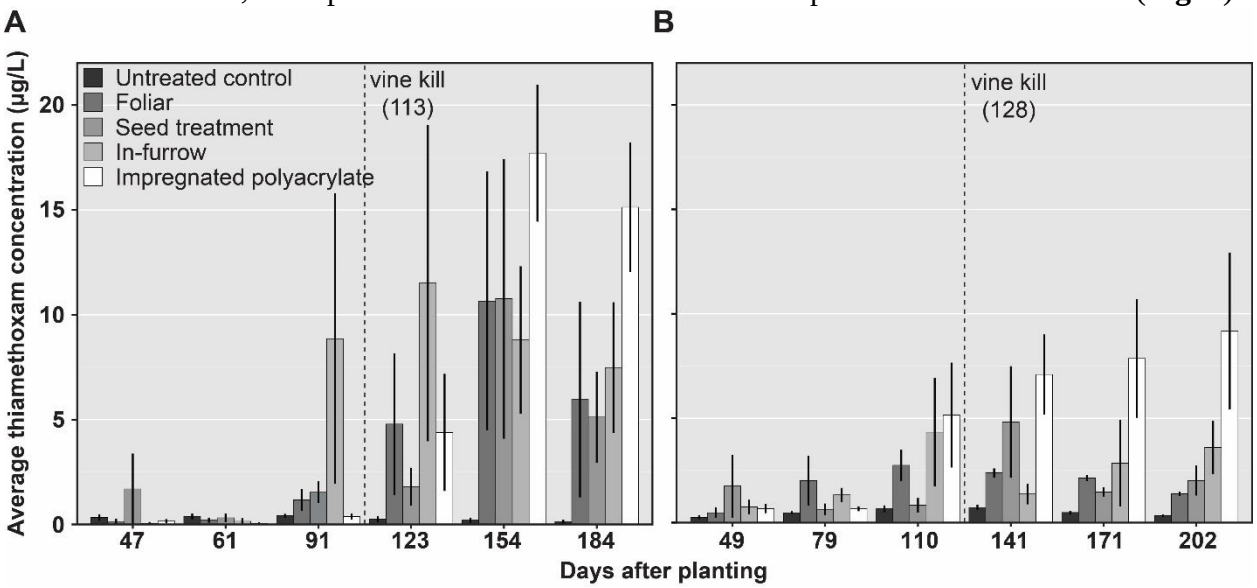


Figure 1. Thiamethoxam concentration in leachate from potato. Average thiamethoxam (±SD) recovered from in-furrow and foliar treatments in (A) 2011 an (B) 2012. Dotted lines indicate the date that the producer applied vine desiccant prior to harvest.

All data manipulation and statistical analyses of leachate concentrations were performed in R, version 2.15.2 using the base distribution package. Functions used in the analysis are available in the base package of R unless otherwise noted. Observed concentration for time points in each year were subjected to a repeated-measures analysis of variance (ANOVA) using a linear mixed-effects model to determine significant delivery (i.e. treatment), date, and delivery x date effects ($P<0.05$). Because the agronomic conditions differed between years and given that our comparison of interest was at the insecticide delivery treatment level, insecticide concentrations were analyzed separately for each year. Mixed-effects models were fit using the lme function (package nlme).

The neonicotinoid insecticide thiamethoxam was included in field experiments to investigate the potential for leaching losses associated with different types of pesticide delivery. We hypothesized that thiamethoxam would be most vulnerable to leaching early in the season when plants were small and episodic heavy rains can be common. Interestingly, we observed the greatest insecticide losses following vine-killing operations which much later in the growing season (**Fig. 1**). Detections of thiamethoxam in lysimeters varied between treatments through time in 2011 (treatment x day interaction, $F=2.1$; d.f.=20,88; $P=0.0131$) and again in 2012 (treatment x day interaction, $F=1.8$; d.f.=20,87; $P=0.0384$). Moreover, the impregnated polyacrylamide delivery produced the greatest amount of thiamethoxam leachate late in each growing season (**Fig. 1**) when compared with other types of insecticide delivery.

Objective 3. *Investigate the spatial scale of insecticide (neonicotinoid) contamination in groundwater using state sampling techniques.*

<u>Groundwater contamination.</u> Permanent groundwater monitoring wells maintained by the Wisconsin Department of Agriculture, Trade and Consumer Protection-Environmental Quality Section (WI DATCP-EQ) were used to measure neonicotinoid contamination of subsurface water resources as one

component of an ongoing study documenting agrochemical (e.g., insecticides, herbicides, nutrients) impact on groundwater quality. Beginning in 2006, analytical water quality assessments for neonicotinoid contamination were conducted by the Wisconsin Department of Agriculture Trade and Consumer Protection-Bureau of Laboratory Services. Concentrations of acetamiprid, clothianidin, dinotefuran, imidacloprid, and thiamethoxam were monitored in 20-30 different monitoring well locations from 2006-2012. Data provided by WI DATCP-EQ characterize the temporal and spatial profile of thiamethoxam and other neonicotinoid detections that occurred between 2008-2012, and these data are presented in summary (**Table 3**).

Table 3. Positive (means±SD) neonicotinoid detections in groundwater from 2008-2012, State of Wisconsin Department of Agriculture Trade and Consumer Protection.

							Insecticide concentration (µg/L)[d]		
Year	***County***	***Area potato (ha)***[a]	***Row crops (ha)***[b]	***Percent potato***[c]	***Well ID***	***N positive samples***	***clothianidin***	***imidacloprid***	***thiamethoxam***
2008	*Adams*	*2,617*	*21,385*	*10.9*	*6*	*2*	*-*	*-*	*4.34 (4.97)*
	Grant	*0*	*47,827*	*0.0*	*10*	*1*	*-*	*-*	*1.25*
	Iowa	*18*	*25,795*	*0.1*	*11,12,13*	*9*	*-*	*-*	*1.50 (0.67)*
	Richland	*29*	*9,582*	*0.3*	*16*	*1*	*-*	*-*	*0.69*
	Sauk	*30*	*31,931*	*0.1*	*17*	*2*	*-*	*-*	*2.41 (1.32)*
	Waushara	*2,630*	*29,447*	*8.2*	*20*	*2*	*-*	*-*	*0.67 (0.05)*
2009	*Adams*	*3,989*	*24,894*	*13.8*	*6*	*2*	*-*	*-*	*5.31 (5.12)*
	Dane	*22*	*101,527*	*0.0*	*9*	*1*	*-*	*-*	*1.61*
	Iowa	*343*	*33,375*	*1.0*	*11,12*	*3*	*-*	*-*	*1.31 (0.68)*
	Richland	*87*	*14,402*	*0.6*	*16*	*1*	*-*	*-*	*1.26*
	Sauk	*328*	*40,571*	*0.8*	*17*	*2*	*-*	*-*	*3.00 (0.94)*
2010	*Adams*	*4,188*	*24,871*	*14.4*	*6*	*4*	*3.43*	*-*	*2.97 (2.04)*
	Brown	*1*	*39,322*	*0.0*	*7*	*1*	*-*	*-*	*0.52*
	Dane	*34*	*110,979*	*0.0*	*8,9*	*4*	*0.54 (0.24)*	*0.54*	*1.08*
	Grant	*49*	*74,566*	*0.1*	*10*	*1*	*0.73*	*-*	*-*
	Iowa	*356*	*38,840*	*0.9*	*11,12,13*	*7*	*-*	*-*	*1.25 (1.02)*
	Sauk	*188*	*45,309*	*0.4*	*17*	*5*	*0.41*	*-*	*1.81 (0.88)*
	Waushara	*4,184*	*33,576*	*11.1*	*19,20*	*2*	*-*	*2.77 (0.81)*	*-*
2011	*Adams*	*4,066*	*27,693*	*12.8*	*2,5,6*	*9*	*0.63 (0.36)*	*0.33*	*0.63 (0.26)*
	Brown	*7*	*38,309*	*0.0*	*7*	*1*	*-*	*-*	*0.21*
	Dane	*33*	*107,214*	*0.0*	*8*	*2*	*0.62 (0.19)*	*-*	*-*
	Grant	*13*	*75,436*	*0.0*	*10*	*1*	*0.30*	*-*	*-*
	Iowa	*47*	*40,138*	*0.1*	*12*	*4*	*-*	*0.34 (0.09)*	*0.88 (0.23)*
	Portage	*7,364*	*45,324*	*14.0*	*15*	*1*	*-*	*-*	*0.32*
	Sauk	*213*	*46,686*	*0.5*	*17,18*	*5*	*0.54 (0.10)*	*-*	*1.92 (0.43)*
	Waushara	*4,536*	*36,676*	*11.0*	*19,20,21,23*	*23*	*0.25 (0.03)*	*0.78 (0.69)*	*1.40 (0.56)*
2012	*Adams*	*4,263*	*27,037*	*13.6*	*1,3,4,6*	*6*	*0.52 (0.30)*	*0.51 (0.26)*	*0.27*
	Dane	*11*	*115,501*	*0.0*	*8*	*1*	*0.67*	*-*	*-*
	Grant	*4*	*72,920*	*0.0*	*10*	*1*	*0.26*	*-*	*-*
	Iowa	*369*	*40,764*	*0.9*	*12*	*2*	*0.24*	*0.28*	*0.44*
	Juneau	*907*	*28,542*	*3.1*	*14*	*2*	*0.42 (0.18)*	*-*	*0.20*
	Portage	*7,622*	*46,337*	*14.1*	*15*	*2*	*-*	*0.47*	*0.47*
	Waushara	*5,904*	*38,999*	*13.1*	*21,22,23*	*13*	*-*	*0.68 (0.88)*	*1.51 (0.72)*
			summary	*N =*	*23*	*67*	*25*	*30*	*68*
						Average	*0.62 (0.63)*	*0.79 (0.83)*	*1.59 (1.51)*
						Range	*0.21-3.34*	*0.26-3.34*	*0.20-8.93*

III. Goals and Outcomes Achieved

Improvement of resistance management and environmental quality through fundamental and applied research in Wisconsin will provide the necessary incentive for growers to reinvest in reduced risk practices. Promotion of innovative groundwater management practices within the USDA and NRCS's Environmental Quality Incentive Program (EQIP) may further promote greater awareness and acceptance of these practices through economic incentives. With EQIP, potato growers experiencing elevated neonicotinoid resistance and insecticide loss may optimize pest management by adopting innovative management for greater farm profitability, resource conservation, environmental assessment, and biodiversity restoration. Proposed outcomes of our research will be consistent with objectives of the U.S. Farm Bill by addressing pest management needs of the growers while working to limit non-target impacts to the environment. Moreover, the outcomes of the generated research will (1) begin to build a more comprehensive picture of the extent of neonicotinoid resistance in the upper Midwest production region, (2) the potential for neonicotinoid movement into groundwater resources, and (3) the extent of off-site movement of selected neonicotinoids through a cluster analysis water-monitoring survey.

An additional extension outcome will be an increased level of resistance management adoption at the level of 50%. We have used survey methods to document that growers, land managers, and pest management practitioners have reached, or exceeded, their resistance management targets. Specifically, we coordinated these surveys through the Wisconsin Potato and Vegetable Growers Association, Annual Grower Education Conference held in Stevens Point, WI February 2013 and the outcome of their Environmental Impact Quotient scores are provided (**Fig. 2**).

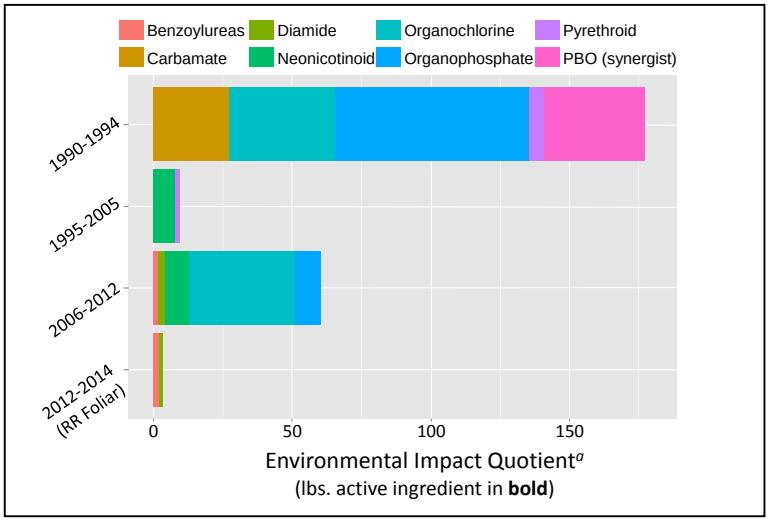


Figure 2. Environmental impact quotient estimates associated with periods of elevated levels of Colorado potato beetle resistance to insecticides in the discrete time frames (1990-94) and again (2006-2012). Prevailing insecticide resistance issues in each time frame resulted from synthetic pyrethroid and neonicotinoid insensitivity, respectively.

B. Experimental results were presented through the horticultural crops Extension Entomology program via field days (2013 and 2014, Hancock Potato Field Days), the vegetable extension newsletter (http://www.plantpath.wisc.edu/vegetable-newsletter-supplement-3-released), and formal conference presentations including the WPVGA Grower Education Conference in both 2013 and

2014. Research results were also published in the scientific literature through a combination of research venues as follows:

- Huseth, A.S., Groves, R.L., Chapman, S.A., Alyokhin, A., Kuhar, T.P., McRae, I.V., Szendrei, Z. and Nault, B.A. 2014. Managing Colorado Potato Beetle Insecticide Resistance: New Tools and Strategies for the Next Decade of Pest Control in Potato. J. Integ. Pest Mgmt. 5(4):http://dx.doi.org/10.1603/IPM14009.
- Huseth A.S. and Groves, R.L. 2014. Environmental Fate of Soil Applied Neonicotinoid Insecticides in an Irrigated Potato Agroecosystem. PLoS ONE 9(5): e97081. http://doi:10.1371/journal.pone.0097081.

- Huseth, A.S., Lindholm, J., Groves, C.L., and Groves, R.L. 2014. Variable concentration of soil-applied insecticides in potato over time: implications for management of *Leptinotarsa decemlineata*. Pest Mgmt. Sci. 70:1863-1871.

IV. Beneficiaries

Research objectives outlined in this study are anticipated to benefit agricultural producers, crop consultants, University of Wisconsin Specialists and County Educators, and other stakeholders and will be essential for properly timing insect population control measures and further limiting environmental contamination. The proposed project was submitted and supported by the Wisconsin Potato and Vegetable Growers Association (WPVGA). The mission of the WPVGA is to assist members to be successful through education, information, environmentally sound research, promotion, government action, and involvement. The WPVGA has directly coordinated the execution of the sub-contracted research with the University of Wisconsin in support of the research and funding. Moreover, they have worked closely with each participating program and monitor progress throughout the term of the granting period. Preliminary reports from this research have been presented at the annual meeting in Stevens Point, WI in February 2013 and 2014. A more comprehensive and sustainable management approach to document the potential for insecticide movement into, and throughout plants, as well as leachate moving through the soil column is designed to increase the sustainability of the potato and processing vegetable industry in this ecologically important region of Wisconsin. The proposed goals and expected outcomes outlined herein are fully supported by the Wisconsin Potato and Vegetable Growers. The producers of potatoes in the State of Wisconsin are immediate benefactors of this research to learn about tools of insecticide delivery that may limit offsite movement. Other basic researchers are also direct benefactors of this research to describe sources of environmental contamination in groundwater resources. Finally, natural resource conservationists are an obviously an additional set of benefactors of this information.

V. Lessons Learned

- <u>Major rainfall events did not significantly influence detections of neonicotinoids in the experimental area</u>. Early season rainfall was not exceptionally heavy in either year of this experiment. The accumulation of leachate detections in lysimeters likely is reflected by the steady application of irrigation water and rainfall. One clear exception to this pattern occurred in 2012 at 155-156 days after planting when 89 mm of rain fell within a 24-hour period. Peak detections of thiamethoxam in 2012 began to trend upward following this rain event, however the timing of similar detections across treatments in 2011 occurred at about the same time.

One additional explanation may be that increased levels of pesticide losses are associated with plant death or senescence.

- In each year of this study, the largest proportion of pesticide detections in leachate occurred shortly after vine killing in potato. Vine killing in commercial potato production is a common practice designed to aid the tubers in developing a periderm. Perhaps the rapid loss in root function following plant death permits excess pesticide to be solubilized and washed through the soil profile more quickly in root channels. In both seasons of this study, however, large episodic rain events did not occur early in the growing season. These results do appear, however, to document low to moderate levels of leaching losses that occur throughout the season even when the crop is managed at nominal evapo-transpirative need.

- Untreated control plots also yielded low-level detections of thiamethoxam throughout both seasons. To better understand these insecticide detections in control plots, we sampled water directly from the center pivot irrigation system providing irrigation directly to the potato crop. Samples were taken while the systems were operational from lateral spigots mounted on the well casings. In both years, samples revealed low concentrations of thiamethoxam present in the groundwater at two time points in each sample season from which irrigation water was being drawn. Clothianidin was also present at a single time point in 2012. These positive detections of low-dose thiamethoxam were obviously being unintentionally applied directly to the crop through irrigation and this information is new to the producers in the Central Sands of Wisconsin. Although systemic neonicotinoids have recently been detected from surface water runoff and catch basins associated with irrigated orchards, to our knowledge no other study has documented the occurrence of neonicotinoids in sub-surface groundwater being recycled through operating irrigation wells.

VI. Additional Information

None

VII. Contact Info

Tamas Houlihan
Executive Director
Wisconsin Potato Industry Board
P.O. Box 327
Antigo, WI 54409
715-623-7683
thoulihan@wisconsinpotatoes.com

13) Development of a sustainability program for Wisconsin strawberry producers (FY12-013)

Report Date: November 2, 2014

I. Project Summary

A. Consumer interest in where there food comes from and how it is grown continues to increase, yet only about 1% of the population is involved in agricultural production. This gap has resulted in poor communication lines at best or mistrust at worst between farmers and consumers of their products. In this project, we conducted a strawberry producer sustainability assessment that captured social, economic and environmental information that was subsequently communicated directly to you-pick consumers. We also wrote and published a best management practices workbook for strawberry farmers that addresses areas for potential improvement identified in the assessment.

B. We have worked on other sustainability projects for other specialty crop industries funded with SCBG funds but this project is not directly related to any of them.

II. Project Approach

We began by working directly with the strawberry farmers to design and implement a practice-based, holistic whole farm and strawberry sustainability assessment survey that was distributed to all Wisconsin strawberry farms through the Wisconsin Berry Growers Association. Over 5,000 farmed acres were represented in the survey results. Farms averaged over 8 acres in strawberries. One hundred percent of the farms were family owned and owners averaged over 26 years in farming. The results of the assessment were used to create two communication tools that were distributed widely to consumers. The first was a 6-page, multicolor brochure that included all assessment results. The second was a promotional brochure that was distributed to all you-pick customers by the growers during the 2014 harvest. Ten thousand promotional brochures were distributed during the harvest season. The second part of the project was to write and publish a best management practices workbook for growers that will continue advancements on the sustainability continuum. While this project was delayed with the departure of co-PI Rebecca Harbut, who was going to lead this portion, the end product was very high quality. The 80-page book is customized to Upper Midwest strawberry production and includes full color pest identification images. The book is also posted in electronic searchable form for easy grower access: http://nisa.cals.wisc.edu/nisa-the-whole-farm-approach/best-management-practices/strawberries/.

III. Goals and Outcomes Achieved

A. Goals:

Goals:

1) Work with growers to develop and implement a sustainability assessment program that holistically captures environmental, economic and social changes behind the farm gate; and,

2) Write and publish a best management practices workbook for strawberry growers that will drive continuous advancement in sustainability parameters.

Both of these goals were accomplished as described above. Best management practices workbooks were distributed to all strawberry growers at their annual grower member meeting in January 2015 (about 80 attendees – all received the workbook). The goal for the assessment survey was 50% participation and 38 out of 80 members participated, so this was nearly achieved also.

B. All proposed goals were completed as described above.

IV. Beneficiaries

The Wisconsin strawberry growers and their consumers were the primary beneficiaries as the communications conduit was improved. Ten thousand strawberry sustainability brochures were distributed to consumers during the 2014 harvest season. These brochures and the more detailed 6-page publication communicated the economic, social and environmental advancements behind the farm gate and reconnected consumers to a greater knowledge of how their strawberries were grown. Additionally, best management practice books will have been distributed to all Wisconsin strawberry growers by their annual meeting in January 2015.

V. Lessons Learned

As always, the role of a strong working relationship with the growers has proven key in advancing behavioral change. Without a strong partnership with the grower community and mutual respect, these projects would not be possible. It is important to note that such a process with many partners takes time, sometimes more than anticipated, but leads to high quality results and accomplishment of the proposed objectives.

VI. Additional Information

None

VII. Contact Info

Jed Colquhoun
Professor of Horticulture
University of Wisconsin - Madison
484 Moore Hall-Plant Sciences
1575 Linden Dr
Madison, WI 53706
608-890-0980
colquhoun@hort.wisc.edu

14) Driftwatch program education and outreach (FY12-014)

Report Date: May 5, 2014

I. Project Summary

A. The Driftwatch.org Pesticide Sensitive Crop Registry was developed through a collaboration of producers of pesticide sensitive specialty crops, stewards of at-risk habitat (including pollinators) and pesticide applicator communities. The Driftwatch Registry assists producers in mapping their field(s) and identifying their specialty crop type on the publicly accessible website www.driftwatch.org. Pesticide applicators can view sensitive fields in the area of their scheduled applications and use the information to make informed choices about pesticide use and application techniques.

B. This project built off of a 2010 Specialty Crop Block Grant that initiated the Driftwatch program for the state of Wisconsin. This grant extended our outreach efforts to populate the Driftwatch site making it more useful to pesticide applicators.

II. Project Approach

The agency hired a part-time staff person to manage DriftWatch outreach and administrative duties. The agency trained the DriftWatch coordinator about about pesticide regulations in Wisconsin, and DriftWatch staff taught her to use the software. She then reached out to a number of organizations including Wisconsin Grape Growers Association, the Wisconsin Organic Advisory Council, the Wisconsin Honey Producers, Wisconsin Agri-Business Association and the Wisconsin Cooperative Network. She also spoke with a number of pesticide applicators and a number of organic certification agencies. Through these conversations, she identified the best outlets for reaching out to stakeholders and potential DriftWatch users. Using input from these groups, she developed an outreach strategy.

Implementation of the strategy included attendance at multiple trade shows, producer conferences and meetings. They included the Midwest Organic and Sustainable Education Services conference, the Wisconsin Beekeepers Association conference, the Wisconsin Fresh Fruit and Vegetable Growers conference, the Wisconsin Value-Added Agriculture conference and more than a dozen local beekeeping club meetings around the state. At these events, she spoke to participants and helped register them for the DriftWatch program.

Outreach to producers also included a mailing to organic farmers in partnership with one of the state's organic certifying agencies. Outreach to pesticide applicators included making printed materials available to men and women who come into the building to take their required pesticide applicator registration exams. When the part-time coordinator's position was ending, she trained a permanent staff person to conduct the ongoing maintenance activities required to continue registering fields and bee yards in the program. The outreach portion of the job was transitioned to a permanent public information officer, who continued to educate potential participants at events including Farm Technology Days.

III. Goals and Outcomes Achieved

A Through 2014, about 500 specialty-crop producers had registered sites on Wisconsin's DriftWatch map. Additionally, 27 pesticide applicators had registered. Applicators may use the map without registering for the program so it is a little difficult to assess use by applicators.

Through FY 14, about 500 specialty-crop producers had registered sites on Wisconsin's DriftWatch map. Additionally, 27 pesticide applicants had registered. Applicants may use the map without registering for the program.

These numbers were considerably lower than the original goal. The coordinator identified a number of challenges that could have contributed to this. For example, beekeepers hesitated to mark the locations of hives on a publicly accessible map for fear of hive theft. Additionally, many rural residents lack the access to high-speed internet allowing them to conveniently register their fields and keep them updated. Additionally, many potential participants simply indicated an unwillingness to use a web-based registry.

The low number of applicator registrants could be explained by the fact that applicators are not required to create an account in order to use the map. They are free to access the map and use the information without having to sign up.

IV. Beneficiaries

Beneficiaries included beekeepers, organic specialty crop producers, grape growers, tree fruit growers and anyone else with pesticide sensitive crops. The 500 registered growers and 27 applicators were the direct beneficiaries but all sensitive crop and pollinator dependent crop growers benefitted from this project. All applicators who were made aware of the site also benefitted. While we cannot count how many this might be because the site can be viewed by anyone, registration is not required, we know that we disseminated information to all individuals taking the pesticide applicator license exam in the state during the

V. Lessons Learned

The primary unexpected challenge to the program was the fact that many potential DriftWatch participants do not use computers. Some prefer not to do so, and others are prohibited from doing so for religious or social reasons. To address this issue, the DriftWatch coordinator made sure to inform potential participants that having or using a computer was not necessary to participate in DriftWatch. She designed a paper application that participants could fill out and mail to DATCP at their convenience. She also encouraged people to call and register sites over the phone. This helped reduce this barrier.

VI. Additional Information

None

VII. Contact Info

Lori Bowman
DATCP – Agrichemical Management
P.O. Box 8911
Madison, WI 53708
608-224-4550
lori.bowman@wi.gov

15) Development of IPM, grape canopy, and index tools (FY12-015)

Report Date: October 20, 2014

I. Project Summary

A. The wine industry in Wisconsin has grown from fewer than 10 wineries in 2000 to more than 100 wineries in 2014. While these wineries depend extensively on grapes and concentrate brought in from other states, winemakers clamor after locally grown grapes. Growers face the challenge of producing a crop that is relatively new to the region and have limited research on which to base management decisions. The purpose of this project was to provide in-season workshops and an on-line pest management report based on research and observations made on cold hardy varieties in Wisconsin to help growers produce high-quality grapes in a sustainable manner.

B. This was the first SCBG project on wine grape management in Wisconsin.

II. Project Approach

The project was initiated by Rebecca Harbut when she was in the UW-Madison Department of Horticulture. After she departed in May of 2013, Patricia McManus of the Department of Plant Pathology led the project. Major activities included:

1. IPM scouting and grape phenology reporting. This activity was led by Dean Volenberg, UW-Extension Agricultural Agent for Door and Kewaunee counties, with support from other team members. Dean produced 20 and 12 in-season IPM reports in 2013 and 2014, respectively. These reports were distributed to 161 subscribers of the Wisconsin Grape Growers Google group and are archived on the UW-Extension Door county website at:
http://door.uwex.edu/grape-growing/grape-integrated-pest-management-reports/
The reports track the weekly growth and development (i.e., phenology) of 15 wine grape varieties, along with observations of important insect and disease pests, in relation to growing degree days. The reports contain photos of growth stages of grapes as well as insects and disease symptoms throughout the growing season. Additionally, late-season reports contain information on fruit quality (e.g., pH and Brix), which is of particular importance for wine making. Most observations and data were collected at Peninsular Agricultural Research Station (Door county) and West Madison Agricultural Research Station (Dane county). In addition to the data and field reports, UW-Extension and UW-Madison fruit specialists contributed articles on pest biology and management.

2. In-season IPM field days. The events that took place were:

1. UW-Madison Table and Wine Grape Field Day, Madison, August 23, 2012. UW-Extension specialists Rebecca Harbut and Patricia McManus covered new vineyard establishment and disease IPM for 27 participants.
2. Regional Vineyard Walk, Chippewa Falls, August 8, 2013. UW-Extension specialists Patricia McManus and Christelle Guédot covered disease and insect IPM for 35 participants.
3. Regional Vineyard Walk, St. Croix County, July 22, 2014. UW-Extension specialists Patricia McManus and Christelle Guédot covered disease and insect IPM for 45 participants.

III. Goals and Outcomes Achieved

A. In December 2013, a survey was sent to 161 subscribers of the weekly IPM reports. There were 56 responses (35% response rate). Of those responding, 98% indicated that they read the IPM reports. Survey participants were asked to rate the information found within the report as highly useful, useful, rarely useful, or never useful. The survey participants rated the information as highly useful (64%) or useful (36%). The survey participants (91%) used information contained within the reports when making crop management decisions. Additional data collected:

Question	Yes	No	Unsure
		%	
Increase their knowledge or understanding of grape IPM	96	2	2
Adopt at least one new IPM practice	80	4	16
Reduce or minimize pesticide use	56	15	29
More effectively time pesticide applications	85	6	9
Adopt a reduced risk alternative to manage a pest	47	15	38
Help identify pests	95	0	5

B.

Goal	**Actual accomplishment**
Weekly IPM reports	20 reports in 2013 and 12 reports in 2014
Two IPM field days targeting 50% of Wisconsin's grape growers	Three IPM field days in late 2012 through 2014. Total attendance was 107, which would be about 66% of Wisconsin's approximately 160 grape growers. Because these events were held in geographically distinct locations, there were few (if any) individuals who attended more than one event.
Target of having 80% of grape growers adopt a recommendation as a result of this work.	80% of survey respondents reported "yes" that they adopted at least on new IPM practice as a result of the IPM reports. Even more (91%) reported using information to make a crop management decision.
Fruit ripening report	Fruit ripening reports were including in late-season IPM reports in 2013 and 2014.
Optimize fruit quality workshop	Due to the departure of Rebecca Harbut, a horticulturist with expertise in this area, this workshop intended for January 2014 did not take place. However, we did have a Beginning Grape Grower School at the Wisconsin Fresh Fruit and Vegetable conference in January 2014, in which some related topics were covered.

IV. Beneficiaries

The main beneficiaries are 160+ grape growers in Wisconsin, especially those who benefited directly by reading the on-line IPM reports and attending field days. It should be noted that the data, articles, and photos posted in the reports have been "recycled" for use in additional educational programs (e.g., winter and spring meetings), thus benefiting even more growers. Quantitative estimates of how many people were directly benefited are included in the above table (part III.B).

V. Lessons Learned

The most obvious lesson learned is that Wisconsin's wine grape growers are very eager for locally-relevant information on growing grapes and managing insects and diseases. Field days attracted large audiences no matter where they were held or when they were scheduled, and there were always requests to do more such events. Likewise, feedback on the IPM newsletter was extremely positive, and informally growers have indicated that they would like to see this expanded to include more topics. Although we embarked on this project knowing that we had a wide range of expertise in our audience of grape growers (amateurs with a few vines as well as those who have established vineyards), it was nevertheless a challenge to provide field days appropriate for such a diverse audience. However, much of the learning at field days happens when growers interact with each other, and our field days provided important networking opportunities. It is unfortunate that we were not able to provide a workshop on optimizing fruit quality, but when the original project leader left her position, we did not have the necessary expertise to conduct this event.

VI. Additional Information

In addition to the UW-Extension website listed above, IPM reports are also archived at: http://fruit.wisc.edu/archives/category/grapes-2

VII. Contact Info

Dr. Patricia McManus
Professor of Plant Pathology
University of Wisconsin - Madison
391b Russell Laboratories
1630 Linden Drive
Madison, WI 53706
608-265-2047
psm@plantpath.wisc.edu

16) Potential control of powdery mildew and leaf spot disease (FY12-016)

Report Date: December 9, 2013

I. Project Summary

This was the last year of a multi-year trial on cut flowers. There are two aspects of research that were addressed in this grant: One study evaluated the potential control of powdery mildew and leaf spot diseases using low-risk bio fungicides on high value cut-flower crops; the second aspect of research examined the effectiveness of a novel mulch product, cranberry leaves, for weed suppression in cut flower beds. This report will summarize the results from the 2013 season and tie it in with the previous years' trials: One additional year of cranberry leaf mulch treatments (2012) and two more years comparing fungicide treatments (2011, 2012).

Cut flowers and perennials can be a large portion of the income that fresh market growers, small farmers, Community Supported Agriculture (CSAs), and greenhouse businesses can rely on to extend their growing season. They depend on a high value crop that, if healthy plants are grown, will provide a good income stream. Powdery mildew and leaf spot are serious disease problems for the cut-flower industry because they can reduce yields, quality, and value. Since these common diseases reduce potential crop income, conventional pesticides are often used for control, posing risk to workers, consumers, and the environment. In order to minimize these risks, this trial has tested and evaluated two bio-pesticides as alternatives to conventional synthetic fungicides on three high value cut-flower crops, *Echinacea* (coneflower), *Rudbeckia* (black-eyed susan), and *Helianthus* (sunflower).

Changing weather patterns across Wisconsin exacerbate conditions resulting in increased problems with foliar diseases on Rudbeckia, Sunflowers, and Echinacea. Leaf spot and powdery mildew develop later in the growing season, just as the plants are beginning to flower and cut for market production. Early intervention using low-risk chemicals as a preventive spray could save a high value crop. Additionally, having more modes of action to choose from will help delay fungicide resistance. Two of the cut flowers we have been trialing are perennial, and one an annual. Having multiple years of data will allow us to compare results on three different genuses across three different growing seasons and thus provide a better picture of treatment effects.

In addition to foliar leaf disease challenges, weed pressure can be significant and costly to control. Mulch is a common tool used by landscapers to inhibit weed germination. In this study, a novel treatment, composted cranberry leaf mulch was trialed at two depths with a control (i.e. no mulch) treatment. Wisconsin is the largest producer of cranberries in the United States. Wisconsin cranberry producers yielded a record 4.83 million barrels of cranberries in 2012, 60% of the nation's production (USDA-NASS, 2012). With this impressive production of cranberries in the state, there are many leaves that fall off during the season and eventually removed during harvest. For years, growers have been accumulating these leaves as part of the harvest process. Disposal of these leaves are part of the waste stream of the harvest process and some growers have been giving them away to home gardeners. These gardeners have reported a significant measure of weed suppression. These leaves are small, light weight, retain soil moisture, and are attractive. Having cranberry leaves on the market as a mulch would benefit the cranberry growers by giving them an additional product as a source of

income, less waste to manage, as well as supplying gardeners and landscapers with a quality, local product.

II. Project Approach

Activities and Tasks Performed

The photo below shows two rows of the experimental plots with several replicates of each cultivar as well as mulch treatments and respective weed pressure.

For the fungicide trials, the study design included three fungicides: one conventional and two certified organic products, as well as an untreated control. 'Cease' and 'Regalia' were the two certified organic bio-fungicides chosen, and 'Heritage' was the synthetic, conventional fungicide. The conventional fungicide treatment was added in order to create a full spectrum study and compare, not only how certified organic fungicides perform against no fungicide application, but also how they perform compared to a commonly used product. The two organically approved fungicides were chosen to compare their different modes of action. 'Cease' contains a bacterium strain (*Bacillus subtilis* QST 713), which produces active compounds that disrupt cell membranes, thus inhibiting the germination and growth of plant pathogens on a leaf surface. 'Regalia' contains an extract of giant knotweed (*Reynoutria sachalinensis*) which induces a response in the plants defense systems by producing cell strengtheners, antioxidants, phenolics, and pathogenesis-related proteins which inhibit plant pathogens (both fungal and bacterial) internally. 'Heritage' contains Azoxystrobin, a commonly used conventional fungicide in the industry and is a broad spectrum, preventive fungicide with systemic and curative properties. All three fungicides and the untreated control were laid out in independent rows that were separated by a 5-foot alley covered with wood chip mulch and a surrounding wood-chip border around the perimeter of the study area. Plot size was 36 square feet.

The three fungicides were tested on two cultivars of Purple Coneflower: *Echinacea purpurea* and *Echinacea purpurea* 'Rubinstern'; two cultivars of Black-eyed Susan: *Rudbeckia fulgida* 'Goldstrum' and *Rudbeckia fulgida* 'Summer Blaze'; and three cultivars of sunflower: *Helianthus annuus* 'Valentine', 'Ikarus' and 'Sonja'. Each row of fungicide treatment had six repetitions of sunflowers (i.e. two plots for each of three cultivars), with five plants/plot for a total of 30 plants/treatment in this genus. There were five repetitions each for *Rudbeckia* and *Echinacea*, with each plot consisting of five plants, for a total of 25 plants/treatment in each genus. Since the conventional fungicide treatment was added later than the original three treatments, it only had two repetitions of *Rudbeckia* and *Echinacea* or 10 plants each and three repetitions of sunflowers or 15 plants to evaluate.

The sunflowers (annual) were seeded in the greenhouse in May each year and planted in the field, alongside the *Rudbeckia* and *Echinacea*, in mid-to-late June. All three fungicides were applied, at the manufactures recommended rate, every two weeks. These rates were as follows: 'Regalia': 0.96 ounces/gallon; 'Cease': 1.92 ounces/gallon; and 'Heritage': 0.10 ounce/gallon. The first spray application each year occurred in late June or early July and continued into mid-August. The first sets of evaluations were taken in mid-August, with subsequent evaluations taken weekly or biweekly. In Year 2 and 3 of the study, the plant canopies were visually bisected, with the overall percent disease coverage or severity of disease categorized into upper and lower halves of the plant. This method was used after Year 1 because it was evident that the bottom half of a plant develops significantly more disease compared to the upper half, yet does not have a significant impact on the economic value of a cut-flower as the upper half does. The 2013 growing season was delayed due to cool wet spring weather. This retarded plant growth and disease development by 2-3 weeks. The mid-September disease ratings on sunflowers in 2013 were used over the Sept 30 ratings since more than 90% of the sunflowers were past bloom, and not worthy of sale anymore, by late Sept.

The cranberry leaf mulch was obtained from Cranberry Creek Cranberries. The leaves were stored on-site at the agricultural research station. All leaves were turned during the winter and spring using a tractor-operated windrow compost turner. Mulch treatments were randomized and replicated.

Two depths, 2" and 4" deep, of composted leaf mulch as well as no mulch plots were tested within the three rows of *Rudbeckia*, *Echinacea*, and sunflowers of the fungicide study. About 40% of the plots were treated with the 2" of mulch, 40% were treated with 4" of mulch, and the remaining plots were not mulched. Before the mulch was applied, the plots were weeded thoroughly and plants were tilled around to break up the soil surface crust.

Weed counts in the cranberry leaf mulch study were taken four times in 2012, during July and August, and two times in 2013, during July and August. Weeds were recorded as either dicot weeds (broadleaved weeds) or monocot weeds (grass-like weeds). This was done in order to observe if there is a difference in types of weeds the cranberry leaves suppress. In 2012, weeds were counted and not removed after each count to establish a season long weed environment. However, as weeds continued to grow they began to interfere with other aspects of the trial. Therefore, the weeds were mowed to 8" height after the third count. In 2013, weeds were removed after each count and both individual, as well as, cumulative weed counts were analyzed. When combining years, the difference in weed numbers between counts of 2012 was used for analysis to match 2013.

For this grant we have worked with the Commercial Flower Growers of Wisconsin in discussing the parameters of these two studies. They, along with private sector flower growers, helped determine which varieties of cut flowers to use by speaking of their own experiences in which varieties they

observe to have the most development of powdery mildew and leaf spot. Not only did they suggest which genus to evaluate, but recommended 2 or 3 cultivars within a genus to compare genetic resistance potential among cultivars. The same private sector growers helped suggest the conventional fungicide to use because it is the one that is most commonly used in the industry. W. & E. Radtke Inc. and Benary Seed Co. generously donated the plant material for the fungicide study and Cranberry Creek Cranberries donated the cranberry leaves for the leaf mulch study. The UW-Extension plant pathologist, Brian Hudelson, came to the Agricultural Research Station to observe the plants in the field as well as performed the tests on the plant material brought into the Plant Disease Diagnostic Clinic. Additionally, UW Greenhouses assisted with the propagation of sunflowers each year.

Environmental and Infection Conditions

Powdery mildew is a fungal disease caused by several closely related fungi that survive in plant debris or on infected plants. According to UW Plant Disease Diagnostic Lab's Wisconsin Garden Facts 'XHT 1005c', the powdery mildew fungus that infects one type of plant (e.g., phlox) is not the same powdery mildew fungus that infects another (e.g., sunflower). It covers the leaves and flowers with an unsightly white coating, decreasing the value of the cut flowers by reducing its aesthetic appeal or making them unsalable by prematurely killing stems or in severe cases killing the entire plant.

Leaf spot disease can be of bacterial or fungal origin and both pathogen types were monitored in our trial. Bacterial leaf spot can be caused by a number of genuses such as *Pseudomonas, Xanthomonas or Epipremnum. These bacterial pathogens can* cause reddish-brown angular to circular spots with yellow halos that may cause the leaf to distort. In some plants these bacteria can cause dead spots in foliage and sometimes cankers in stems. These bacteria overwinter in dead plant material, but do not survive for long in water or soil. Bacteria pathogens need a natural opening (stomates and lenticels) or an injury (mechanical, insect or another disease) to infect.

Septoria is a fungal pathogen that can infect a wide range of plants including ornamentals, vegetables, and grain crops. There are numerous species of Septoria diseases, each one infecting a narrow range of plant species. For example, *Septoria rudbeckiae*, one of the most common foliar pathogens of Rudbeckia is a different species than the Septoria which infects the vegetable tomato (i.e. *Septoria lycopersici*). According to UW Plant Disease Diagnostic Lab's Wisconsin Garden Facts 'XHT1073', Septoria survives in plant debris or on infected plants. Septoria leaf spot makes the foliage unsightly, leaving dark brown blotches, which ultimately desiccates the leaves, causing leaves to fall off. Septoria leaf spot symptoms typically begin as plant canopies start to close. The Septoria leaf spot fungus prefers a thin film of water on leaf surfaces to allow its spores to germinate and infect. Higher rainfall and humidity tends to favor sporulation once infection has occurred. Dense foliage leads to high humidity and longer periods of leaf wetness that favor the disease. For this reason it is best to avoid overhead irrigation. It is also best to not overcrowd plants to increase air circulation and hasten drying. Symptoms of Septoria leaf spot first appear at the base of affected plants, where small (approximately ¼ inch diameter) spots appear on leaves and stems. Eventually multiple spots on a single leaf will merge, leading to extensive destruction of leaf tissue. Septoria leaf spot can lead to total defoliation of lower leaves and even the death of an infected plant.

The weather conditions at the West Madison Agricultural Research Station were recorded using Davis Vantage Pro Weather Station. Reviewing the monthly and hourly climatological summaries, general seasonal patterns are noted (Fig 2 and Table 1). In 2 of the past 3 years, late summer weather conditions were not conducive for optimal growth and development of leaf spot or powdery mildew

infection. From July-Sept, rainfall was minimal in most cases. In 2011, the year with the most powdery mildew disease reported in our trials (as shown in Fig. 1), rainfall was fairly normal early then it turned very dry in late summer. Most days in July through September were calm with wind speeds less than 5mph and had favorable temperatures for powdery mildew (i.e. being between 65 and 85 degrees Fahrenheit; see Table 1). 2011 also had higher humidity frequency than in the other two years.

2012 was the hottest and driest on record. There were not many days above 85% humidity (Table 1) needed for powdery mildew to germinate. Likewise, due to lack of rainfall all season, leaf wetness was minimal which hindered development of Septoria leaf spot.

The season of 2013 went from one extreme to the other. It started out very wet and cool. Rainfall was well above average for each of April, May and June; cumulatively 10" above normal for these three months (Fig. 2). This delayed spring transplanting into June and foliar disease evaluations didn't begin until the end of August. Furthermore, the heavy spring rainfall caused a lot of nitrate-nitrogen to leach from the rooting zone which in turn delayed plant growth. The 2013 summer growing degree units continued to be below average most of the season even though late-season warmth brought it within 100 units of the 30-yr norm. Plants were 2-3 weeks behind in development. August and September rainfall was below average minimal with almost no rain in August (Fig. 1). The weather conditions resulted in low humidity conditions that likely prevented or delayed germination of powdery mildew. However, early season rainfall seemed to encourage Septoria leaf spot disease on the overwintered Rudbeckia plants.

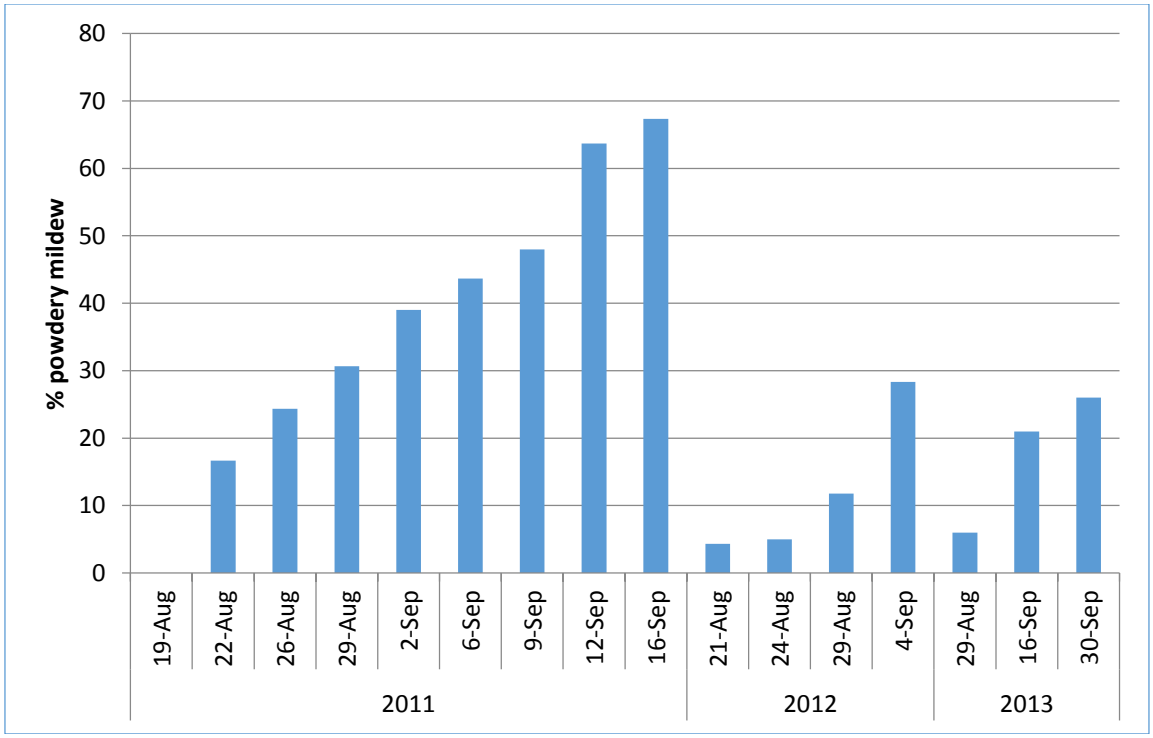


Figure 2. Powdery mildew inception and progression on sunflower cultivars in 2011, 2012, and 2013 from the untreated control plot.

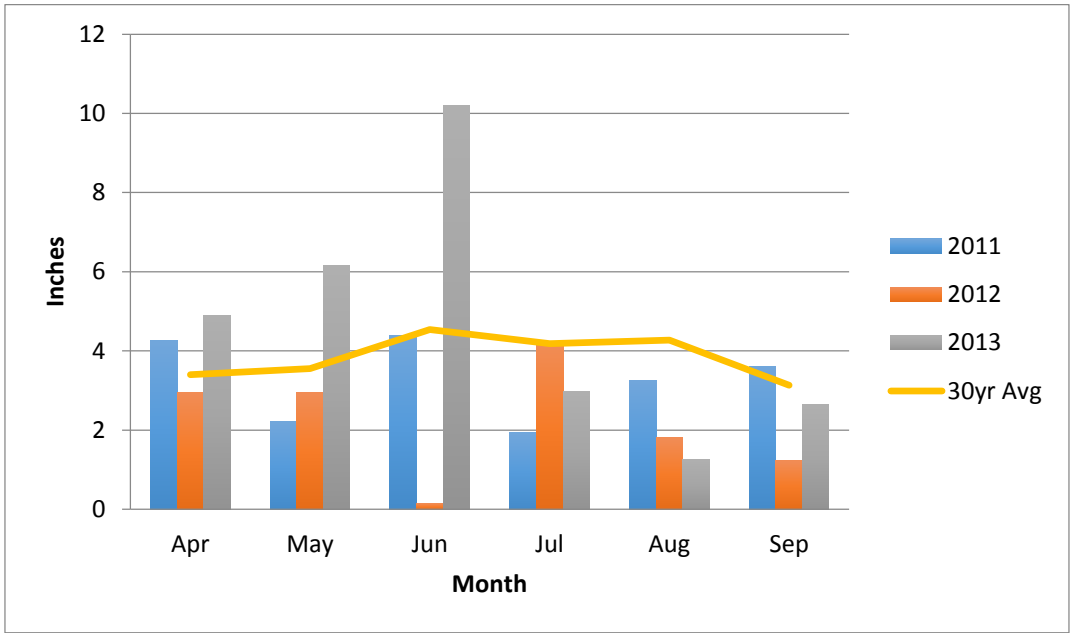


Figure 3. Monthly rainfall at West Madison Ag Research Station, 2011-2013 vs. 30-yr norm.

Table 1. Frequency of hours with favorable conditions for formation of powdery mildew or Septoria leaf spot over June, July, and August at WM ARS.			
	Temps between 65-85F	Max Relative Humidity >85%	Both conditions
2011	75%	34%	21%
2012	69%	16%	9%
2013	66%	32%	15%

Fungicide Trials

Quantitative Analysis

Powdery mildew was not found on Rudbeckia or Echinacea during the three years of trialing. Sunflower developed powdery mildew each year, particularly on the lower half of the plant. Figure 3 shows the effect of the fungicide treatments on percent coverage of powdery mildew over the season of 2011 as scored over the entire sunflower plant. 'Regalia' was impressive at supressing powdery mildew most of the season, averaging just 12% disease, and was similar to the conventional fungicide, 'Heritage'. In contrast, 'Cease' was ineffective against powdery mildew with a steady increase of disease resulting in a signficant infection rate of nearly 60% by mid-September.

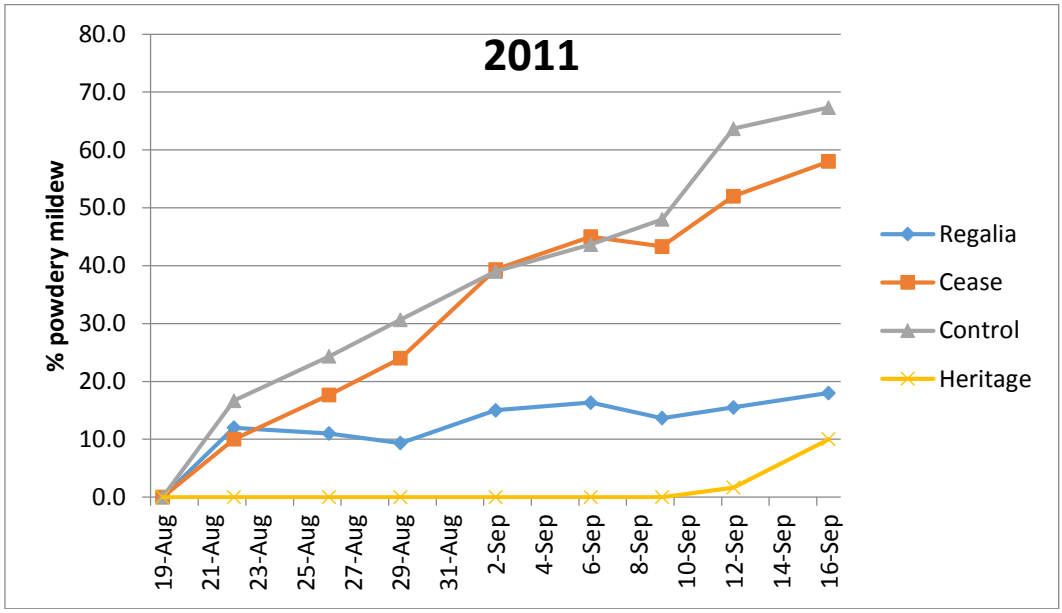


Figure 4. Effect of fungicide treatments on powdery mildew coverage over time in 2011 averaged across three sunflower cultivars.

The following three graphs describe the effect of the fungicide treatments on powdery mildew when rated in September within the sunflower genus, across the 3 cultivars over three different years. As shown in Fig. 4a, in 2011, 'Regalia' was almost as effective against powdery mildew as the conventional product, 'Heritage'. However the other bio-fungicide, 'Cease' was no better than the untreated control treatment.

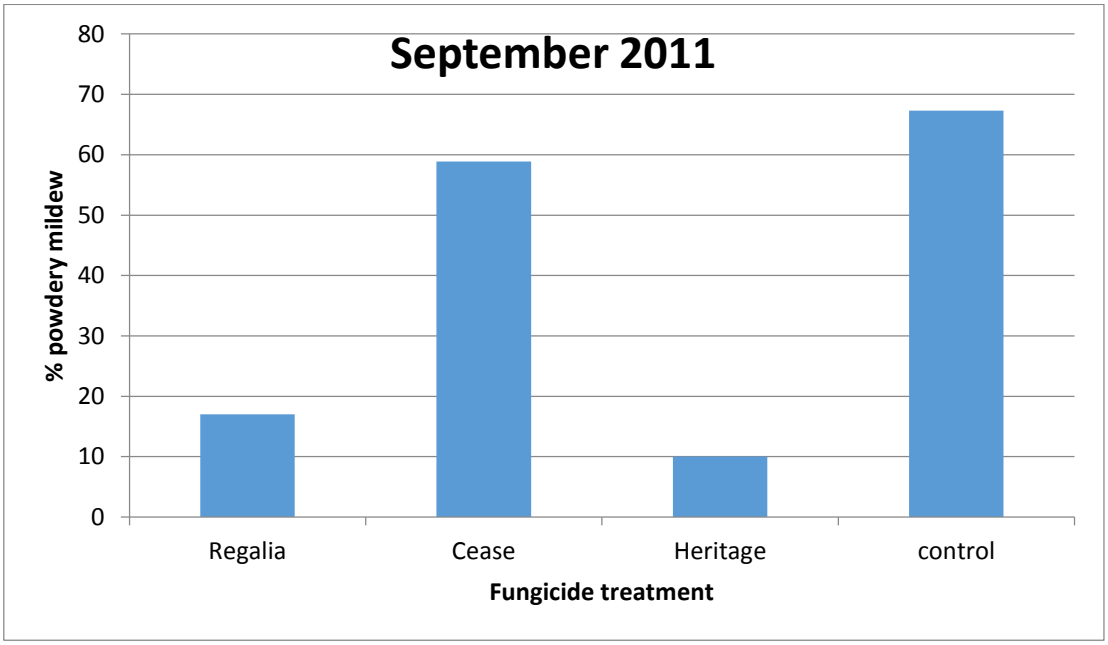


Figure 5a. Effect of fungicide treatments on powdery mildew coverage rated in September 2011 (averaged across three sunflower cultivars).

In 2012, the disease rating protocol was modified from 2011 by scoring both upper and lower halves of the plants. As shown in Fig. 4b, the upper canopy was considerably less infected by powdery mildew than the lower canopy (21.7 vs. 41.8%, respectively). Like 2011, 'Regalia' was very effective

at controlling powdery mildew, similar to 'Heritage' especially on the upper canopy. Again, 'Cease' performed only slightly better than the untreated blocks.

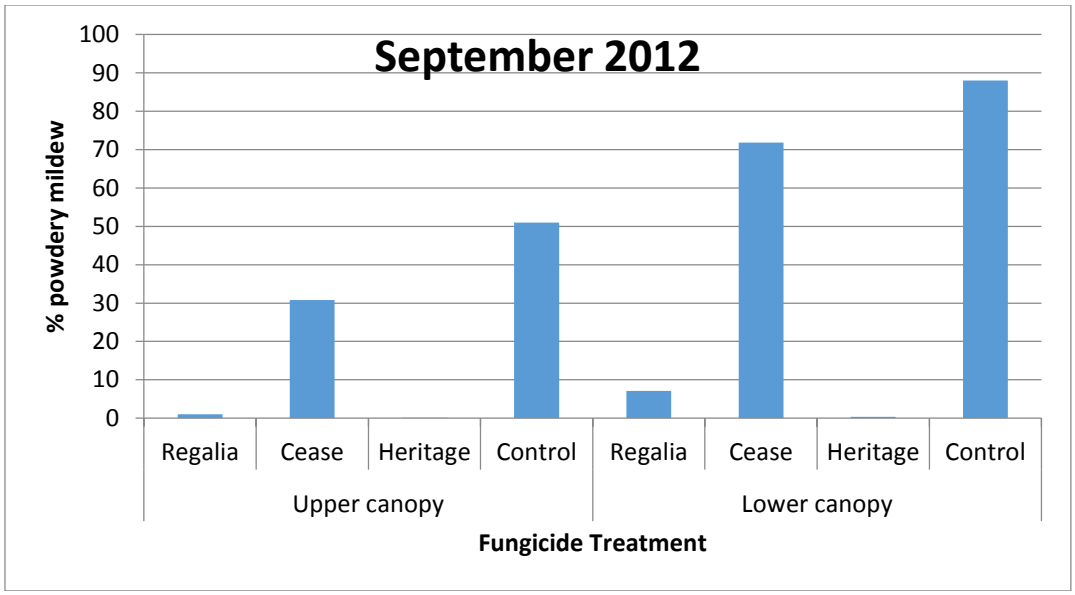


Figure 4b. Effect of fungicide treatments on powdery mildew coverage rated in September 2012 (averaged across three sunflower cultivars)

In 2013, though a different rating scale was used than the prior two years (i.e. 1 to 5 severity scale vs. % disease coverage), the treatment rankings were the same as the previous two years: 'Heritage' ranked best followed by 'Regalia', and lastly 'Cease' similar to the untreated control. Unlike the previous 2 years, no powdery mildew disease was found on any species or cultivar until late August. By mid-September, only the *Helianthus* had trace levels of powdery mildew on the upper canopy (average rating 1.5) and minor levels on the lower canopy (average rating 2.5) (Fig.4c). The last evaluation, done on September 30, revealed a bit more powdery mildew, but still at minor levels and only on *Helianthus* (data not shown). The best treatment to control powdery mildew in 2013 was 'Heritage' which treated plants exhibited no disease on the upper canopy and only a 'trace' rating of 2.0 on the lower canopy. The two organic fungicides had low severity as well, but were not different than the untreated plot as shown by similar means and error bars (Fig. 4c).

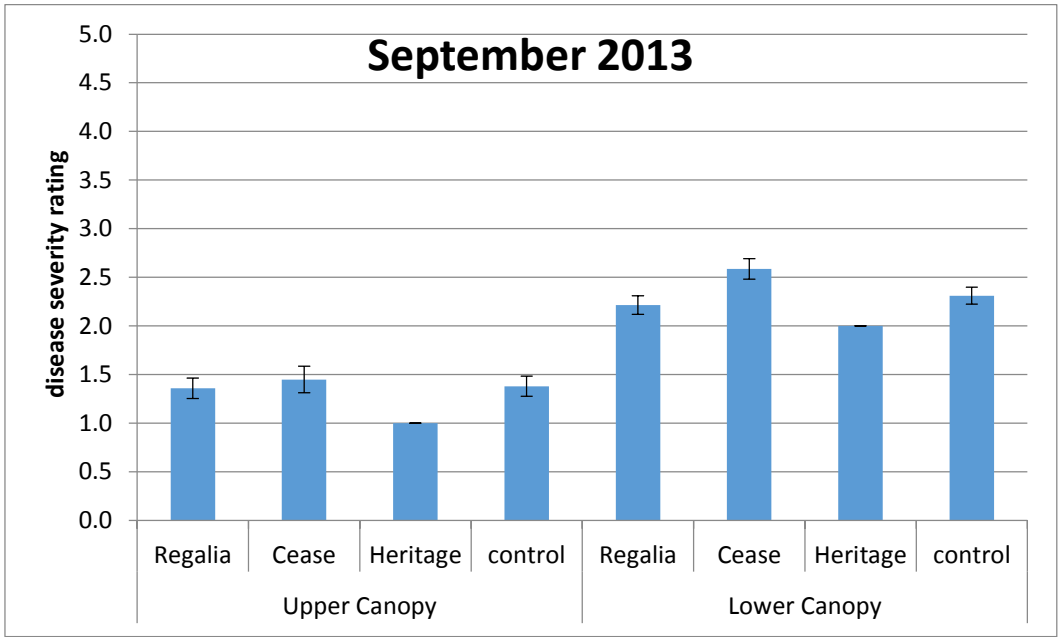


Figure 4c. Powdery mildew severity across Sunflower cultivars rated September 2013. Score 1 to 5 with 1=no disease; 2=trace; 3=minor; 4=moderate; 5=severe. Vertical bars on each column show standard error of the mean.

There was interest in evaluating individual sunflower cultivars for inherent powdery mildew resistance and to see if there was an interaction with fungicide treatments. There was no clear pattern that one cultivar/fungicide combination had an advantage over another in any year. On the untreated check plot, 'Valentine' contracted more powdery mildew than 'Sonja' in 2011 and 2013 while the opposite was true in 2012 (Figs. 5a-5b). 'Sonja' had the lowest disease in all three years under 'Heritage'. 'Valentine' and 'Ikarus' did not show a consistent trend in one contracting more powdery mildew than the other, showing the difference in effectiveness of each fungicide is not based on cultivar selection.

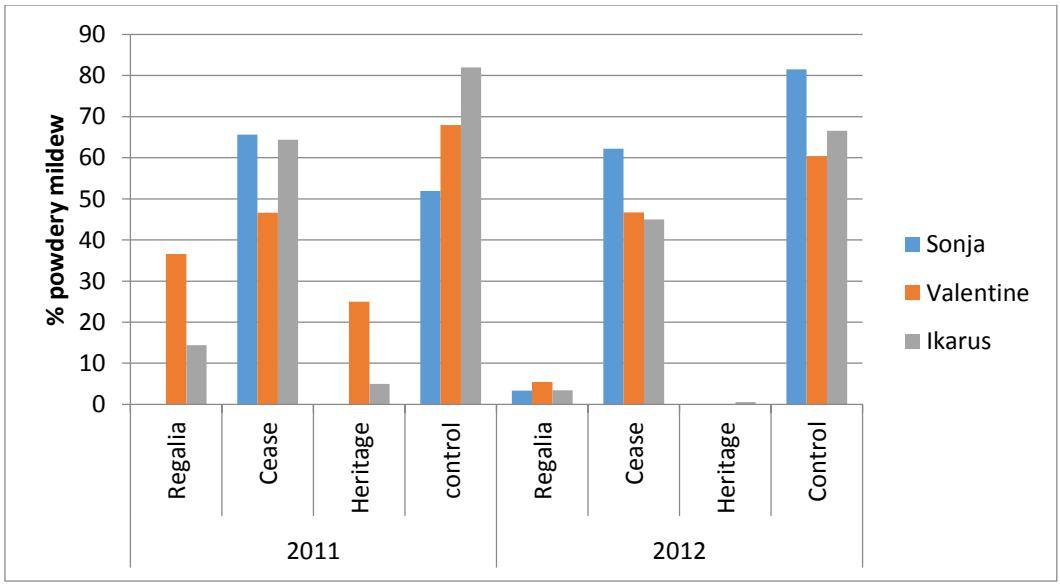


Figure 6a. Powdery mildew disease percentage by sunflower cultivar in 2011 and 2012 (averaged over upper and lower canopy)

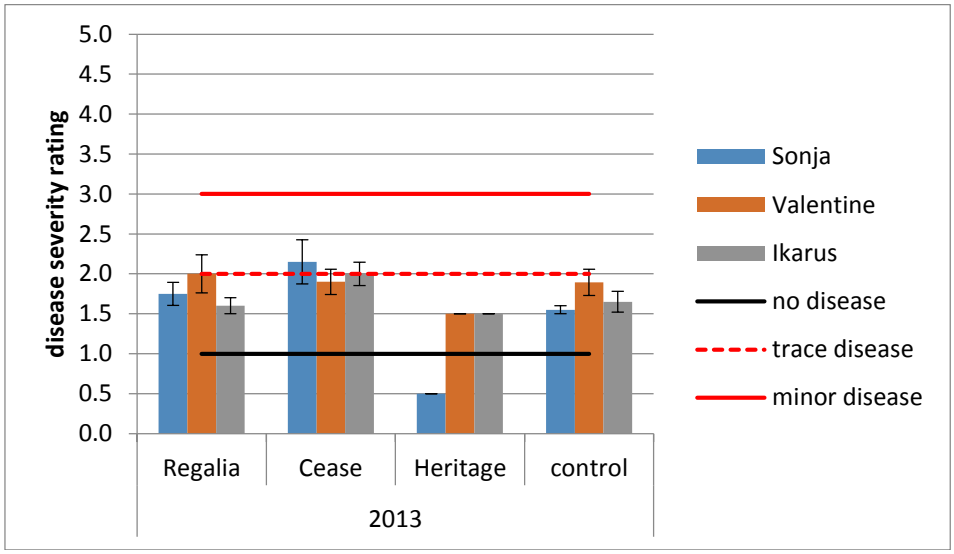


Figure 5b. Powdery mildew disease severity ratings by sunflower cultivar in 2013 (averaged over upper and lower canopy).

No leaf spot disease was found on *Rudbeckia* and *Echinacea* in 2011 or 2012. By mid-September 2013, *Helianthus* and *Echinacea* species had only trace levels with disease ratings less than 1.3 in the upper canopy and 2.2 on the lower canopy. Septoria leaf spot, as confirmed by the UW Plant Disease and Diagnostic Clinic, was found on the two cultivars of *Rudbeckia* at similar incidence rates but by late September the 'Goldstrum' cultivar had moderate disease severity (Fig. 6). It is interesting to see that the 'Summer Blaze' cultivar had more resistance to Septoria leaf spot than 'Goldstrum' with only trace-to-minor severity. Leaf spot severity on 'Goldstrum' under the 'Heritage' fungicide was 2 whole rating points below that of the bio-fungicides, both of which were no better than the untreated check for controlling the disease. Though labeled for protection against bacterial borne disease, neither 'Cease' nor 'Regalia' was effective at controlling Septoria leaf spot under moderate severity.

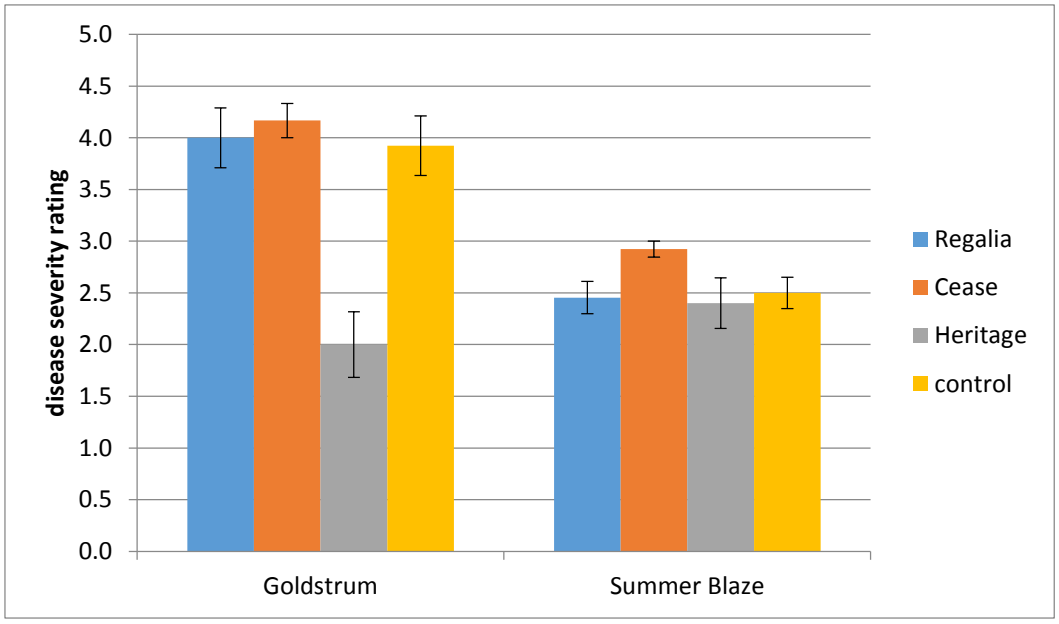


Figure 7. Septoria leaf spot disease severity on Rudbeckia 'Goldstrum' and 'Summer Blaze' cultivars on Sept 30, 2013. Score 1 to 5 with 1=no disease; 2=trace; 3=minor; 4=moderate; 5=severe. Vertical bars on each column show standard error of the mean. Upper and lower canopy scores were nearly identical for leaf spot severity so they were averaged as shown here.

Cut flowers were counted in September of 2013 for the 7 cultivars tested under the various fungicide treatments. Most counts were not affected by fungicide treatment with the exception of 'Cease' having a significantly lower number of cut flowers than the other treatments for Sunflower 'Sonya' ($P<0.0036$) and Rudbeckia 'Summer Blaze' ($P<0.0320$). Looking at Fig. 5b and Fig. 6, both cultivars had a higher disease rating, especially in the upper canopy, under 'Cease' than for the other treatments. This shows a direct link to disease control and potential crop income.

Qualitative Analysis

In all three years, powdery mildew only developed on the sunflowers; not on the *Echinacea* or *Rudbeckia*. At the time of the first rating in mid-August 2013, 'Cease' and the untreated control had about 10% incidence of powdery mildew on sunflower but no diseased plants were found under 'Regalia' or 'Heritage' treatments at this time. A month later, nearly all (>90%) of the sunflower plants under the bio-fungicide treatments had some powdery mildew disease, albeit at low severity. At the same time, less than half the plants under 'Heritage' treatment were diseased.

Likewise, for Septoria leaf spot on Echinacea, disease incidence rose from 13 to 79% during September 2013 on the bio-fungicide treatments (similar to the untreated control) while under the 'Heritage' treatment, incidence rose from 0 to 50% during September. Septoria leaf spot incidence was more prevalent on Rudbeckia with 80 and 91% of the plants showing disease in early September, for the conventional and bio-fungicides treatments, respectively. Looking at Figures 4a-c over the 3 years of trialing, the treatments ranked consistently for control of powdery mildew. The conventional fungicide 'Heritage' provided the most control; 'Regalia' ranked second. 'Cease' was not effective and comparable to the untreated control. No clear pattern emerged for a particular sunflower cultivar being resistant to powdery mildew over the three years, as in each year a different cultivar had the highest disease in the untreated plot.

Cranberry Mulch Data

The cranberry leaf mulch trial was carried out for two years. During the second year (2013) of the trial, wet soils coupled with soil borne diseases likely reduced overall plant vigor. Therefore, mulching with cranberry leaves was delayed until late June to allow the soil surface to warm from sunlight and allow the plants to flourish. This delayed initial weed counts until late July.

Quantitative Analysis:

Table 2 shows the total number of monocot (i.e. grassy weeds) and dicot (broadleaf) weeds for a 4" depth, 2" depth and no mulch (control) treatments of cranberry leaves over the 2-yr sampling period. There were statistically fewest weeds in the 4" depth. The cranberry leaf mulch treatments showed significant differences in the number of weeds that were suppressed (Table 2). The 4" depth provided the best weed suppression with 49% fewer grass weeds and 71% few broadleaf weeds compared to the 2" treatment.

Table 2. Summary of weed counts in cranberry leaf mulch trial, 2-yr avg.				
	Average # monocots	Average # dicots	% reduction in weed counts over control	
No mulch	197 a	168a	Monocots	dicots
2"	158a	58b	20	65
4"	81b	17c	59	90
p-value	0.0021	0.0001		
Same letter within a column are not statistically different				

Weed counts were not only higher, but also much more variable in the un-mulched and 2" depth vs. 4" depth as shown by the height of the bars and vertical lines in Fig. 7. The 2" depth did not perform as well as the 4" depth as it decomposed faster and allowed more weeds to emerge later in the summer (counts 3 and 4). Figure 7 also shows the cranberry leaf mulch resulted in better control of dicot weeds than monocot weeds over the season in both depths. This is presumed to be because the grass-like blades are better able to penetrate through the small spaces between the cranberry leaves than leaves of dicot weeds.

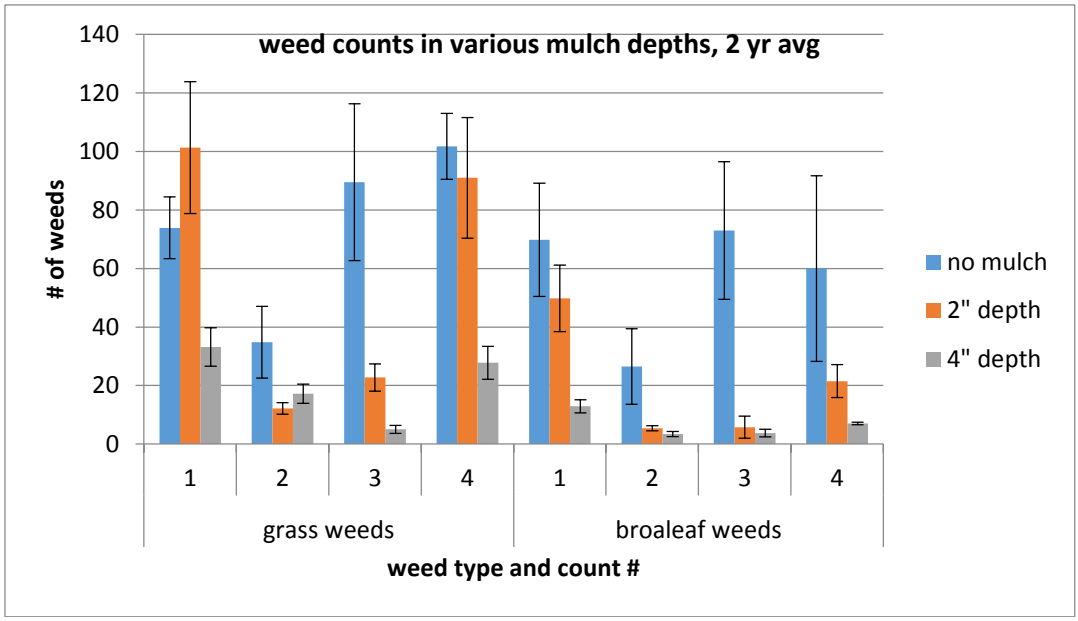


Figure 8. Summary of weed counts over time at different mulch treatments (2-yr average). Vertical lines are standard error of the mean.

Qualitative Analysis:

Cranberry leaf mulch at 4" depth was an effective barrier against weeds for most of the season, particularly against broadleaf weeds, 905 less than in the control. Compared to no leaf mulch, the 2" suppressed many weeds after the first round of weeds were removed. However, the grassy weeds started breaking through the 2" depth after about a month's time and in some cases, wasn't much better than no mulch.

Contributions and Role of Project Partners

A special thanks to W. & E. Radtke Inc. for generously donating the *Echinacea* and *Rudbeckia* plants in year one, and to Benary Seed Co. for donating the sunflower seeds each year. Significant contributions from the cranberry industry were the donated cranberry leaves. They not only donated material, but also facilitated transport coordination and loading of the leaves onto our trucks. Consulting advice from the CFGW was also highly valued and important to the success of this project.

III. Goals and Outcomes Achieved

A. In the fungicide study the perennial *Echinacea* and *Rudbeckia* were already established and the annual sunflowers were seeded in the greenhouse and planted in the field in a reasonable time for them to be established before powdery mildew and leaf spot growth occurred. There were three to five spray applications of each fungicide sprayed in 14 days increments. Data was taken on three to

six occasions starting mid-August, when powdery mildew first developed, through the end of September when most of the plants were well beyond bloom stage.

Being a multi-year project, protocol improvements were made along the way. In year one, percent disease was assessed across the whole plant. By year two, the protocol was changed to rate both the upper canopy which is the salable portion of the cut flowers, as well as the lower canopy which is typically infected first and can be a source of inoculums to the upper leaves. In the final year, under new management, disease severity ratings were taken. Though techniques changed over time, having three years of data with a range in weather conditions gave us solid data to draw conclusions from.

One peer reviewed extension fact sheet on bio-fungicides for selected plant species was sent to 91 extension agents each year. The extension agents can then disseminate the information to their constituents, an estimated 8,000 or more individuals and 500 to 600 Master Gardeners. The factsheet can then be placed on the 'Horticulture Team' Web Site and the Master Gardener's web site for public access. Information was also provided to individual growers, consumers and educators that visit the display gardens each season.

Information was shared at the Commercial Flower Growers field day to 55 growers Green industry representatives. Through the Wisconsin Commercial Flower Growers' newsletter, and the Wisconsin Green Industry publication 'Green Side Up', a summary of the research is made available to 750 individuals and to approximately 250 National Cut Flower Association Members. Reports were also posted to the University Display Garden website blog at www.universitydisplaygardens.com

Records were maintained of growers/visitors and stakeholders visiting the West Madison Ag Research Station Trial and Demonstration Garden web site. The blog was viewed over 27,700 times in since 2011 from over 135 countries. The busiest viewing period occurred in August 2012 with 1,298 views. This is tremendous outreach tool that will expand the information gathered in this project.

B. To establish baseline data, when evaluating disease pressure each year, the untreated control plot was monitored closely and the first rating was taken while plants were still disease free so treatments could be compared evenly as disease evolved over time.

For the weed suppression study, 2013 followed mulch treatments from 2012. To remove any residual effect from the previous mulch treatment, and since Echinacea and sunflower were being transplanted in 2013, 2/3 of the plot area was tilled before planting in 2013. The overwintered Rudbeckia plots were hand tilled around the perennial to bury the previous year's mulch treatment and remove the soil crust. The tillage also removed any existing weeds prior to mulching and helped stimulate new weed seed germination.

In Fig. 7 and Table 2 the data shows how effective the cranberry leaves perform as a weed suppression mulch. It can be seen there is a significant reduction in the number of weeds that grew in areas with cranberry leaves as compared to the areas with no cranberry leaves. The amount of weed suppression in the two-year study gives promise to show the impact this product could have on cranberry growers and consumers. There are very clear differences in the number of weeds that grew in different mulch depths across 2 years. The major conclusion is that 4" depth does an excellent job of suppressing weeds, especially for broadleaf type weeds and has a longer seasonal effect than the 2" depth.

IV. Beneficiaries

From analyzing the data and graphs that are shown in Figures 5a-c, it can be seen that there is a significant benefit of the organic fungicide 'Regalia' as it performed very similarly to the conventional fungicide that is currently being used in the cut-flower industry. This shows strong evidence that Regalia can be used in some situations to replace or alternate with the use of conventional fungicides to control powdery mildew. Fungicide resistance can be delayed by rotating fungicide classes and modes of action, described as FRAC codes (Beckerman, 2008). This not only aides in delaying fungicide resistance, it will benefit field workers, florists, consumers, as well as the environment. Likewise, when using chemicals such as those found in conventional pesticides, one has to worry about crop rotation restrictions: 'Regalia' and 'Cease' have zero pre-harvest intervals and no plant back restrictions unlike 'Hertitage'. The research also shows the organic bio-fungicide, 'Cease, does not perform at the same level as either Heritage or Regalia which indicates that this fungicide does not provide the adequate protection the cut-flower industry requires in order to provide an extended period of harvest of high-value flower products.

We will be keeping in contact with cut-flower growers in order to track their increase in sales after this information has been available to them.

V. Lessons Learned

Cultural controls include several viable options that go a long way in disease prevention. Using varieties that have resistance to disease (i.e. Rudbeckia 'SummerBlaze') is the first step a grower can use as part of an integrated pest management program. In the absence of resistant varieties a grower should limit nitrogen applications. Limiting nitrogen fertilizer in the late summer will decrease the chance of new plant growth, which would be more susceptible to infection, and will discourage weed growth. Reducing relative humidity by avoiding overhead watering, removing infected plant parts and plants that are overcrowded to increase air circulation, and clean up and removal of the infected plant debris in the fall are all practices that can improve control of powdery mildew. However, when trying to evaluate products for disease control in a research, trial, all of these 'not-to-do' practices should be implemented to encourage pathogen inoculation so products can be tested under more rigorous conditions.

Early in the season of 2012, 100% of the *Echinacea* were infected with aster yellows, as diagnosed by the UW's Plant Disease Diagnostic Clinic. This stunted the growth, discolored the leaves and contorted the flowers; leaving the plant in a condition not conducive to powdery mildew infection. For 2013, new 2-yr old *Echinacea* plants were transplanted in the trial making comparison to the overwintered *Rudbeckia* confounded for that season. Besides the infected Echinacea in 2012, the drought proved to be hard on all three genera. It was difficult to keep the sunflowers well watered in their first establishment and many had to be replaced after the first planting date. Due to the irrigation system and set up in the gardens and throughout the agricultural research station, it was difficult to keep the plants in this study well watered and the annual sunflowers had a particularly difficult time getting established.

The location of the trial was unfortunate for a disease rating study as it was up on a hill that received regular breezes and ample air movement. The breezy conditions made it challenging to time applications and often delayed spraying. Ratings were taken until the end of September with little-to-no disease severity on most plants in 2013. This underscores the importance of cultural practices that can alleviate many disease issues. The experiment being located on a hill with consistently breezy conditions made it difficult to assess the treatments under high disease severity as we did not have the

conditions to allow heavy disease incidence or severity. Furthermore, in 2012, the prevailing winds had made many of the sunflowers grow at an angle; making it difficult to spray and take accurate data. This also makes more branches grow towards and/or at ground level where powdery mildew is more conducive to grow. The wind broke off large numbers of branches of sunflowers on a weekly basis throughout the data taking period. During a storm on September 1st in 2012, there were high gusts of winds that broke the main stem of four sunflowers in half; eliminating them from the study. This reinforces the need for using multiple plants and replication in a study. In order to prevent this being a problem, the sunflowers for 2013 were seeded in 4" pots in the greenhouse and planted in the ground a few weeks after they have been the previous two years, towards late June. This resulted in healthy plants that were in good physical condition throughout the summer of 2013.

Two challenges we overcame involved a fungicide treatment and the mulch per se. During the first fungicide application, one small impediment was with the 'Regalia' product. Being a plant-based formula, it was very sticky, and thick, molasses-like. Using battery powered backpack sprayers that only had battery power for a couple hours was a challenge with this product. Expelling the product from the sprayer seemed to drain the battery more so than the other fungicides. This was overcome by constant and vigorous agitation and having a backup or spare sprayer on hand. In hindsight, this product should be applied with a sprayer that has an agitation pump installed.

A couple challenges occurred with the cranberry leaf weed suppression study. Not having thorough experience with weed studies, the sampling protocol evolved over time. In 2012, the control sections where there was bare ground, weeds established and grew quickly, making it difficult to get accurate weed counts. The weeds also quickly grew in height next to the *Echinacea*, *Rudbeckia* and sunflowers, which gave the potential to alter the micro-climates. The weeds also interfered with uniform fungicide application. In order to correct this, at the end of July, the tallest weeds were cut to approximately 8" in height. In 2013, the protocol was changed to remove weeds after being counted. A second challenge in 2013 was that the cranberry leaf mulch seemed to carry/harbor weed seed in it so evaluating the mulch for weed suppression was difficult. This issue was overcome by removing weeds after being counted and counting a month apart. Analyzing the counts separately gave us double the observations to compare the treatments. Also, having an augmented control i.e. on fewer plots than the 2" or 4" treatments, provided ample evidence that some mulch was better than none all without having to do the tedious weed counts from an excessive number of plots. Combining the 2 years of data was a challenge for two reasons: 1) the weed count protocols differed between years; and 2) we had to adjust the data to represent the difference in new weeds over count instead of a cumulative figure. Analysis was done using a statistical processor that could handle unbalanced designs.

VI. Additional Information

http://Universitydisplaygardens.com Blog site for posting results from this trial

References consulted:

Beckerman, J. 2008. Disease management strategies for horticultural crops. BP-71-W http://www.extension.purdue.edu/extmedia/BP/BP-71-W.pdf

Heimann, M.F, W.R. Stevenson, and G.L. Worf. 1996. Powdery mildew on ornamentals. A2404 SR-05-96 UW-Extension.

Hudelson, Brian. 2012. Septoria leaf spot. UW Garden Facts XHT1073. UW Plant Disease & Diagnostics Laboratory, UW Extension.

Hudelson, Brian. 2010. Powdery Mildew. UW Garden Facts XHT-1005c. UW Plant Disease & Diagnostics Laboratory, UW Extension.

Shaw, Beverly, March 7, 2011, Rudbeckia Leaf Spot, Purdue Plant and Pest Diagnostic Laboratory, Purdue Extension, 18 Oct. 2011 http://www.ppdl.purdue.edu/ppdl/expert/Rudbeckia_leaf_spot.html>

USDA-National Agricultural Statistics Survey. 2012. Wisconsin 2012 Fruit Summary. http://www.nass.usda.gov/Statistics_by_State/Wisconsin/Publications/Crops/ann_fruit_summary.pdf

Wisconsin State Cranberry Growers Association. 2013. 1 Nov. 2013. www.wiscran.org

a. Rudbeckia with leaf spot b. healthy Sunflower c. Healthy Echinacea

VII. Contact Info

John Esser
Executive Secretary
Commercial Flower Growers of Wisconsin
5301 Portsmouth Way
Madison, WI 53714
608-244-3088
jresser@charter.net

17) Local produce in the middle (FY12-017)

Report Date: September 25, 2014

I. Project Summary

A. "Local Produce in the Middle" aimed to help owners of mid-size fresh fruit and vegetable farms in Southern Wisconsin access the intermediate (middle) market for local produce through a local produce sales meeting to help farmers and intermediate buyers network. The intermediate market for produce includes buyers such as institutions, restaurants, grocery stores, and distributors. Purchasing local produce is a growing trend in this market - the National Restaurant Association asked chefs to predict the top industry trends each year and buying local produce has taken second place (right behind buying local meat) from 2011 through 2014.

Wisconsin farmers need networking opportunities to access the intermediate market for local produce, in turn increasing the competitiveness of their produce. We have seen intense interest in this kind of programming in the past. IFM had excellent attendance at our 2010 meeting "Best Practices for Selling to Institutions"(61 attendees), a local produce sales meeting in 2010 (43 attendees), and a local produce sales meeting in 2011 (56 attendees). The local produce sales meetings were an opportunity for produce farmers, institutional buyers, and distributors to introduce themselves to each other and explain what their interests were in terms of buying or selling.

This project was timely because the popularity of buying local produce in the intermediate market is growing strong, creating an opportunity for Wisconsin farmers to grow their businesses and increase the competitiveness of their local produce by selling to new, large volume customers.

B. This project did not built on a previously funded project with the SCBG funds.

II. Project Approach

Activity: Local food sales meeting planning, outreach, and preparation

- Planned networking activities for the meeting based on research of other farmer-buyer networking meetings
- Created and implemented an outreach strategy that included:
    - A paper mailing (508 letters) and emails (240 emails) to farmers; chefs and foodservice directors (700 emails); and distributors (100 emails)
    - Handing out fliers to farmers and buyers at 8 different meetings including ***Post-Harvest*** Handling and On-Farm Food Safety, Networking Across the Supply Chain, and the Wisconsin Restaurant Expo
    - Posting of information on listservs, in our IFM Local Sourcing News emails, and through a press release
    - Special attention to minority groups through meetings with the Farley Center (they work with Hmong, Latino, and African American farmers) and the Rainbow Farmers Cooperative (they do outreach to African American Farmers), and through letters to a cooperative of Amish farmers
- Prepared for the meeting by inviting and preparing panelists, sending lists of questions to participants in advance to help them be prepared to talk to sales partners, creating an agenda

and an evaluation sheet, putting together educational materials for the folders, and organizing registration

Recommendation/Results:
We received great feedback about the style of networking from the meeting, so it was worth it to investigate how others had done it.

We felt our outreach efforts were strong and resulted in a good turnout for the event. Despite a last minute meeting date change, 19 farmers, 5 distributors, 26 buyers, and 6 food systems professionals registered for our final date (March 15). Total attendance was 56. Our goal was 70. However, considering that our original date was cancelled due to a snowstorm at the last minute, we felt the attendance was good.

We wish more farmers had attended, but the reaction from the farmers in attendance seemed to be that they were learning that the market for local produce is strong. So, we considered this a lesson and believe more outreach needs to be done to farmers about the fact that there is demand for local produce, and with assistance on how to produce for and connect with that market.

Activity: Local produce sales meeting
The meeting took place on March 15 and included a local produce panel discussion, group networking time, a local food lunch (paid through non-grant sources), a group discussion, and additional networking time at the end of the day.

Recommendation/Results: This format worked well as most of the day was devoted to buyers and sellers getting to know each other. Conversation in the group was lively throughout the networking time.

We received 23 completed surveys from the meeting. Respondents were asked how many potential new business partners they met. Their answers ranged from 2 to 12, with an average of 5.1. When asked the best thing they gained from the meeting, 14 referenced making connections. When asked what to change about the meeting the future, the most common response was “more farmers,” with 5 people making this suggestion.

Activity: Follow up assistance for meeting participants
Meeting participants were all contacted to see if they need help connecting with people they met at the meeting, follow up with those people, or other assistance.

Recommendation/Results: Surprisingly, very few participants requested help. We had initially devoted more staff time to this activity but were able to use that time for other activities as it was not needed here.

Activity: Follow up evaluations and reporting
Attendees were asked to complete evaluations directly after the meeting and again 15 months later. We received 23 completed surveys at the meeting, but only 9 from the follow up survey.

Recommendations/Results: We were disappointed in the number of responses we received from our follow up evaluations. We attribute the low response rate to both the lag time between the meeting and the follow up, and also the change in staff. The lag time was originally scheduled to be a year. It turned out to be longer because of Laura’s departure from the IFM Coordinator position and the extra

time it took for the new IFM staffing team (Claire, Sharon, and Carrie) to get up to speed. Thus, not only did attendees feel less connected to the original meeting over time, they also had to adjust to a change in IFM staffing. We speculate that these factors decreased both response rate and attendees ability to accurately attribute subsequent sales to the meeting. See section III B for more details.

Other Activities:
These activities were made possible due to the reduced time needed for follow up assistance for meeting participants.

- Created a local food networking meeting fact sheet to assist others wishing to set up a similar meeting. This activity was a response to many inquiries about our meetings and was a great opportunity to highlight making sales connections between produce growers and buyers. The fact sheet is posted on our website and attached to this report.
- Local Sourcing News - these newsletters provide foodservice directors and chefs with information about sourcing local produce in large volumes, upcoming events, and help with identifying sources of produce. They also help farmers see demand for local produce.
- Preliminary planning for an Association for Nutritional and Foodservice Profession Meeting on "Local Sourcing in Large Volumes." A tentative date for the meeting was set for August but then had to be postponed and eventually cancelled due to staff illness.
- Local Food Means Business – Following a similar format to the Local Produce Meeting, the Local Food Means Business meeting on October 18th brought together producers and buyers to make connections and learn how others are successfully buying and selling local food. Our experience with the Local Produce Meeting indicated that vegetable producers are in particular demand within the system. With that information in mind, we specifically reached out to farmers to attend this meeting and have counted time spent on that effort as part of this project. There were 22 producers (including 10 vegetable farmers), 23 buyers, and 7 distributors in attendance. Forty two of 58 total attendees responded to the meeting evaluation survey and indicated that they met anywhere from 1 to 10 potential new business partners at the meeting. The average was 4.4.
- 2014 Southern WI Vegetable Production Workshops – As a further response to the clear demand from buyers for more local produce, we focused these workshops specifically on grower identified crops with which they need production assistance (onions, lettuce, peppers, winter squash). Farmers presented on production issues ranging from seeding to scaling up to post-harvest handling for wholesale buyers. 64 farmers attended the workshops. 50 attendees responded to the evaluation survey for onions and lettuce, and 37 responded to the survey for peppers and winter squash. Of those, 92% (onions and lettuce), 86% (peppers) and 76% (winter squash) said they would change their production systems "somewhat" or "a great deal" based on the workshops.

**While one of the workshops had non-specialty crop producers attend, all materials created were specific to specialty crops and all staff time, supplies and any other expenses charged to the grant were only for work with specialty crops and specialty crop producers. Any interactions that included non-specialty crop producers or supplies used by non-specialty crop producers were funded through other sources.

III. Goals and Outcomes Achieved

A. See question II for a complete accounting of activities and notes on their contribution to the goals and outcomes of the project.

B. Goal 1: Our goal was to offer a networking opportunity for fruit and vegetable farmers to meet intermediate buyers. To measure this, we would consider the number of farmers and buyers that attend the meeting with a target attendance of 30 farmers and 40 buyers.

Actual: 19 farmers, 5 distributors, 26 buyers, and 6 food systems professionals registered for our final date (March 15). Total attendance was 56. Considering that our original date was cancelled due to a snowstorm at the last minute, we felt the attendance was good.

Goal 2: Our goal was to facilitate sales connections between local produce growers and intermediate buyers. At least 10 farmers making sales from buyers they met at the meeting within the year after the workshop

Actual: 2 of the 5 farmers who responded to our follow up survey reported making sales to 5 different buyers after the meeting. These numbers are far less than our goal. We attribute the low response rate from the farmers to the long lag time between the event and the follow up survey. The lag time reduced farmers' connection to the event and made them less interested in responding to our questions. It also likely reduced their ability to accurately report sales attributable to the meeting.

We had a much higher response rate on the surveys attendees completed at the meeting. The average number of "potential new business partners" that the 23 respondents (farmers and buyers) reported directly after the meeting was 5.1

IV. Beneficiaries

Farmers

19 farmers attended our local produce sales meeting
4 farmers attended the Annual Meeting
10 farmers attended Local Food Means Business
64 farmers attended the vegetable production workshops
More than 200 farmers receive the Local Sourcing News emails
5 farmers responding to our follow up survey reported a total of $271,850 in local produce sales

Foodservice buyers

26 buyers attended our local produce sales meeting
37 buyers attended the Annual Meeting
20 buyers attended Local Food Means Business
Approximately 600 buyers receive the Local Sourcing News emails
7 buyers responding to our follow up survey estimated a total of $635,500 is local produce purchases

Distributors

5 distributors attended our local produce sales meeting
11 distributors attended the Annual Meeting
7 distributors attended Local Food Means Business
Approximately 100 distributors receive the Local Sourcing News emails

V. Lessons Learned

We think the style of networking we used in the local produce meeting went very well, we had great feedback about it. The small group networking ensured that people made face-to-face connections without feeling awkward the way one-on-one speed dating can (and also one-on-one speed dating can

result in two parties who already know each other speaking, taking up a limited amount of networking time for them). The facilitators kept the conversation flowing as needed. We decided to create a fact sheet about styles of networking for other practitioners after receiving numerous calls. We felt this would also be a way to help the momentum of this project continue in other areas.

We felt our outreach efforts for the meeting were strong and resulted in a good turnout for the event, despite a last minute meeting date change due to a snowstorm. Due to advance preparation the event ran very smoothly. We were disappointed that more underserved participants (Hmong, Latino, Amish, African American) were not able to attend despite reaching out to leaders in those communities. Perhaps more guidance or training could help practitioners reach these groups.

Surprisingly, very few participants who have been contacted requested help. We had initially devoted more staff time to this activity but were able to use that time for other activities as it was not needed here.

From the two panels at the IFM Annual Meeting (local produce buying panel and food safety panel), the need for continued education amongst buyers about local food was demonstrated. With the food safety panel in particular, no buyers had any internal protocols developed for themselves about local food and safety. They were very interested in learning about GAP and FSMA but needed that information presented to them in an abbreviated way, as the buyers are not familiar with agricultural practices. Their interest in these topics also reinforced our knowledge that the demand for local food among foodservice buyers is strong.

The need for more growers who are willing and able to meet the demand has been clear in our surveys. When asked what to change about the local produce meeting, the most common response was “more farmers.” Five people made this suggestion. As one buyer put it in our separate follow up survey “the hardest thing is getting out there and finding the farmers.” In order to bring along more farmers, we are now also looking at grower education on scalable production techniques that could help get them to a place where they could serve the institutional market. The 2014 Southern WI Vegetable Production Workshops were a step in that direction. We plan to do work more on the supply side of this equation in the future.

VI. Additional Information

Attached: Networking resource fact sheet, Local Produce agenda

VII. Contact Info

Clare Strader
Dane County UW-Extension
1 Fen Oak Court
Madison, WI 53718
608-244-3710
strader.claire@countyofdane.com

18) Survey of Christmas tree fields for a new root rot disease

Report Date: June 2, 2015

I. Project Summary

Christmas tree production in Wisconsin ranked 5th in the nation with over 600,000 trees harvested in 2012, worth $12.5 million in annual sales according to the 2012 USDA Census of Agriculture and the last USDA Census of Horticultural Specialties in 2009. This project to survey for new root rot disease in Christmas Tree fields was initiated after tree losses were observed by growers in 2010. Testing of affected trees lead to the discovery of a root rot and a phytophthora species (*P. sp. "kelmania"*) that hadnever before been found in Wisconsin. A systematic survey was started to evaluate the prevalence of Phytophthora root rot disease in the state and to identify the species of Phytophthora involved.

B. This research built on FY2011 SCBG "Survey of christmas Tree fields for a New Root Rot Disease". The current project expanded the survey by adding more growers, fields, and tree hosts over the course of an additional three years through the end of 2014 to determine how widespread the problem is in Wisconsin.

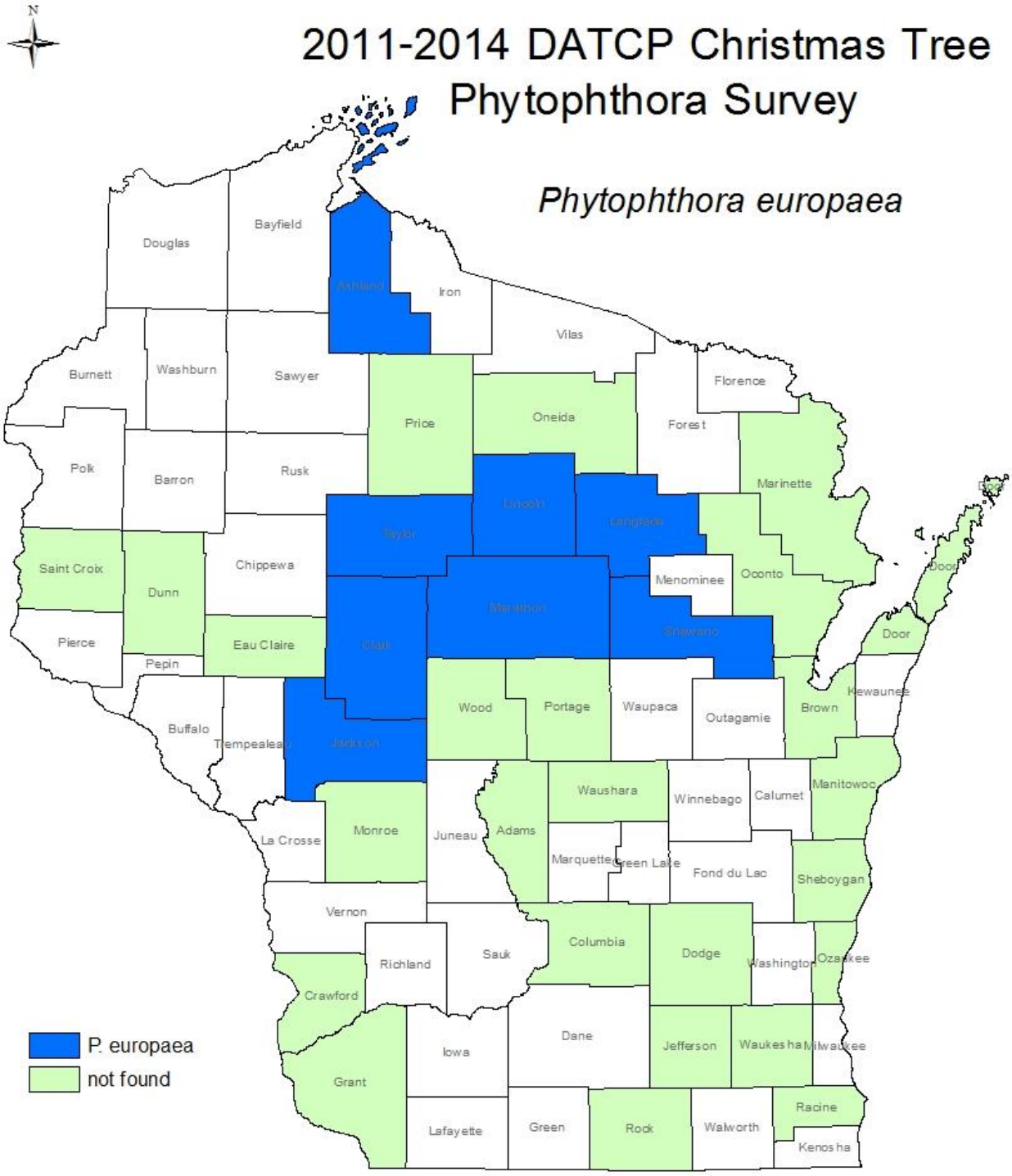
II. Project Approach

This project was a collaboration of DATCP's Plant Industry Bureau Laboratory (PIB LAB) and the Christmas tree program, the Christmas tree growers and the Wisconsin Christmas Tree Producers Association (WCTPA). DATCP inspectors surveyed for Phytophthora root rot disease during annual Christmas tree field inspections and the lab provided diagnostic services to identify pathogens causing root rot disease. Results were shared with participating growers individually. Summary reports of survey findings were prepared each year, including disease distribution maps. Reports were published in newsletters, on websites and at annual winter meetings. A summary of the multi-year survey was presented at the 2015 annual Wisconsin Christmas Tree Producers convention. A factsheet for Christmas tree growers was developed in collaboration with University of the Wisconsin Plant Disease Diagnostic Clinic

The results of this project show that there are six species of Phytophthora involved with tree decline, three of these species were first detections in plants in Wisconsin. The new pathogens require further research to evaluate their ability to infect otherwise healthy trees, therefore culture isolates were shared with several researchers for further study, such as Dr. Chastagner at Washington State University who are working on finding root rot resistant fir species for Christma tree production.

2011-2014 DATCP Christmas Tree Phytophthora Survey

Phytophthora europaea

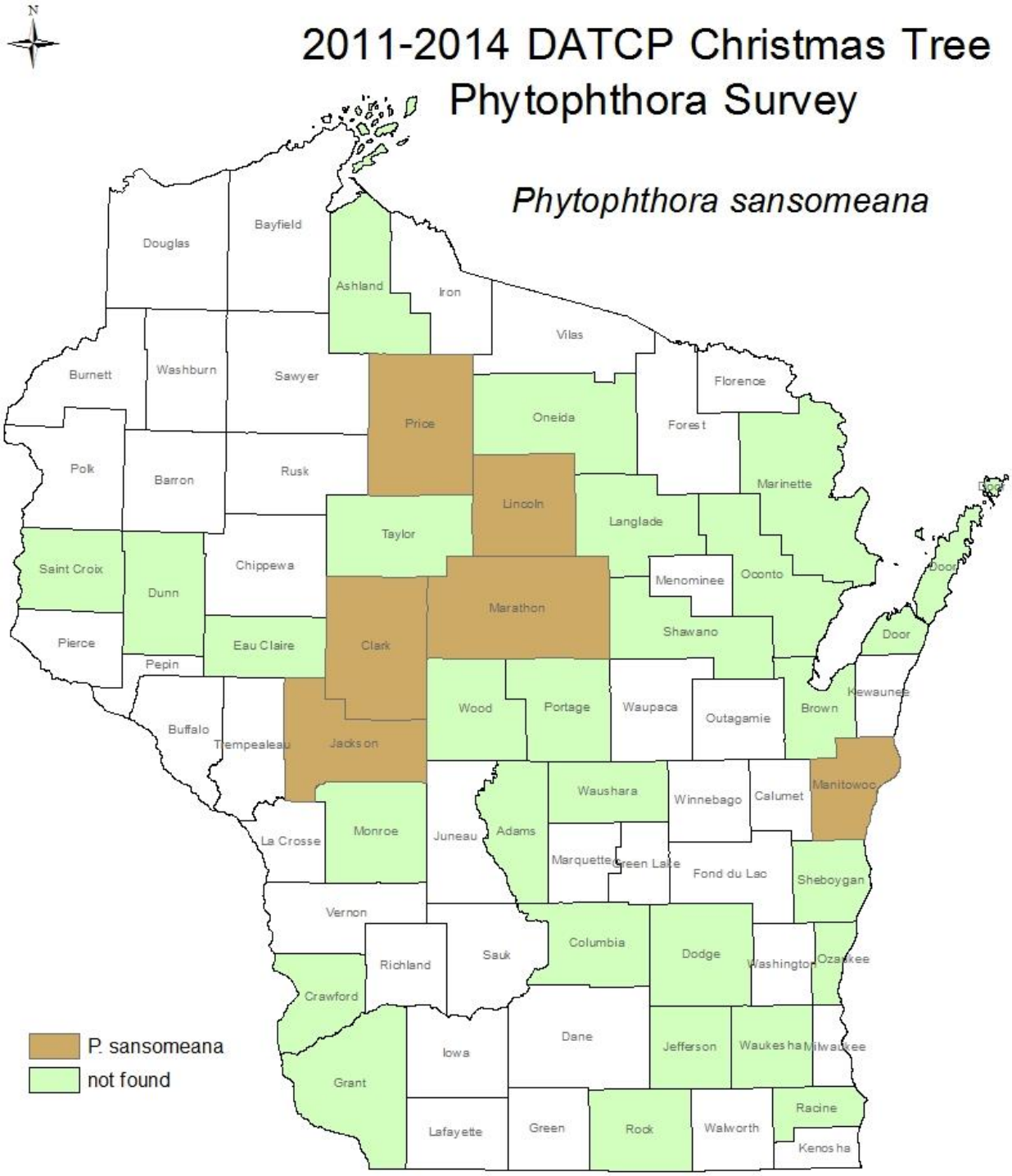


DATCP Christmas Tree Program and Plant Industry Bureau Laboratory,
in cooperation with Wisconsin Christmas Tree Growers

12/1/2014

2011-2014 DATCP Christmas Tree Phytophthora Survey

Phytophthora sansomeana

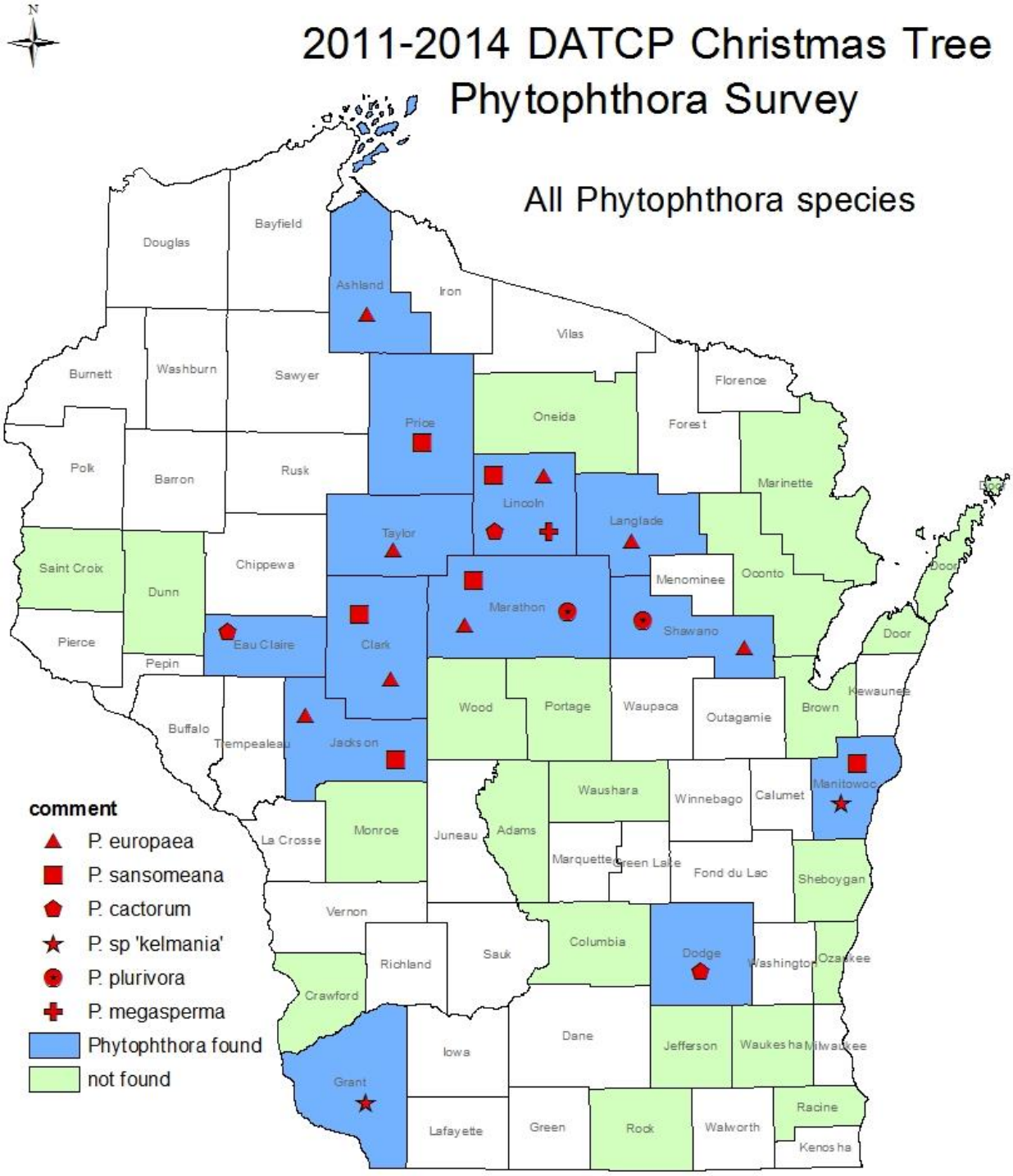


DATCP Christmas Tree Program and Plant Industry Bureau Laboratory,
in cooperation with Wisconsin Christmas Tree Growers

12/1/2014

2011-2014 DATCP Christmas Tree Phytophthora Survey

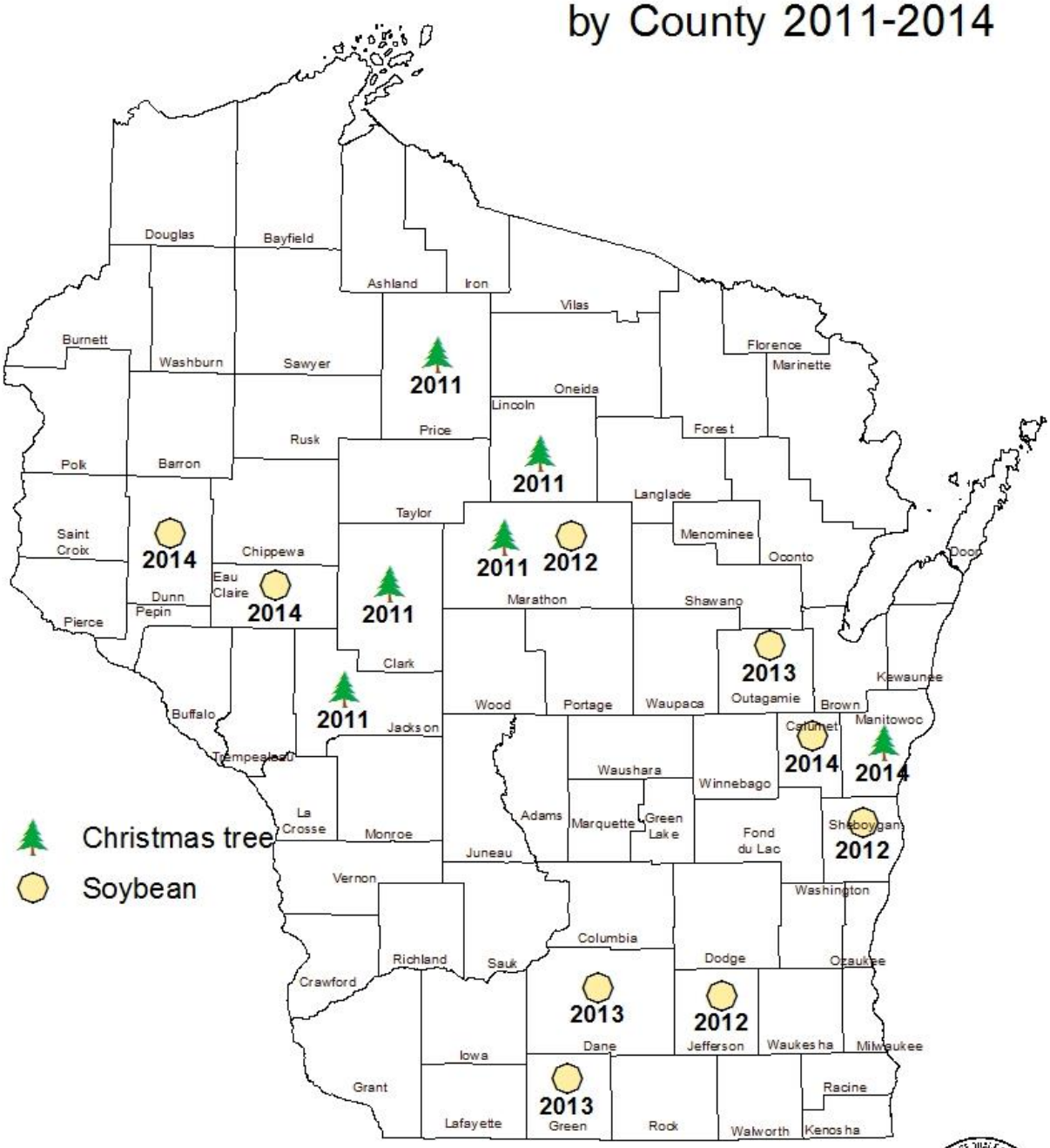
All Phytophthora species



DATCP Christmas Tree Program and Plant Industry Bureau Laboratory,
in cooperation with Wisconsin Christmas Tree Growers

12/1/2014

First Detection of *Phytophthora sansomeana* by County 2011-2014



DATCP Christmas Tree Program, Pest Survey Program and Plant Industry Bureau Laboratory, in cooperation with Wisconsin Christmas Tree Growers

12/12/2014

III. Goals and Outcomes Achieved

From 2011 to 2014, a cumulative 91 growers in 49 counties participated in this survey. Several growers and fields were visited more than once and we added additional growers, fields and counties each year, to reach as many growers in as many Christmas tree growing areas as possible. Table 1 shows the number of growers, fields and counties inspected and sampled broken down for each survey year. Data from 2011 is included in Table 1 since the FY12 survey builds on data and outcomes of the FY11 survey.

1) The goals of inspecting 650 fields and 250 producers annually were surpassed every year of the survey.
2) We projected that 10% or 65 fields would be sampled each year but the actual numbers were between 4.7% and 8.3% due to lower number of symptomatic trees observed in fields.

   We also tested for other pest and diseases each year, adding 50 samples in 2011, 39 samples in 2012, 31 in 2013, 28 in 2014. Other pest and diseases diagnosed were: Armillaria, cytospora, diaporthe/phomopsis, cerambycid beetle, white pine weevil and root aphid, which caused field symptoms similar to phytophthora root rot. Blue stain fungi and bark beetle, frost injury to tips and winter kill were observed as well. Rhizosphaera needle cast, sclerophoma shoot blight, and spidermite injury were regularly diagnosed on fir and spruce.
3) Lab results were sent to all 91 participating growers.
4) Outreach materials were updated each year.
5) Maps were produced shoing the distribution of this disease in Wisconsin by county.

Table 1. Christmas Tree Program Survey Statistics

Year	**2011**	**2012**	**2013**	**2014**	**Totals**
Collection timeframe	9/26-10/14	8/16-10/29	9/15-10/31	9/8-10/17	
Growers inspected	297	304	324	278	
Fields inspected	689	702	767	666	
Growers sampled	**32**	**37 (26 new)**	**31 (23 new)**	**23 (10 new)**	**91**
Fields sampled (% of total fields inspected)	**51 (7.4%)**	**58 (8.3%)**	**44 (5.7%)**	**31 (4.7%)**	**187***
Counties sampled	18	18 (8 new)	17 (4 new)	14 (3 new)	**33**

6) Summaries were published in WCTPA newsletters and on websites. See http://pestsurvey.wi.gov/plantdisease/ornamentals.html; the WCTPA newsletter reaches 270 households, DATCP's Pest Bulletin has a circulation of 3000.
7) 100 growers attended the winter meetings where reports and maps were displayed at a booth and presentations were given by staff. A factsheet on "Phytophthora root rot diseases of Christmas trees" that includes disease management information was developed for growers in collaboration with University of Wisconsin – Madison Plant Diognostic Clinic's Dr. Brian Hudelson and Ann Joy. The factsheet is posted on University of Wisconsin – Extension Garden Facts website http://labs.russell.wisc.edu/pddc/fact-sheet-listing-diseases-conifer/ and DATCP websites and be made available in hard copy at future Christmas tree producer conventions.

B. see above

IV. Beneficiaries

The main beneficiaries of this project are Wisconsin's 270+ Christmas tree producers. In addition, the thousands of families who enjoy real Wisconsin Christmas trees each year also benefited from the results of this project.

V. Lessons Learned

Over the course of this survey, Wisconsin experienced unusually extreme weather patterns. Christmas trees in the Central Sands counties suffered severly under the 2012 drought. These fields were not sampled for the survey because of the obvious impact of the drought. Record cold during the winter of 2013/2014 killed less cold hardy tree species like Fraser fir.

VI. Additional Information

Article in Agri-View newspaper http://www.agriview.com/news/crop/christmas-tree-producers-talk-trends-and-more/article_1b6dd030-57ac-5601-993a-0cfd5d136538.html

VII. Contact Info

Anette Phibbs
Plant Industry Laboratory Director
Wisconsin Department of Agriculture, Trade and Consumer Protection
P.O. Box 8911
Madison, WI 53708
608-224-4600
Anette.phibbs@wi.gov

19) Production Tools for Minority Growers

Report Date: June 23, 2015

I. Project Summary

Production Tools for Minority Growers provided Hmong, and other minority fresh market growers access to production tools to enhance their farm enterprises. Wisconsin's Hmong-speaking farmers have few training opportunities to increase their knowledge of organic and other production practices delivered in their native language. Learning new farming practices can be a challenge for anyone. Adding a language barrier can be the difference between success and failure. This project provided access by removing financial and language barriers for Hmong farmers to gain organic fresh market fruit and vegetable production knowledge at the largest organics conference in the Nation (MOSES – Midwest Organic Sustainable Education Service conference).

B. This project built on a previously funded 2011 SCBG project. Last year DATCP brought over 50 Hmong growers to the conference. Hmong speaking staff set expectations for the growers, helped them find their way to workshops, organized a Hmong network session, and worked with the Farley Center and Midwest Organic and Sustainability Education Service (MOSES) to provide one training session in Hmong language. Evaluations completed by the growers indicated they learned new information that they planned to integrate into their growing practices. Building on that success, DATCP worked closely with MOSES and Farley Center to bring new production tools to Hmong growers at the 2015 conference. Two Hmong special sessions which were presented in Hmong by Hmong farmers, Hmong interpreters were available at other regular sessions and four (4) Hmong guides provided directions to Minority fresh market growers.

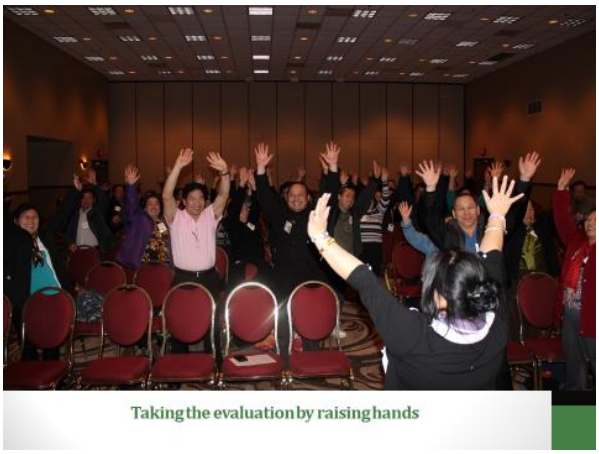
II. Project Approach

During the grant period, several meetings were held between our partners (DATCP, Farley Center and MOSES) to collaborate on this project to bring the minority fresh market growers to attend the 2015 MOSES Organic Farming Conference which was held on February 26 – 28, 2015. Farley Center was charged with finding Hmong presenters for Hmong special sessions, finding Hmong interpreters, interpreting equipment and outreaching to minority fresh market growers in Minnesota. MOSES worked on the special Hmong sessions schedule, find meeting space for Hmong sessions, worked on the lunch menu and transportation for the minority fresh market growers. DATCP recruited the minority fresh produce growers and 4 Hmong guides, and was responsible for conference registrations, lodging, coordinating activities at the hotel and at the conference.

Due to our outreach efforts and a keen interest from the growers, a total of 68 minority fresh market growers (64 participants + 4 guides) were registered and attended the 2015 MOSES Organic Farming Conference in La Crosse on February 26 – 28, 2015. Two (2) Hmong interpreters were hired from Interpreters' Cooperative of Madison to provide interpreter services at the conference. An orientation meeting/networking was hosted at the hotel on February 26, 2015 (the day before the big conference), and two (2) special Hmong sessions which were presented by Hmong growers at the conference on both days (February 27 and 28, 2015). In addition, three (3) pre-selected sessions with Hmong interpreters were offered to minority fresh produce growers on February 27, 2015. Participants also explored the exhibits and attended other sessions at the conference. The Hmong guides helped

participants find their way around the conference and helped with general interpretation needs. Toward the end of the conference, the minority fresh market growers gathered together to share what they learned and completed the evaluation. There were 66 minority fresh market growers in the room that responded to the evaluation.

*This project only benefitted fresh fruit and vegetable growers. Only presentations related to specialty crops were presented or attended by participants. No funds benefited non-specialty crops in any way.



III. Goals and Outcomes Achieved

The goals of this project was to bring a total of 50 minority fresh market growers to the MOSES Organic Farming Conference where 98% surveyed would increase their knowledge and plan to implement at least one new production practice. DATCP would bring 25 participants and Farley Center would brining the other 25. We exceeded our goal, bringing a total of 68 minority fresh market growers (64 participants and 4 guides) to the 2015 MOSES Organic Farming Conference. Since attending the conference was of so much interest to the minority fresh market growers, and we did not want to turn anyone away, and since MOSES was offering information on cover cropping at the conference, we chose to forgo the Michael Fields Institute cover crop event and spent all the funds to allow more producers to attend the MOSES event. We felt this was a better use of funds since it would reach more growers in total and still provided the same production tools expected from the Michael Fields event.

As part of partnership, MOSES gave us a group discount rate ($160/person). The regular rate was $205/person. They waived the conference registration fees for four (4) Hmong guides and two (2) Hmong interpreters to the conference. They also gave us a full page in the conference program with Hmong activities listed at no cost, value $220. Furthermore, MOSES staff spent about 42 hours to help coordinate group registrations, meeting rooms, planning, program text, workshops, and other special needs for this project. These were provided as in-kind services. We were very satisfy with the results as shown on the evaluation summary.

2015 MOSES
ORGANIC FARMING
CONFERENCE
SURVEY

			Enter a number to all questions that apply														
								DEMOGRAPHICS: What is the size of your farm?						How many people work with you on the farm?			
Hmong Farmers	Date: 2/27 & 28/2015	Event: Organic Panel / CSA- May Lee	1). Please raise your hand if you learned something new at this workshop or meeting.	2). Please raise your hand if you learned something you plan to apply to your farm operation or business.	3). Please raise your hand if you learned about a new resource.	4). Please raise your hand if you made a new connection with someone.	5). Please raise your hand if you thought the workshop or meeting was useful.	1/2-2 Acres?	2-5 Acres?	5-10 Acres?	10-20 Acres?	20-40 Acres?		1 other person?	2-4 others?	4-6 others?	More than 6 others?
66		66	66	66	66	66	66	15	28	8	4			15	38	2	

	6). Please let us know what you thought was most useful about this workshop or meeting. Comments and other responses.
	I've learned so much coming to the Moses Conference that I am beginning to value what I do in my garden.
	I learned about the different types of tractors that is available.
	Thanks to Jack and Ying for making this happen and for bringing us here.
	I feel that I have improve much after coming to this conference.
	I learned not to over plant and layout my plans as to what I will be planting so that I can sell them all.
	I learned how to plant better in my hoop house from looking at the photos that has been shown.
	Seeing so many farmers inspires me to want to continue farming.
	Thank you for the shuttle bus. We felt like we were treated as flying first class instead of transported on a bus.
	Understanding the types of tractor can make a big difference in the garden.
	I am from Minnesota and this is my first time attending Moses Conference. I learned so much that I wish I was 15 years younger. Now that I'm 60, I still want to apply what I've learned from today.
	The panels were very helpful in providing some of the answers we needed to hear.
	We are not lost this year as we did last year.
	We are not lost this year as we did last year.
	Last year we didn't know where to go or what workshops to attend. This year you guys have organized it well. We feel more like a group that is truly here to learn.
	I learned how to set up my booth better for the safety of our customers.
	I learned a lot just touring the exhibits and seeing what's available for farmers.
	I am happy that I belong to a garden community. Coming to see them and knowing the importance of our roles are important to me.
	I learned that I am not the only one that is having problems in my garden.

I am happy that we were greeted well and providing a special entrance for us to enter as a group.
I am happy and very thankful for the organizations who made this possible for us. Please continue to bring us back to learn more about farming.
I learned that my valuable and expensive flowers should be planted in the hoop house for more protection instead of outside.
I learned about obtaining insurance to protect my farming business.
I learned about the different types of cover crops to prevent weeds.
I notice that there are lots of improvement this year compare to last year. That includes topics assigned for us, seeing our names in the Moses handbook, symbols being recognized, interpreters available, and going places as a group.
Next time, please look for qualified interpreters. We are disappointed that the interpreters did not interpret accurately and completely.
The flower workshop was very useful, but it's too bad that the interpreter did not interpret everything.
The food was not good. We were still hungry. As a suggestion for next year, if you are going to pay us for lunch, save that money for us to go out to grab something to eat instead of eating lunch and dinner at the conference.
It would be more useful if some of the workshops don't overlap because we also want to hear and learn about that topic as well too.
I am happy to be able to meet a lot of good farmers and to tour many vendors.
I have been separated from the love of my life for over 45 years. What a dream come true to learn about farming and to be able to meet that person personally again.

B. 100% of grant participants who completed the evaluation reported that they learned at least one new production practice that they planned to implement on their farm in the next growing season. This exceeded our goal of 98% of participants. Overall, the activities were a huge success and we think the benefits of this project will far exceed the costs, as information learned is spread through word of mouth in our Hmong farming communities.

IV. Beneficiaries

After reading the comments/feedbacks from the evaluations, this project truly impacted the lives of 64 minority fresh produce growers. They learned how to select the right tools for their farm operation, better ways for pest and/or weed control, how to protect their valuable crops, and networked with other growers for ideas and problem solving. Attending this kind of conference will improve the minority fresh market growers' risk management skills and help them become productive growers for the local and regional economy. In addition to the conference attendees, this project will benefit Hmong farmers who live in the communities with the attendees, but who did not attend themselves. In Hmong culture, information spread by word of mouth and personal experience is highly valued. Those who attended will share their knowledge with those who did not. Because of the respect and value of personal knowledge, farmers who receive this information are highly likely to implement it on their own farms. Please see the evaluation above for more details about what individuals learned. MOSES benefited by gaining more experience in how to accommodate minority growers to attend their conference. Barriers to information are beginning to be overcome.

V. Lessons Learned

This project demonstrates how partnerships are formed and how many entities benefit when diverse people and cultures are brought together. When DATCP first brought participants to the MOSES conference on a 2011 SCBG project, we worked with MOSES a little on some logistics but planned most of the aspects on our own. MOSES staff saw benefit to having a large group of minority farmers attending and was amazingly gracious in the financial discounts and in-kind funding they provided to make this project an even greater success, not out of some charitable desire, but because of the value it added to their conference for all conference participants.

In the registration process for the conference, we had overwhelming interest from Hmong farmers. This led us to re-evaluate our project plans to host two events and we decided we could reach the same outcomes in one event that would allow us to accept all who wanted to attend the conference. Projects rarely go as planned and it is important to work with grant staff as you find things you may want to change in your project. We greatly appreciate the flexibility of this funding. We believe this flexibility allowed us to make a greater impact than if we had stuck to our original plan.

We also learned a few logistical things from this project such as the interpreting equipment needs to be checked and tested before the event if we plan to use them in the near future. We also learned that most of the minority fresh produce growers could not tolerate the food provided at the conference. They need a special diet. These concerns were addressed at our final partner meeting for improvements.

VI. Additional Information

Below are more photographs about our project activities at the 2015 MOSES Organic Farming Conference on February 26 – 28, 2015 in La Crosse, Wisconsin.

Taking 2 buses from hotel to the 2015 MOSES Conference

Orientation Meeting for 2015 MOSES Organic Farming Conference

Check-in at the 2015 MOSES Conference

Overview the Conference Programs

Hmong Session: Organic Certification Panel Discussion

Attending Regular Session with Hmong Interpreters

At the Exhibits

At the Exhibits

VII. Contact Info

Kathy Schmitt
Farm Center
Wisconsin Department of Agriculture, Trade and Consumer Protection
P.O. Box 8911
Madison, WI 53708
608-224-5048
Kathy.schmitt@wi.gov

20) Survey of Christmas tree fields for a new root rot disease

Report Date: October 14, 2015

I. Project Summary

Wisconsin's (WI) green industries and the environment are at a constant risk of new and exotic pests being accidently introduced. With the help of this project the DATCP Plant Industry Bureau Laboratory (PIB lab) and the Nursery Program screened greenhouse and nursery materials to detect and intercept recently emerged pests, such as certain plant viruses including tobacco mosaic virus, and fungal diseases like boxwood blight, and impatiens downy mildew. The survey represents a commodity approach to pest detection, by focusing on greenhouses and nurseries as pathways for inadvertent introduction of exotic and harmful plant pests to the state.

B. This project build on a previous survey for "Viruses in Imported and Domestically Produced Ornamentals" funded by Farm Bill FY12. That survey increased awareness among growers for virus infected plants, which resulted in a continued demand by growers and nursery inspectors for testing after the grant cycle was completed in 2014 (110 sample submissions in 2012, 211 samples in 2013, 228 in 2014). The current 12-020 project provided funds for laboratory supplies that allowed the PIB lab to offer virus and other exotic pathogen diagnosis to greenhouse growers and nurseries free of charge.

II. Project Approach

Nursery inspectors screened greenhouses and other nurseries (50 entities) with the purpose of intercepting virus infected plant materials before they enter the market. Suspect plants were sampled and transported to PIB lab for virus screening and other disease diagnosis (150 total samples). Results were reported to growers by emailing lab reports via their nursery inspectors. Reports also included links to pertinent webpages and UW-Extension factsheets.
Symptomatic plants were photographed and the best digital images will be included on the DATCP website http://pestsurvey.wi.gov/plantdisease/ornamentals.html and on Bugwood http://www.ipmimages.org/browse/Archivethumb.cfm?Arc=8 for outreach purposes.

This grant was well-timed, in that it coincided with a detection of tomato chlorotic dwarf viroid (TCDVd) in petunias in a Wisconsin greenhouse that was reported to the DATCP by the UW Diagnostic Clinic. TCDVd, a pospiviroid is a serious economic pest of greenhouse grown tomatoes and it is not known to occur in WI. Grant funding was used by the PIB lab to quickly adapt a RT-PCR test and screen a total of 42 petunia samples from nine different entities in WI. Representative plants were confirmed by Dr. Rose Hammond at USDA ARS. The PIB lab also confirmed PCR products by sequence analysis. All petunias of the "Peppy Lavender" variety tested positive and the affected greenhouse cooperated by destroying the entire shipment of 900 plugs, verified by a state inspector. The State Plant Health Director (SPHD) and State Plant Regulatory Official (SPRO) were kept appraised of the situation.

The PIB lab also collaborated on virus diagnosis with Dr. Dimitre Mollov at USDA ARS, Elizabeth Dorman, Michigan Department of Agriculture and Gail Ruhl, Purdue University, IN.

For a detailed summary of all virus detections and host plants affected please see section VI. Additional Information.

III. Goals and Outcomes Achieved

The DATCP Nursery Program database was queried for producers that import propagative stock directly from countries that have a history of infected plant stock. See appendix for detailed survey results table including information about survey participants and plant sources.

To alert more growers to the available virus screening, we announced the survey in DATCP's weekly Wisconsin Pest Bulletin on April 30, 2015. Survey update and results summaries were published in the bulletin on April 23, May 14, May 28, June 4 and July 30, 2015.

By June 30, 2015, 150 suspect samples had been submitted from 50 sellers of plant materials (26 greenhouses, 17 retail garden centers and 7 nurseries). The PIB lab screened 150 samples for plant viruses and other pathogens. The number of samples exceeded the goal for sample numbers (100) by 50%. The number of sellers of plant material was estimated at 50 and this goal was met.

Other pathogens of concerns screened for were boxwood blight, basil and impatiens downy mildew. Five samples were screened for boxwood blight (1 boxwood and 4 pachysandra). All submissions tested negative for this new disease. One sample of basil downy mildew was confirmed positive, no impatiens downy mildew was detected.

B.

Project Activity	Who	Timeline	Actual accomplishments
Greenhouse inspections and sampling	**DATCP Plant Industry Bureau Inspectors**	**March 1 to June 30, 2015**	**Inspections and sampling conducted March 11 to June 29, 2015**
Purchasing supplies and equipment	**DATCP PIB Lab Plant Pathologist**	**March 1 to June 30, 2015**	**Purchased supplies March 12 to June 24, 2015.**
Laboratory diagnosis	**DATCP PIB Lab Plant Pathologist**	**March 1 to June 30, 2015**	**Lab set-up and diagnosis from March 1 to June 30, 2015.**
Report lab results to individual growers	**DATCP PIB LAB Plant Pathologist**	**March 1 to June 30, 2015**	**Individual results reported by June 30, 2015.**
Assess grower response/actions	**DATCP PIB LAB Plant Pathologist**	**March 1 to June 30, 2015**	**Inspectors report full cooperation from growers removing infected plants.**

IV. Beneficiaries

Fifty growers benefited by receiving free lab diagnosis and reports for their propagating stock. Growers were able to screen out and return infected materials to suppliers for re-imbursement. Producers cooperated in destroying infected materials, thereby avoiding the release of the diseased plants in the retail market and protecting Wisconsin gardens, agricultural crops and the environment. TCDVd infected petunias were destroyed before they could leave the greenhouse, which benefits the producers of tomatoes and potatoes in this state.

V. Lessons Learned

Communication and cooperation between producers, State, University and Federal plant pathologists is crucial in detecting and identifying new disease threats. The TSDVd infected petunias, which were asymptomatic were appropriately dealt with because all stakeholders communicated and cooperated in a timely fashion. The grower notified University diagnostic clinic staff who in turn alerted the State PIB lab. Subsequently the PIB lab tested and confirmed the pathogen with help from USDA ARS. The State removed plants from sale before they could enter the market. Another lesson learned is to screen certain key host plants, like petunias that have a history of carrying latent diseases of phytosanitary concern.

We are pleased to note that propagators and retailers are starting to offer bleeding heart varieties that are free of TRV.

VI. Additional Information

2015 Greenhouse and Nursery Inspection Survey Summary

Nursery inspectors collected 150 virus-symptomatic plant samples from 50 greenhouse producers and retailers from March 11 to June 29, 2015. Plant Industry Bureau laboratory (PIB LAB) tested fourteen different host genus plants, each for a range of up to a dozen host appropriate viruses. Seventy-five of 150 (50%) samples tested positive for at least one plant virus. The most common viruses were hosta virus X (HVX) with 7 positives of 12 (58%), tobacco rattle virus (TRV) with 44 positives of 85 (52%), followed by viruses in the potyvirus group with 15 positives of 30 (50%). Table 1 shows the results of virus testing.

Potyviruses were found on canna, iris, lily and sedum. TRV infected astilbe, barrenwort, bleeding heart, hosta and peony. Seventy-four percent (25 of 34) of bleeding heart plants tested positive in the laboratory. All TRV infected bleeding hearts belonged to the varieties “Alba”, “Pink” and “Valentine”. However fern-leaf bleeding hearts “King of Hearts”, “Love Hearts” and “Luxuriant” were clean in lab testing.

Cucumber mosaic virus (CMV) was found on hydrangea and florist’s geranium in 2 of 45 (4%) samples tested. Impatiens necrotic spot virus (INSV) showed up in 6 of 41 (15%) samples, all begonias. Dahlia common mosaic caulimovirus (DMV) was detected in one dahlia samples. AMV, ArMV, TMV and TSWV were not found during the 2015 survey. Greenhouse producers, nurseries and retailers cooperated with nursery inspectors by removing all virus-infected plant materials from sale.

Petunias “Peppy Lavender” were infected with tomato chlorotic dwarf viroid (TCDVd), despite not showing any symptoms. In total 42 samples from seven greenhouses and retailers were tested for this pospiviroid that is a major issue in greenhouse produced tomatoes. Several other petunia varieties

were screened as well such as: Peppy Red, Johnny Flame, Supertunias, Sweetunia, Queen Bee, and Royal Velvet. All other petunias were clean. The TCDVd infected plants could be traced to a single source, all of them "Peppy Lavender", all were removed from sale and destroyed.

Images of virus symptomatic plants can be viewed on http://pestsurvey.wi.gov/ and on bugwood.org.

Table 1. Results of Virus Testing Virus	**Total tests**	**Positive**	**Percent Positive**
Alfalfa mosaic virus (AMV)	5	0	0
Arabis mosaic virus (ArMV)	10	0	0
Cucumber mosaic virus (CMV)	45	2	4%
Dahlia mosaic virus (DMV)	1	1	NA
Hosta virus X (HVX)	**12**	**7**	**58%**
Impatiens necrotic spot virus (INSV)	41	6	15%
Potygroup viruses	**30**	**15**	**50%**
Tobacco mosaic virus (TMV)	40	0	0
Tobacco rattle Virus (TRV)	**85**	**44**	**52%**
Tomato chlorotic dwarf viroid (**TCDVd**) / pospiviroids	**42**	**10**	**24%**
Tomato spotted wilt virus (TSWV)	38	0	0

Other plant diseases of concern encountered during inspections were: **Basil Downy Mildew** (*Peronospora belbahrii*), a serious problem of basil. The affected basil was removed from sale at a retailer in Milwaukee.

Inspectors continue to watch for **Impatiens Downy Mildew** (*Plasmopara obducens*), a devastating disease of the popular shade bedding plant, but did not observe any so far in 2015. Five suspect **Boxwood Blight** samples, one boxwood and four pachysandra were submitted to the lab. All tested negative for the pathogen (*Cylindrocladium pseudonaviculatum*), but positive for the more common Volutella blight instead.

Appendix

Sample Lab Number	Date Received	Grower	County	Source	Common Name	Scientific Plant Name	Variety	Primary Disease	Scientific Name of Pathogen	More Disease Results
15003	3/11/2015	Heidi A Heath Farms	ADAMS	Dummen-Red Fox, El Salvador	Petunia	Petunia hybrid	Peppy Red	Negative for TCDVd		
15004	3/11/2015	Heidi A Heath Farms	ADAMS	Dummen-Red Fox, El Salvador	Petunia	Petunia hybrid	Peppy Lavender	Positive for TCDVd	Tomato chlorotic dwarf viroid	
15005	3/11/2015	Heidi A Heath Farms	ADAMS	Dummen-Red Fox, El Salvador	Petunia	Petunia hybrid	Peppy Lavender	Positive for TCDVd	Tomato chlorotic dwarf viroid	
15006	3/11/2015	Heidi A Heath Farms	ADAMS	Dummen-Red Fox, El Salvador	Petunia	Petunia hybrid	Peppy Lavender	Positive for TCDVd	Tomato chlorotic dwarf viroid	
15008	3/24/2015	Floral Plant Grower	KEWAUNEE	Dummen Red Fox, El Salvador	Petunia	Petunia hybrid	Peppy Lavender	Positive for TCDVd	Tomato chlorotic dwarf viroid	Negative for CMV, INSV,TSWV, TMV
15009	3/24/2015	Floral Plant Grower	KEWAUNEE	Dummen Red Fox, El Salvador	Petunia	Petunia hybrid	Peppy Lavender	Positive for TCDVd	Tomato chlorotic dwarf viroid	
15010	3/24/2015	Floral Plant Grower	KEWAUNEE	Dummen Red Fox, El Salvador	Petunia	Petunia hybrid	Johnny Flame	Negative for TCDVd		Negative for CMV, INSV,TSWV, TMV
15011	3/24/2015	Floral Plant Grower	KEWAUNEE	Dummen Red Fox, El Salvador	Petunia	Petunia hybrid	Bubbalou	Negative for TCDVd		
15012	3/24/2015	Floral Plant Grower	KEWAUNEE		Larkspur	Delphinium sp.	Magic Fountain Dk Blue Bee	Negative for root rot, possible chill injury		Negative for CMV, INSV,TSWV, TMV, TRV
15013	3/24/2015	Floral Plant Grower	KEWAUNEE		Larkspur	Delphinium sp.	Magic Fountain Lavender White Bee	Crown rot	Rhizoctonia sp.	Negative for CMV, INSV,TSWV, TMV, TRV
15014	3/24/2015	Floral Plant Grower	KEWAUNEE		Larkspur	Delphinium sp.	Magic Fountain Lavender White Bee	Negative for root rot, possible chill injury		Negative for CMV, INSV,TSWV, TMV, TRV
15015	3/24/2015	Floral Plant Grower	KEWAUNEE		Larkspur	Delphinium sp.	Grace, Social Butterfly	Crown rot	Rhizoctonia sp.	Negative for TRV
15016	3/24/2015	Floral Plant Grower	KEWAUNEE		Astilbe	Astilbe arendsii	Drum & Brass	Negative for TRV		
15017	3/24/2015	Floral Plant Grower	KEWAUNEE	Dummen	Bleeding heart	Lamprocapnos spectabilis	alba	Positive for TRV	Tobacco rattle virus	
15018	3/24/2015	Floral Plant Grower	KEWAUNEE	Dummen	Bleeding heart	Lamprocapnos spectabilis	pink	Positive for TRV	Tobacco rattle virus	
15019	3/27/2015	Heidi A Heath Farms	ADAMS	Dummen Red Fox, El Salvador	Petunia	Petunia hybrid	Peppy Lavender	Positive for TCDVd	Tomato chlorotic dwarf viroid	
15019	3/27/2015	Heidi A Heath Farms	ADAMS	Dummen Red Fox, El Salvador	Verbena	Verbena sp.		Negative for TCDVd		
15020	3/27/2015	Heidi A Heath Farms	ADAMS	Dummen Red Fox, El Salvador	Petunia	Petunia bybrid	Peppy Lavender	Positive for TCDVd	Tomato chlorotic dwarf viroid	
15020	3/27/2015	Heidi A Heath Farms	ADAMS	Dummen Red Fox, El Salvador	Verbena	Verbena sp.		Negative for TCDVd		
15021	3/27/2015	Heidi A Heath Farms	ADAMS	Dummen Red Fox, El Salvador	Petunia	Petunia hybrid	Peppy Lavender	Positive for TCDVd	Tomato chlorotic dwarf viroid	
15021	3/27/2015	Heidi A Heath Farms	ADAMS	Dummen Red Fox, El Salvador	Verbena	Verbena sp.		Negative for TCDVd		
15022	3/27/2015	Heidi A Heath Farms	ADAMS	Dummen Red Fox, El Salvador	Petunia	Petunia hybrid	Supertunia Magenta flower	Negative for TCDVd		Negative for CMV, INSV,TSWV, TMV

Sample Lab Number	Date Received	Grower	County	Source	Common Name	Scientific Plant Name	Variety	Primary Disease	Scientific Name of Pathogen	More Disease Results
15023	3/27/2015	Heidi A Heath Farms	ADAMS	Dummen Red Fox, El Salvador	Petunia	Petunia hybrid	Supertunia Purple flower	Negative for TCDVd		
15024	3/27/2015	Heidi A Heath Farms	ADAMS	Dummen Red Fox, El Salvador	Petunia	Petunia hybrid	Supertunia Purple, white, rose red	Negative for TCDVd		Negative for CMV, INSV,TSWV, TMV
15025	3/27/2015	Heidi A Heath Farms	ADAMS	Dummen Red Fox, El Salvador	Petunia	Petunia hybrid	Supertunia white with pink lines, purple	Positive for TCDVd	Tomato chlorotic dwarf viroid	
15026	3/27/2015	Heidi A Heath Farms	ADAMS	Dummen Red Fox, El Salvador	Petunia	Petunia hybrid	Supertunia Purple, white, lavender	Negative for TCDVd		
15027	3/27/2015	Heidi A Heath Farms	ADAMS	Dummen Red Fox, El Salvador	Petunia	Petunia hybrid	Supertunia Magenta, white, lavender	Negative for TCDVd		
15028	3/27/2015	Heidi A Heath Farms	ADAMS	Dummen Red Fox, El Salvador	Petunia	Petunia hybrid	Supertunia Lavender, pink flowers	Negative for TCDVd		
15029	3/27/2015	Heidi A Heath Farms	ADAMS	Dummen Red Fox, El Salvador	Petunia	Petunia hybrid	Supertunia Red flowers	Negative for TCDVd		Negative for CMV, INSV,TSWV, TMV
15030	3/27/2015	Heidi A Heath Farms	ADAMS	Dummen Red Fox, El Salvador	Petunia	Petunia hybrid	Supertunia Red flowers	Negative for TCDVd		
15031	3/27/2015	Heidi A Heath Farms	ADAMS	Dummen Red Fox, El Salvador	Petunia	Petunia hybrid	Supertunia Pink flowers	Negative for TCDVd		Negative for CMV, INSV,TSWV, TMV
15032	3/27/2015	Heidi A Heath Farms	ADAMS	Dummen Red Fox, El Salvador	Petunia	Petunia hybrid	Supertunia Purple flowers	Negative for TCDVd		
15033	3/27/2015	Heidi A Heath Farms	ADAMS	Dummen Red Fox, El Salvador	Petunia	Petunia hybrid	Supertunia Lavender flowers	Negative for TCDVd		
15034	3/27/2015	Heidi A Heath Farms	ADAMS	Dummen Red Fox, El Salvador	Petunia	Petunia hybrid	Supertunia Purple flowers	Negative for TCDVd		
15035	3/27/2015	Heidi A Heath Farms	ADAMS	Dummen Red Fox, El Salvador	Petunia	Petunia hybrid	Supertunia Lavender pink flowers	Negative for TCDVd		Negative for CMV, INSV,TSWV, TMV
15036	3/27/2015	Heidi A Heath Farms	ADAMS	Dummen Red Fox, El Salvador	Petunia	Petunia hybrid	Supertunia Purple flower	Negative for TCDVd		
15037	3/27/2015	Heidi A Heath Farms	ADAMS	Dummen Red Fox, El Salvador	Petunia	Petunia hybrid	Supertunia Purple flower	Negative for TCDVd		
15038	3/27/2015	Heidi A Heath Farms	ADAMS	Dummen Red Fox, El Salvador	Petunia	Petunia hybrid	Supertunia Purple flower	Negative for TCDVd		
15039	3/27/2015	Heidi A Heath Farms	ADAMS	Dummen Red Fox, El Salvador	Petunia	Petunia hybrid	Supertunia Purple flower	Negative for TCDVd		Negative for CMV, INSV,TSWV, TMV
15040	3/27/2015	Heidi A Heath Farms	ADAMS	Dummen Red Fox, El Salvador	Petunia	Petunia hybrid	Supertunia Dark pink flowers	Negative for TCDVd		Negative for CMV, INSV,TSWV, TMV
15041	3/27/2015	Heidi A Heath Farms	ADAMS	Dummen Red Fox, El Salvador	Petunia	Petunia hybrid	Supertunia Purple flowers	Negative for TCDVd		Negative for CMV, INSV,TSWV, TMV
15042	4/1/2015	Floral Plant Grower	KEWAUNEE	Darwin Plants Netherlands, Ball	Bleeding heart	Lamprocapnos spectabilis	alba	Positive for TRV	Tobacco rattle virus	
15043	4/1/2015	Floral Plant Grower	KEWAUNEE	Darwin Plants Netherlands, Ball	Bleeding heart	Lamprocapnos spectabilis	pink	Positive for TRV	Tobacco rattle virus	

Sample Lab Number	Date Received	Grower	County	Source	Common Name	Scientific Plant Name	Variety	Primary Disease	Scientific Name of Pathogen	More Disease Results
15044	4/1/2015	Floral Plant Grower	KEWAUNEE	Darwin Plants Netherlands, Ball	Bleeding heart	Lamprocapnos spectabilis	pink	Positive for TRV	Tobacco rattle virus	
15045	4/1/2015	Floral Plant Grower	KEWAUNEE	Darwin Plants Netherlands, Ball	Bleeding heart	Lamprocapnos spectabilis	alba	Positive for TRV	Tobacco rattle virus	
15046	4/1/2015	Floral Plant Grower	KEWAUNEE	Darwin Plants Netherlands, Ball	Bleeding heart	Lamprocapnos spectabilis	King of Hearts	Negative for TRV		
15047	4/1/2015	Floral Plant Grower	KEWAUNEE	Darwin Plants Netherlands, Ball	Bleeding heart	Lamprocapnos spectabilis	King of Hearts	Negative for TRV		
15048	4/9/2015	Plant Marketing	EAU CLAIRE		Hosta	Hosta sp.	Blue Angel	Negative for HVX		Negative for ArMV, CMV, INSV,TSWV, Poty, TRV
15049	4/9/2015	Plant Marketing	EAU CLAIRE		Coneflower	Echinacea purpurea	Prairie Splendor	Fusarium root rot	Fusarium sp.	
15053	4/15/2015	Home Depot	RACINE	Sawyer Nursery, 5401 Port Sheldon St, Hudsonville, MI 49426	Bleeding heart	Lamprocapnos spectabilis	pink	Positive for TRV	Tobacco rattle virus	
15054	4/15/2015	Schroeder Flowers, Inc.	OUTAGAMIE	Darwin Plants Netherlands, Ball	Bleeding heart	Lamprocapnos spectabilis	alba	Positive for TRV	Tobacco rattle virus	
15055	4/15/2015	Schroeder Flowers, Inc.	OUTAGAMIE	Darwin Plants Netherlands, Ball	Bleeding heart	Lamprocapnos spectabilis	pink	Positive for TRV	Tobacco rattle virus	
15056	4/15/2015	Schroeder Flowers, Inc.	OUTAGAMIE	Growing Colors, 788 Hampden Ave., St. Paul, MN 55114	Bleeding heart	Lamprocapnos spectabilis	pink	Positive for TRV	Tobacco rattle virus	
15057	4/15/2015	Schroeder Flowers, Inc.	OUTAGAMIE	Darwin Plants Netherlands, Ball	Bleeding heart	Lamprocapnos formosa	King of Hearts	Negative for TRV		
15058	4/15/2015	Schroeder Flowers, Inc.	OUTAGAMIE	Darwin Plants Netherlands, Ball	Bleeding heart	Lamprocapnos formosa	Love Hearts	Negative for TRV		
15059	4/15/2015	Schroeder Flowers, Inc.	OUTAGAMIE	Darwin Plants Netherlands, Ball	Bleeding heart	Lamprocapnos formosa	Luxuriant	Negative for TRV		
15060	4/15/2015	Schroeder Flowers, Inc.	OUTAGAMIE	Growing Colors, 788 Hampden Ave., St. Paul, MN 55114	Bleeding heart	Lamprocapnos spectabilis	Valentine PPAF	Positive for TRV	Tobacco rattle virus	
15061	4/15/2015	Schroeder Flowers, Inc.	OUTAGAMIE	Darwin Plants Netherlands, Ball	Hosta	Hosta sp.	August Moon	Positive for HVX and TRV	Hosta virus X, tobacco rattle virus	Negative for ArMV, TSWV
15062	4/15/2015	Schroeder Flowers, Inc.	OUTAGAMIE	Dummen	Petunia	Petunia hybrid	Surprise Queen Bee	pending USDA testing		Negative for AMV,TCDVd,TMV, ArMV,CMV,INSV,TSWV,Poty
15063	4/15/2015	Schroeder Flowers, Inc.	OUTAGAMIE	Dummen	Petunia	Petunia hybrid	Sweetunia Grape Ice	pending USDA testing		Negative for AMV,TCDVd,TMV, ArMV,CMV,INSV,TSWV,Poty
15064	4/15/2015	Schroeder Flowers, Inc.	OUTAGAMIE	Dummen	Petunia	Petunia hybrid	Sweetunia Blueberry Ice	pending USDA testing		Negative for AMV,TCDVd,TMV, ArMV,CMV,INSV,TSWV,Poty
15065	4/15/2015	Schroeder Flowers, Inc.	OUTAGAMIE	Swift Nursery, Milwaukee	Larkspur	Delphinium sp.	Round Table Mix Pacific Giant	Possible chill injury		Negative for AMV, CMV, TMV, TRV
15066	4/15/2015	Schroeder Flowers, Inc.	OUTAGAMIE	Swift Nursery, Milwaukee	Larkspur	Delphinium sp.	Magic Fountains Mix	Possible chill injury		Negative for AMV, CMV, TMV, TRV
15067	4/15/2015	Schroeder Flowers, Inc.	OUTAGAMIE	Linders Greenhouse, St. Paul, MN	Iris, Bearded	Iris germanica	Immortality	Positive for potyvirus	Potyvirus	
15069	4/28/2015	Milaeger's Inc.	RACINE	Garden World, MN	Bleeding heart	Lamprocapnos spectabilis	Valentine	Positive for TRV	Tobacco rattle virus	

Sample Lab Number	Date Received	Grower	County	Source	Common Name	Scientific Plant Name	Variety	Primary Disease	Scientific Name of Pathogen	More Disease Results
15070	4/28/2015	Milaeger's Inc.	RACINE	Garden World, MN	Bleeding heart	Lamprocapnos spectabilis	pink	Positive for TRV	Tobacco rattle virus	
15071	4/28/2015	Milaeger's Inc.	RACINE	Monrovia	Snail Vine	Vigna caracalla		Pythium root rot	Pythium sp.	Fusarium, dead spidermites, scale
15072	4/28/2015	Milaeger's Inc.	RACINE		Angel's Trumpet	Brugmansia isignis	pink	Bacterial blight	Pseudomonas sp.	Negative for TMV
15073	4/28/2015	Milaeger's Inc.	RACINE		Lobelia	Lobelia sp.	Starship Deep Rose	Negative for CMV,INSV, TSWV, TMV,TRV		Possible chill injury, no mites observed.
15074	4/28/2015	Milaeger's Inc.	RACINE	Red Fox brand	Begonia	Begonia hybrid	Baladin	Negative for CMV,INSV, TSWV, TMV,TRV		Poor root development, chlorosis possibly due to chill.
15075	4/28/2015	Bayside Garden Center	MILWAUKEE	Growing Colors, 788 Hampden Ave., St. Paul, MN 55114	Bleeding heart	Lamprocapnos spectabilis	Valentine	Positive for TRV	Tobacco rattle virus	
15076	4/28/2015	Milaeger's Inc.	MILWAUKEE	Growing Colors, 788 Hampden Ave., St. Paul, MN 55114	Bleeding heart	Lamprocapnos spectabilis	alba	Positive for TRV	Tobacco rattle virus	
15077	4/28/2015	Milaeger's Inc.	MILWAUKEE	Growing Colors, 788 Hampden Ave., St. Paul, MN 55114	Bleeding heart	Lamprocapnos spectabilis	pink	Positive for TRV	Tobacco rattle virus	
15078	4/28/2015	Lowes	KENOSHA	Color Point, Granville, IL	Petunia	Petunia hybrid	mixed basket	Positive for TCDVd	Tomato chlorotic dwarf viroid	
15079	5/1/2015	W & E Radtke Inc.	WASHINGTON	Rijnbeek, Netherlands	Barrenwort	Epimedium grandiflorum	Lilafee	Positive for TRV	Tobacco rattle virus	
15080	5/1/2015	W & E Radtke Inc.	WASHINGTON	Netherland Bulb	Bleeding heart	Lamprocapnos spectabilis	Gold Heart	Positive for TRV	Tobacco rattle virus	
15081	5/1/2015	W & E Radtke Inc.	WASHINGTON	Rijnbeek, Netherlands	Barrenwort	Epimedium grandiflorum	Lilafee	Pythium root rot and root lesion nematode	Pythium sp., Pratylenchus sp.	Negative for TRV
15082	5/1/2015	W & E Radtke Inc.	WASHINGTON		Pachysandra	Pachysandra sp.		Volutella blight, Fusarium & Pythium root rot	Volutella pachysandrae, Fusarium sp., Pythium sp.	Negative for TRV, two-spotted spidermites
15083	5/1/2015	W & E Radtke Inc.	WASHINGTON		Pachysandra	Pachysandra sp.		Fusarium & Pythium root rot	Fusarium sp., Pythium sp.	Negative for TRV
15084	5/1/2015	W & E Radtke Inc.	WASHINGTON		Pachysandra	Pachysandra sp.		Fusarium & Pythium root rot	Fusarium sp., Pythium sp.	Negative for TRV
15085	5/1/2015	W & E Radtke Inc.	WASHINGTON		Pachysandra	Pachysandra sp.		Volutella blight, Fusarium & Pythium root rot	Volutella pachysandrae, Fusarium sp., Pythium sp.	Negative for TRV
15086	5/1/2015	W & E Radtke Inc.	WASHINGTON	Darwin Plants Netherlands, Ball	Barrenwort	Epimedium sulphureum	bicolor	Positive for TRV	Tobacco rattle virus	
15087	5/7/2015	Charles Wery Farms	BROWN	TBD	Begonia, Tuberous	Begonia hybrid	Non-Stop Mocca Mix	Positive for INSV	Impatiens necrotic spot virus	Negative for CMV, TSWV, TMV, Potyvirus
15088	5/7/2015	Charles Wery Farms	BROWN	TBD	Begonia, Tuberous	Begonia hybrid	Non-Stop Orange	Positive for INSV	Impatiens necrotic spot virus	Negative for CMV, TSWV, TMV
15089	5/7/2015	Charles Wery Farms	BROWN	TBD	Begonia, Tuberous	Begonia hybrid	Non-Stop White	Positive for INSV	Impatiens necrotic spot virus	Negative for CMV, TSWV, TMV

Sample Lab Number	Date Received	Grower	County	Source	Common Name	Scientific Plant Name	Variety	Primary Disease	Scientific Name of Pathogen	More Disease Results
15090	5/7/2015	Charles Wery Farms	BROWN	TBD	Begonia, Tuberous	Begonia hybrid	Non-Stop Deep Red	Positive for INSV	Impatiens necrotic spot virus	Negative for CMV, TSWV, TMV
15091	5/7/2015	Charles Wery Farms	BROWN	TBD	Begonia, Tuberous	Begonia hybrid	Non-Stop Rose Pink	Positive for INSV	Impatiens necrotic spot virus	Negative for CMV, TSWV, TMV
15092	5/7/2015	Charles Wery Farms	BROWN	TBD	Begonia, Tuberous	Begonia hybrid	Non-Stop Yellow	Positive for INSV	Impatiens necrotic spot virus	Negative for CMV, TSWV, TMV
15098	5/14/2015	Geneva Lake Produce	WALWORTH	own stock	Wandering Jew	Tradescantia sp.		Negative virus screen		Negative for CMV,INSV,TSWV, TMV,TRV, potyvirus.
15099	5/14/2015	Mayfield Nursery, Inc.	WASHINGTON		Violet	Viola odorata		Negative virus screen		Negative for CMV,INSV, TSWV,TMV,TRV, potyvirus. Pot bound
15100	5/14/2015	Groth Country Gardens	WASHINGTON	Dummen	Petunia	Petunia hybrid	Queen Bee	Fusarium wilt	Fusarium sp.	Negative for CMV, INSV,TSWV, TMV, TRV,pospiviroids
15101	5/14/2015	Prange Greenhouses	WASHINGTON	Red Fox brand	Million Bells	Calibrachoa hybrid	Kona Midnight Blue	Abiotic stress		Negative for Pospiviroids, TRV
15102	5/14/2015	Tehan Greenhouses	MILWAUKEE		Supertunia	Petunia hybrid	Royal Velvet	Negative virus screen		Negative for pospiviroids, CMV,INSV,TMV,TSWV.
15103	5/14/2015	Jurgs Greenhouses	WALWORTH	Faribault Growers, Inc., 3135 227th St E, Faribault, MN 55021	Coral bells	Heuchera sp.	Hercules	Abiotic stress		Negative for TRV, potyvirus, nematodes, bacteria
15104	5/14/2015	Marketplace Foods	BARRON	Bert R. Hybels, Inc., Kalamazoo, MI	Hosta	Hosta sp.	Gold Standard	Positive for HVX	Hosta virus X	
15105	5/15/2015	Hartman's Towne & Country Greenhouse	MANITOWOC		Mandevilla	Mandevilla sp.		Negative for CMV		
15106	5/15/2015	Hartman's Towne & Country Greenhouse	MANITOWOC	Leo Burbee Co.	Peony	Paeonia sp.	Primavera	Positive for TRV	Tobacco rattle virus	
15107	5/15/2015	Hartman's Towne & Country Greenhouse	MANITOWOC	Walter's Garden, MI	False spiraea	Astilbe arendsii	Burgundy Red	Positive for TRV	Tobacco rattle virus	
15108	5/15/2015	Mayflower Greenhouse	BROWN	TBD	Canna	Canna X generalis	Red Dazzler	Postive for potyvirus		symptomatic for Canna yellow streak virus
15109	5/15/2015	Schroeder Flowers, Inc.	OUTAGAMIE	Dummen	Sweetunia	Petunia hybrid	Grape Ice	unkown virus		
15110	5/15/2015	Schroeder Flowers, Inc.	OUTAGAMIE	Dummen	Petunia	Petunia hybrid	Surprise Queen Bee	unkown virus		
15111	5/15/2015	Schroeder Flowers, Inc.	OUTAGAMIE	Dummen	Sweetunia	Petunia hybrid	Blueberry Ice	unkown virus		
15113	5/21/2015	K-Mart Corp. #3534	WASHINGTON		Petunia	Petunia hybrid	combo pot	Negative virus screen, thrips present		Negative for ArMV,CMV,INSV, TSWV,TMV,TRV,potyvirus.
15115	5/21/2015	Milaeger's Inc.	RACINE	Hortech, MI	Barrenwort	Epimedium X rubrum	Rubrum	Positive for TRV	Tobacco rattle virus	
15116	5/21/2015	Milaeger's Inc.	RACINE	Hortech, MI	Barrenwort	Epimedium grandiflorum	Lilafee	Positive for TRV	Tobacco rattle virus	
15117	5/21/2015	Milaeger's Inc.	RACINE	Hortech, MI	Barrenwort	Epimedium x youngianum	Niveum	Positive for TRV	Tobacco rattle virus	

Sample Lab Number	Date Received	Grower	County	Source	Common Name	Scientific Plant Name	Variety	Primary Disease	Scientific Name of Pathogen	More Disease Results
15118	5/21/2015	Milaeger's Inc.	RACINE	Hortech, MI	Barrenwort	Epimedium versicolor	Sulphureum	Positive for TRV	Tobacco rattle virus	Pestalotiopsis leaf spot
15125	6/1/2015	Steins	OZAUKEE	TBD	Bleeding heart	Lamprocapnos spectabilis	pink	Positive for TRV	Tobacco rattle virus	
15126	6/1/2015	Steins	OZAUKEE	TBD	Bleeding heart	Lamprocapnos spectabilis	pink	Positive for TRV	Tobacco rattle virus	
15127	6/1/2015	Steins	OZAUKEE	Monrovia	Hosta	Hosta sp.	Striptease	Positive for HVX	Hosta virus X	
15128	6/1/2015	Lowes	MILWAUKEE	Color Point, Granville, IL	Petunia	Petunia hybrid	white and fuchsia stripe	Negative for pospiviroids and TRV		
15129	6/1/2015	Kellner Greenhouses	MILWAUKEE	Own seed	Basil	Ocimum basilicum		Basil downy mildew	Peronospora belbahrii	
15133	6/1/2015	Endeavors Adult Dev. Center, Inc.	POLK	Carlin Plant Sales St. Paul MN	Portulaca	Portulaca grandiflora	Pazzaz Salmon Glow	No primary fungal or bacterial pathogens		Negative for CMV, INSV,TSWV, TMV, potyvirus, TRV
15134	6/1/2015	Chippewa Valley Grows	CHIPPEWA	Darwin Plants Netherlands, Ball	Barrenwort	Epimedium sp.	Amber Queen	Black root rot	Thielaviopsis basicola	Negative for TRV
15135	6/1/2015	Sunrise Greenhouse	CHIPPEWA	Seed	Geranium, florists	Pelargonium hybrid	Pinto Pink	Positive for CMV	Cucumber mosaic virus	
15136	6/1/2015	Sunrise Greenhouse,	CHIPPEWA	Spring meadow Nursery, MI	Hydrangea	Hydrangea	Invincible spirit	Positive for CMV and black root rot	Cucumber mosaic virus	Thielaviopsis root rot
15137	6/1/2015	Chippewa Valley Grows	EAU CLAIRE	Walter's Gardens MI	Iris, standard dwarf bearded	Iris germanica	Blueberry Tart	Positive for potyvirus	Potyvirus	
15138	6/1/2015	Chippewa Valley Grows	EAU CLAIRE	Walter's Gardens MI	Iris, standard dwarf bearded	Iris germanica	Baby Blessed	Positive for potyvirus	Potyvirus	
15139	6/1/2015	Chippewa Valley Grows	EAU CLAIRE	Walter's Gardens MI or Darwin, Ball	Bellflower	Campanula hybrid	Genti Twisterbell	unusual but normal growth habit		
15140	6/1/2015	Chippewa Valley Grows	EAU CLAIRE	Darwin Plants Netherlands, Ball	Hosta	Hosta sp.	white feather	Negative virus screen		Negative for HVX, ArMV, CMV, INSV, TSWV, TMV
15144	6/1/2015	unknown	out-of-state	unknown	Evening Primrose	Oenothera	Cote Johnson	Negative virus screen		Negative for ArMV, CMV, INSV,TSWV, TMV, Poty, TRV
15146	6/1/2015	Joe's Ctry Corner	PRICE	TBD	Peony	Paeonia lactiflora	Festiva Maxima	Positive for TRV	Tobacco rattle virus	
15147	6/1/2015	Joe's Ctry Corner	PRICE	TBD	Canna	Canna hybrid	Holland Striped, orange/red bloom	Positive for potyvirus	Potyvirus	symptomatic for canna yellow streak virus
15148	6/8/2015	Gerbers Nursery	WAUKESHA	Walter's Gardens MI	Hosta	Hosta sp.	Abiqua Drinking Gourd	Chill injury		Negative for HVX and ArMV
15149	6/8/2015	Piala's Nursery	WAUKESHA	Q&Z Nursery Illinois	Hosta	Hosta sp.	Komono Dragon	Chill injury		Negative for HVX and ArMV
15150	6/8/2015	Anna's	WALWORTH	Swift Nursery, Milwaukee	Delphinium	Delphinium sp.	sky blue white bee Magic Fountains	Chill injury		Negative for CMV, INSV,TSWV, TMV, TRV, no foliar nematodes
15151	6/8/2015	Shady Acres Perennial Nursery	WAUKESHA	DeVroomen	Peony	Paeonia lactiflora	Karl Rosenfield	Positive for TRV	Tobacco rattle virus	

Sample Lab Number	Date Received	Grower	County	Source	Common Name	Scientific Plant Name	Variety	Primary Disease	Scientific Name of Pathogen	More Disease Results
15152	6/8/2015	Caan Floral Greenhouses	SHEBOYGAN	De Vroomen	Bleeding heart	Lamprocapnos spectabilis	Valentine	Positive for TRV	Tobacco rattle virus	
15153	6/8/2015	Caan Floral Greenhouses	SHEBOYGAN	De Vroomen	Bleeding heart	Lamprocapnos spectabilis	alba	Positive for TRV	Tobacco rattle virus	
15154	6/8/2015	Caan Floral Greenhouses	SHEBOYGAN	De Vroomen	Bleeding heart	Lamprocapnos spectabilis	pink	Positive for TRV	Tobacco rattle virus	
15155	6/11/2015	Stoffel's County Store	IRON	Walter's Garden MI	Iris, tall bearded	Iris germanica	Bountiful Harvest	Positive for potyvirus	Potyvirus	
15157	6/15/2015	Wood River Garden Store	BURNETT	Growing Colors, 788 Hampden Ave., St. Paul, MN 55114	Iris, Bearded	Iris germanica	Stairway to Heaven	Positive for potyvirus	Potyvirus	
15158	6/15/2015	Wood River Garden Store	BURNETT	Growing Colors, 788 Hampden Ave., St. Paul, MN 55114	Iris, Bearded	Iris germanica	Dangerous Mood	Positive for potyvirus	Potyvirus	
15159	6/16/2015	North Star Company Inc.	SAWYER	Growing Colors, 788 Hampden Ave., St. Paul, MN 55114	Iris, Bearded	Iris germanica	Anaconda Love	Positive for potyvirus	Potyvirus	
15160	6/16/2015	Stroney Creek Landscaping	ONEIDA	Growing Colors, 788 Hampden Ave., St. Paul, MN 55114	Barrenwort	Epimedium sp.	Rubrum	Positive for TRV	Tobacco rattle virus	
15163	6/16/2015	Home Depot	RACINE	The Cottage Gardens, 4992 Middle Ridge Rd, Perry, OH 44081	Boxwood	Buxus sp.	Green Velvet	Volutella blight	Volutella buxi	
15164	6/16/2015	Eberts Greenhouse Village Inc.	JEFFERSON		Hops	Humulus lupulus	Nugget	Negative for Downy & Powdery Mildew		Thrips & spidermites
15165	6/16/2015	Eberts Greenhouse Village Inc.	JEFFERSON		Sweet Pea	Lathyrus latifolius		Negative for ArMV,CMV,INSV,TSWV,TMV,POTY,TRV		spidermites (Tetranychus urticae)
15166	6/16/2015	Eberts Greenhouse Village Inc.	JEFFERSON	Monrovia	Hosta	Hosta sp.	Striptease	Positive for HVX	Hosta virus X	
15167	6/16/2015	Eberts Greenhouse Village Inc.	JEFFERSON	Growing Colors, 788 Hampden Ave., St. Paul, MN 55114	Hosta	Hosta sp.	Gypsy Rose	Positive for HVX	Hosta virus X	
15168	6/16/2015	Eberts Greenhouse Village Inc.	JEFFERSON	TBD	Canna	Canna hybrid	Firebird	Positive for potyvirus	Potyvirus	
15169	6/16/2015	Eberts Greenhouse Village Inc.	JEFFERSON	Van Bloem Gardens, 8079 Van Zyverden Rd, Meridian, MS 39305	Dahlia	Dahlia sp.	Mom's Special	Positive for DMV	Dahlia mosaic virus	
15170	6/18/2015	Shopko	WINNEBAGO	Berry Nurseries, 3656 HWY 51 Hulbert, OK 74441	Peony	Paeonia sp.	Dr. Alexander Flemming	Positive for TRV and black root rot	Tobacco rattle virus	Black root rot (Thielaviopsis basicola)
15176	6/23/2015	Dept of Ag.	MICHIGAN STATE	Courtesy sample	Peony	Paeonia sp.		Positive for TRV	Tobacco rattle virus	

Sample Lab Number	Date Received	Grower	County	Source	Common Name	Scientific Plant Name	Variety	Primary Disease	Scientific Name of Pathogen	More Disease Results
15178	6/26/2015	Season's Harvest Greenhouse	DUNN	Walter's Garden, MI	Sedum	Sedum sp.	Mr. Goodbud	Positive for potyvirus	Potyvirus	
15180.1	6/26/2015	Season's Harvest Greenhouse	DUNN	Walter's Garden, MI	Iris, Bearded	Iris germanica	Immortality	Positive for potyvirus	Potyvirus	
15180.2	6/26/2015	Season's Harvest Greenhouse	DUNN	Walter's Garden, MI	Iris, Bearded	Iris germanica	Batik	Positive for potyvirus	Potyvirus	
15180.3	6/26/2015	Season's Harvest Greenhouse	DUNN	Walter's Garden, MI	Iris, Bearded	Iris germanica	Color Strokes	Positive for potyvirus	Potyvirus	
15181	6/26/2015	Horant's Garden Center	VILAS	Green Select Perennials	Hosta	Hosta sp.	Sum & Substance	Positive for HVX	Hosta virus X	
15182	6/29/2015	The Swartz Nurseries	KENOSHA	W & E Radtke Inc.	Lily	Lilium Asiatic Hybrid	Asiatic Hybrid X Mix	Positive for potyvirus	Potyvirus	
15194	7/2/2015	Deb's Hosta Hut & Alice's Greenhouse	VERNON	Q&Z Nursery, Rochelle, IL	Hosta	Hosta sp.	Wylde Green Cream	Positive for HVX	Hosta virus X	
15198	7/9/2015	Star Valley Flowers, Inc.	CRAWFORD		Viburnum	Viburnum sp.		Spidermite and leafhopper injury		

VII. Contact Info

Anette Phibbs
Plant Industry Laboratory Director
Wisconsin Department of Agriculture, Trade and Consumer Protection
P.O. Box 8911
Madison, WI 53708
608-224-4600
Anette.phibbs@wi.gov