# Final Report
# Grant No. 14-SCBGP-WI-0055
# Specialty Crops Block Grant Program
# Wisconsin Department of Agriculture, Trade and Consumer Protection

**Report Date: December 8, 2017**

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**Secretary**

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## INTRODUCTION

The Wisconsin Department of Agriculture received $1,411,241.16 from the Specialty Crop Block Grant Program, Grant No. 14-SCBGP-WI-0055. The Department was able to fund 24 projects to promote and improve specialty crop industries in the state of Wisconsin or the Midwest. WI DATCP is using 8% of the funds to cover some administrative costs for the finance department to track and disperse the funding and the Grants Manager to implement the program.

Enclosed are the reports submitted by all 24 grantees.

## Grant Projects:

FY14-001 *GAP/GHP Cost Share*
FY14-002 *Genetic mapping of horticultural important traits in cranberry*
FY14-003 *Enhancing first-to-market potato value with improved vine desiccation strategies*
FY14-004 *Promoting seedless table grapes for Wisconsin growers and consumers*
FY14-005 *Wisconsin Pollinator Plan Development*
FY14-006 *Minimizing Pesticide Residues on Ginseng Root to Remove Export Barriers or Wisconsin Growers.*
FY14-007 *Developing web-based pest and disease forecasting tools for enhanced management of vegetable crops in Wisconsin*
FY14-008 *farm to glass: university outreach to improve the quality of Wisconsin's fermented beverages*
FY14-009 *Developing a clean propagative plant process for Wisconsin hops*
FY14-010 *Cranberry flea beetle biology and management*
FY14-011 *Promoting Wisconsin cranberries in India (Mexico)*
FY14-013 *Chop, chop! Wisconsin-grown produce culinary videos for schools*
FY14-014 *Risk Management tools for Hmong growers*
FY14-015 *Virus Diseases, an Emerging Threat to Wisconsin's Cranberry Industry*
FY14-016 *Assessing spotted wing drosophila phenology and overwintering in Wisconsin*
FY14-017 *Utilization of vermicompost and vermicompost tea to improve ginseng production*
FY14-018 *Growing markets for Wisconsin apple growers with fresh and hard cider*
FY14-019 *Neonicotinoid concentrations in succulent snap bean, sweet corn and peas following at-plant concentrations of neonicotinoid insecticides*
FY14-020 *Clarifying Marketing Labels for Wis. Farmers' Market Vendors*
FY14-021 *Testing a sustainable production model to support WI beekeeping*
FY14-022 *On-farm sustainability for small acreage vegetables – documenting practices and using results to promote sales and improve performance*
FY14-023 *Specialty crop outreach activities*
FY14-024 *Enhancing the stability and mutual profitability of specialty crop sales through written contracts*
FY14-025 *Healthy Hospitals*

# 1) GAP/GHP cost share (FY14-001)

**Report Date:** November 10, 2017

## I. Project Summary

**A.** The purpose of this project was to make third-party food safety audits (GAP/GHP, or "Good Agricultural Practices / "Good Handling Practices") available to Wisconsin growers -- many of whom might not have the resources to pay out-of-pocket for the full cost of the audit. Wholesalers and retailers who purchase produce have increasingly required their vendors to obtain certification.

GAP / GHP requirements and audit procedures are governed by USDA - AMS (Agricultural Marketing Service). AMS trains & certifies the state inspectors who conduct the field audits, and approve each individual audit before a certificate is issued. AMS mandates that the price of the audit is $92.00 per hour plus an overhead fee of $50.00 per audit. Under this grant agreement, growers paid 25% of the hourly fee and 75% of the audit fee was covered by the grant (for a split of $23.00 and $69.00 per hour). However, because funds were running short during the final growing season of the grant (Summer & Fall of 2017); the terms were changed so that the grant only covered 50% of this cost and growers' cost share grew to 50% (for a split of $46 per hour each).

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 and for time spent on continuing education to maintain auditor credentials. The free 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. In addition, auditors are required to complete minimum continuing education course-work on an annual basis to maintain their license.

**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. This project allowed us to continue to promote GAP/GHP and expand the number of participants in the program.

## II. Project Approach

The Fruit & Vegetable Inspection Unit conducted a total of 309 GAP/GHP audits under this grant program. Of these, 119 were "Standard" GAP/GHP audits and 190 were Harmonized GAP. Many of these audits would not have been possible without this grant. Businesses audited included a wide variety of fruit and vegetable growers. Examples include Amish vegetable farms, potato producers, hydroponic growers, and apple orchards. (Only specialty crop farms are covered under this program.)

The Fruit & Vegetable Inspection Unit offered a total of thirteen free workshops, seminars or training classes for growers, and two training sessions to further develop auditor skills and knowledge. These sessions represented a total of 125 hours by the Fruit & Vegetable Inspection Unit's Auditors. The workshops were typically arranged by grower trade organizations or by firms that buy the growers' products. 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.** There is a continuing trend away from "traditional" GAP/GHP and toward Harmonized GAP. Harmonized GAP has some additional flexibilities in order to align with other commonly accepted food safety standards such as GFSI (Global Food Safety Initiative) and FSMA (FDA's Food Safety Modernization Act). Of the audits conducted during calendar year 2015 (both the previous FY-13 grant and the current FY-14 grant), 74% were Standard GAP/GHP audits and 26% were Harmonized GAP. During 2016, the mix was 38% Standard and 62% Harmonized. Of the 2017 Audits included in this grant, the mix was 13% Standard and 87% Harmonized.

**B.** At the beginning of this grant period, we had expected to conduct 90 audits during the 2015 growing season, 94 during the 2016 season, and 98 during 2017. Under this grant, we conducted 55 during 2015, 181 during 2016, and 76 through September 28, 2017. Considering the 82 audits conducted during 2015 that were included in a similar FY-13 SCBG, we conducted a total of 137 audits during the 2015 growing season. These numbers represent a 34% increase in the number of audits between 2015 and 2016. Because this grant period ended prior to the conclusion of the 2017 season, additional comparisons are not currently available. However, we have far exceeded the number of audits we had anticipated conducting over the three year period of this grant.

## IV. Beneficiaries

The direct beneficiaries of this program are the growers who were able to use the cost share to help cover the cost of their GAP/GHP audits. Pursuant to AMS requirements, the Fruit & Vegetable Inspection Unit must charge $92.00 per hour for audit services. However, thanks to this grant, the unit was able to charge a fraction of that (in most cases, 25%), and then charge the remainder to the grant. This obviously results in a large cost reduction for the growers.

The Fruit and Vegetable Inspection unit also conducted a number of free clinics and workshops to help growers understand GAP/GHP requirements. The unit's two Auditors conducted a total of 13 clinics and meetings. Typically, these meetings were organized by buyers. These training sessions, as well as staff continuing education activities are listed in the following table:

| Workshops and Continuing Education | | | | | |
|---|---|---|---|---|---|
| **DATCP Auditor(s)** | **Type of Work** | **Date** | **Description** | **Total Hours** | **Location** |
| Tim Leege and Scott Rusch | Staff training | 3/3/2015 | Harmonized Combined Training part 1 | 20.00 | La Farge |
| Tim Leege and Scott Rusch | Staff training | 3/4/2015 | Harmonized Combined Training part 2 | 18.00 | La Farge |
| Tim Leege | Grower workshop | 4/7/2015 | GAP & GHP training for Eli King | 8.00 | Darlington |

| | | | | | |
|---|---|---|---|---|---|
| Tim Leege and Scott Rusch | Staff training | 7/15/2015 | 2015 USDA GAP & GHP Auditor Refresher | 2.50 | |
| Tim Leege | Grower workshop | 5/17/2016 | Aquaponics Green Bay | 4.00 | Green Bay |
| Scott Rusch | Grower workshop | 6/30/2016 | Harmonized Training for Sunnyside | 5.00 | Wilton |
| Scott Rusch | Grower workshop | 8/19/2016 | Harmonized Training for Sunnyside | 5.00 | Wilton |
| Scott Rusch | Grower workshop | 10/4/2016 | GAP Training for David J. Fleischman Farms | 2.00 | Antigo |
| Scott Rusch | Grower workshop | 10/11/2016 | Harmonized Training for Bushman Associates, Inc | 2.00 | Wittenberg |
| Scott Rusch | Grower workshop | 12/6/2016 | Harmonized Training for Organic Valley | 7.50 | La Farge |
| Tim Leege | Grower workshop | 5/23/2017 | Amish Workshop at LaFarge | 6.00 | La Farge |
| Scott Rusch | Grower workshop | 6/15/2017 | Harmonized Training for Sunnyside | 11.00 | Wilton |
| Tim Leege | Grower workshop | 6/15/2017 | Harmonized Training for Amish in Hillsboro | 8.00 | Hillsboro |
| Tim Leege and Scott Rusch | Grower workshop | 6/20/2017 | Harmonized Training for Amish in Sunnyside Growers Group | 12.00 | Wilton |
| Tim Leege | Grower workshop | 9/28/2017 | GAP / GHP Training for Antigo Growers | 4.00 | Antigo |

## V. Lessons Learned

During this grant period, demand for GAP/GHP Certification services exceeded available funds. In order to ensure there were sufficient funds to last the entire period, we adjusted the amount of matching funds required. In the initial grant proposal and during the first two years of the grant period, 75% of the hourly audit fee was reimbursed by the grant. Growers paid the remaining 25%. However, at the beginning of the 2017 season, we shifted this to a 50/50 mix between grant expenses and grower cost share.

## VI. Additional Information

None

## VII. Contact Info

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# 2) Genetic mapping of horticultural important traits in cranberry (FY14-002)

**Report Date:** November 3, 2017

## I. Project Summary

**A.** The goal of this project was to integrate current breeding programs and emerging molecular technology while generating critical applied and basic knowledge in cranberry. To date, genetic improvement of cranberry through breeding and selection has relied solely on phenotypic selection, requiring extensive field space, a long evaluation interval, and intensive and expensive field management. Thus, developing an integrated approach incorporating molecular tools is essential in increasing breeding efficiency and reducing the generation interval, currently 30-50 years, for selection and the field space needed. In this study, we used crosses made in the only existing cranberry breeding programs in the world, in Wisconsin and Ney Jersey. We used three "elite breeding crosses" consisting of 72, 236 and 434 $F_1$ individuals, respectively derived from 'Stevens' x 'Crimson Queen,' 'Mullica Queen' x 'Crimson Queen,' and BGBLNL95 x 'GH1.' We provided breeders phenotypic data for ~30 traits to aid in the determination of superior clones to be released to growers. We extracted genetic information about superior genotypes for genetic mapping. The beneficiaries of this project were the cranberry breeders receiving information from their analyzed populations to best inform their releases, the Wisconsin and the U.S. cranberry industry at large benefited from the field data and releases, and cranberry scientists benefited from the accumulation of applied and basic knowledge and data for future studies.

**B.** NA

## II. Project Approach

The molecular tools developed and phenotypic data generated through this project in conjunction with traditional plant breeding will speed up the creation of unique cranberry cultivars to meet the current and future challenges of the cranberry industry, including increasing yield in sustainable production systems, improving berry quality (including nutrition), and responding to increasingly variable and extreme climates and insects and diseases pressures. This project improved breeding efficiency by providing genetic and phenotype information useful for current selection efforts and future breeding planning. This research proposal addressed the Priority Areas of Food Safety and Increasing Supply and Demand of Locally Produced Foods.

1) Three populations derived from elite cranberry cultivars were phenotyped for three years at two locations in Wisconsin and New Jersey to determine the best performing cranberry clones and provide trait data for genetic mapping. Data was collected and analyzed on ~30 cranberry traits using 742 individuals from the three elite breeding and mapping populations and the best new clones were determined. In addition, several software packages were developed to speed up the process of phenotyping.

2) Simple sequence repeats (SSR) and single nucleotide polymorphism (SNP) markers were developed for molecular mapping. We developed 697, 54, and 61 SSRs and many thousands of SNP markers for molecular mapping in each of the three mapping populations. In addition, a software package was developed to speed up the process of genetic scoring and genotyping.

3) A cranberry composite, high-resolution SSR and SNP molecular map was developed based on the three mapping populations. We constructed two parental maps for each of the three mapping populations, integrated the parental map for each of them, and constructed a composite map based on all three combined mapping populations. Thus, the parental maps of the three populations were merged to create the first high-density, composite cranberry map containing 6073 markers (5437 SNPs and 636 SSRs) in 12 linkage groups (LGs) spanning 1124 cM. In addition, a software package was developed to facilitate the creation and visualization of genetic data resulting from linkage mapping.

4) Genetic associations were identified and localized for economically important traits. Hundreds of genetic-marker associations were identified and localized and their genetic effects studied for horticulturally important traits in three cranberry molecular maps and the composite, high resolution map. In addition, a software package was developed to facilitate the visualization of marker-trait associations resulting from genetic mapping.

5) Dozens of interactions between of genetic effects and traits were investigated for economically important traits. In addition, a software package was developed to facilitate the visualization of marker-trait and effect interactions.

## III. Goals and Outcomes Achieved

### A. Objective 1.

**Phenotypic Data:** This was the most complete study of cranberry traits ever conducted in the ~200 years of cranberry domestication and breeding history. This project leveraged on 742 individuals from three current "elite" breeding populations to produce large amounts of phenotypic and field data useful for growers, breeders, and other scientists alike. The three invaluable elite biparental populations studied consisted of 72 ('Stevens' x 'Crimson Queen'), 236 ('Mullica Queen' x 'Crimson Queen'), and 434 (BGBLNL95 x 'GH1') clones. We collected three years of data in in Wisconsin (W. Hatch and E. Grygleski) and New Jersey (N. Vorsa). We collected per plot data for total yield (g/900 cm2), total sound yield (rot), berry size and weight, total fruit anthocyanin content (mg/100g FW), soluble solids (Brix), titratable acidity, and proanthocyanidin. Additionally, we collected data on 10 individual uprights per plot to determine upright (vertical stem) length of current season's growth, dry weight of leaves, total number of flowers (pedicels with and without fruit), number of berries, number of aborted flowers (pedicels without fruit), berry weight and status of terminal bud (vegetative or reproductive), the biggest berry for each upright measured for length, width, weight, and calyx diameter, seeds counted and weighed for each fruit, and the fruit categorized based on calyx shape, skin, and seed characters. Additionally, we created two high-throughput phenotyping software packages that greatly increased our ability to efficiently phenotype yield and quality traits. They can process different horticultural traits such as total yield per square area and fruit morphological parameters such as length, width, two-dimensional area, volume, projected skin,

surface area, RGB color, among other parameters. The phenotypic data generated in Objective 1 was used or is currently being used to identify and localize marker-trait associations for horticulturally important traits in cranberry.

List of publications generated for Objective 1. (Students and research associates of **Zalapa** are shown in italics).


1. *Diaz-Garcia* L., G. *Covarrubias-Pazaran*, B. *Schlautman*, J. **Zalapa**. 2016. GiNA, an efficient and high-throughput software for horticultural phenotyping. PLoS One, 11(8): e0160439 (1-12).


**Objective 2 and 3.**

**Molecular Mapping:** This project produced the first high quality genetic map in cranberry. We developed three parental consensus maps, one for each elite cross, and a composite high-resolution cranberry map. These maps are essential for any and all future cranberry breeding or genetic studies to identify and integrate genes into breeding backgrounds and genotypes. The composite cranberry genetic map developed consists of transferrable and universal SSR and SNP loci. First, SSR markers were derived from next-generation sequencing (NGS) data available from the New Jersey and Wisconsin (Polashock et. 2014). SSR mining of NGS reads, contigs, and scaffolds data resulted in the development of SSR markers sets consisting of 697, 54 and 61 polymorphic SSRs (Schlautman et al. 2015a; Schlautman et al. 2017a and 2017b). The SNP markers were derived from genotyping by genotyping by sequencing (GBS) experiments (Covarrubias-Pazaran et al. 2016b). The composite map was anchored with universal SSR markers (Schlautman et al. 2015b). Subsequently, the SSR backbone map was augmented using SNP markers (Covarrubias-Pazaran et al. 2016b; Daverdin et al. 2017), and a composite cranberry map was developed containing 6073 markers (5437 SNPs and 636 SSRs) in 12 linkage groups (LGs) spanning 1124 cM (Schlautman et al. 2017). This high-resolution molecular map is essential prerequisite for the genetic mapping of important traits and future marker assisted selection in cranberry. Additionally, we developed two software packages that greatly increase the efficiency of SSR scoring and genotyping (Covarrubias-Pazaran et al. 2016a), and facilitate the creation and visualization of genetic data resulting from linkage mapping (Diaz-Garcia et al. 2017). We also applied the SSR markers in genetic diversity and fingerprinting studies (Zalapa et al. 2015) and evaluated genotype purity impacts on productivity and trait performance (DeVetter et al. 2015; DeVetter et al. 2017). Finally, we transferred the SSR markers to blueberry and developed a linkage map for synteny analysis, synteny-based trait mapping, and evolution studies in cranberry and blueberry (Schlautman et al. 2017).

List of publications generated for Objective 2 and 3. (Students and research associates of **Zalapa** are shown in italics).


1. Polashock J., E. Zelzion, D. *Fajardo*, J. **Zalapa**, L. Georgi, D. Bhattacharya, and N. Vorsa. 2014. The American cranberry: first insights into the whole genome of a species adapted to bog habitat. BMC Plant Biology 14:165 (1-17).
2. *Schlautman* B., D. *Fajardo*, T. *Bougie*, E. *Wiesman*, J. Polashock, N. Vorsa, S. Steffan, and J. **Zalapa**. 2015a. Development and validation of 697 novel polymorphic genomic and EST-

SSR markers in the American cranberry (*Vaccinium macrocarpon* Ait.). Molecules 20:2001-2013.
3. DeVetter L., J. Colquhoun, J. **Zalapa,** and R. Harbut. 2015. Analysis of genetic, physiological, an environmental yield components within commercial cranberry production systems. Scientia Horticulturae. 190:83-93.
4. **Zalapa** J.E., T.C. *Bougie*, T.A. *Bougie*, B.J. *Schlautman*, E. *Wiesman*, A. *Guzman*, D.A. *Fajardo*, S. Steffan, T. Smith. 2015. Clonal diversity and genetic differentiation revealed by SSR markers in wild *Vaccinium macrocarpon* and *Vaccinium oxycoccos*. Annals of Applied Biology 166:196–207.
5. *Covarrubias-Pazaran* G., L. *Diaz-Garcia*, B. *Schlautman*, W. *Salazar*, J. **Zalapa**. 2016a. Fragman: An R package for fragment analysis. BMC Genetics 17:62 (1-8).
6. *Covarrubias-Pazaran* G., L. *Diaz-Garcia*, B. *Schlautman*, J. Deutsch, W. *Salazar*, M. *Hernandez-Ochoa*, E. Grygleski, S. Steffan, M. Iorizzo, J. Polashock, N. Vorsa, J. **Zalapa**. 2016b. Exploiting genotyping by sequencing to characterize the genomic structure of an understudied species, the American cranberry.
7. *Schlautman* B., G. *Covarrubias-Pazaran*, D. *Fajardo*, S.A. Steffan, and J.E. **Zalapa**. 2017a. Discriminating power of microsatellites in cranberry organelles for taxonomic studies in *Vacinium* and Ericaceae. Genetic Resources and Crop Evolution. 64:451–466.
8. *Diaz-Garcia* L., G. *Covarrubias-Pazaran*, B. *Schlautman*, J. **Zalapa**. 2017. SOFIA: an R package for enhancing genetic visualization with Circos. Journal of Heredity 108 (4): 443-448, DOI: 10.1093/jhered/esx023.
9. *Schlautman* B., J. *Bolivar*, S. *Hodapp*, and J.E. **Zalapa**. 2017b. Cranberry SSR multiplexing and poolplexing panels for commercial fingerprinting, genetic diversity studies, and high throughput linkage mapping. Scientia Horticulturae 219 (2017) 280–286.
10. Wasko DeVetter L., E. Beaver, J. Colquhoun, J. **Zalapa,** and R. Harbut. 2017. Comparison of nonstructural carbohydrates across cranberry cultivars. European Journal of Horticultural Science. 81 (6) 321-326 | DOI: 10.17660/eJHS.2016/81.6.5.
11. *Schlautman* B., G. *Covarrubias-Pazaran*, L. *Diaz-Garcia*, M. Iorizzo, J. Polashock, E. Grygleski, N. Vorsa, J. **Zalapa**. 2017. Construction of a high-density American cranberry (*Vaccinium macrocarpon* Ait.) composite map using genotyping-by-sequencing for multi-pedigree linkage mapping. G3: Genes, Genomes, Genetics. 7(4): 1177–1189; DOI: https://doi.org/10.1534/g3.116.037556.
12. *Schlautman* B., L. *Diaz-Garcia*, G. *Covarrubias-Pazaran*, N. *Schlautman*, N. Vorsa, J. Polashock, E. Ogden, A. Brown, Y-C Lin, N. Bassil, E. Buck, C. Wiedow, S. McCallum, J. Graham, M. Iorizzo, L. Rowland, J. **Zalapa**. 2017. Comparative genetic mapping reveals synteny and collinearity between the American cranberry and diploid blueberry genomes. Molecular Breeding. In press.

**Objective 4 and 5.**

**Marker and Trait Associations:** For each mapping cross, we combined the phenotypic data and molecular map to establish the associations between traits and genetic markers. We identified and localized map positions and effects of markers-trait association in each of the three crosses and in each trait from objective 1. We also investigated the genetic correlations among traits, and the genetic effect interactions each cross. Hundreds of QTLs have been identified and localized within and among genetic backgrounds for total yield, biennial bearing, fruit weight and size, fruit rot, fruit shape, anthocyanin content (mg/100g FW), soluble solids (Brix), titratable acidity,

and proanthocyanidin. The interactions between dozens of genetic effects and traits were investigated. All the information is currently being published and compiled in the composite high-resolution cranberry molecular map. The construction of such composite, high-resolution molecular map with trait-makers associations is the single most important accomplishment in ~200 years of cranberry domestication, breeding, and genetics work.

List of publications generated for Objective 2 and 3. (Students and research associates of **Zalapa** are shown in italics).


1. *Schlautman* B., G. *Covarrubias-Pazaran*, L. *Diaz-Garcia*, J. Johnson-Cicalese, M. Iorrizo, L. *Rodriguez-Bonilla*, T. *Bougie*, T. *Bougie*, E. *Wiesman*, S. Steffan, J. Polashock, N. Vorsa, and J. **Zalapa**. 2015b. Development of a high-density cranberry SSR linkage map for comparative genetic analysis and trait detection. Molecular Breeding. 35:177 (1-18).
2. Daverdin G. J. Johnson-Cicalese, J.E. **Zalapa**, N. Vorsa, J. Polashock. 2017. Mapping and identification of fruit rot resistance QTL in American in American cranberry using GBS. Molecular Breeding. 37:38, DOI 10.1007/s11032-017-0639-3.
3. *Covarrubias-Pazaran* G., B. *Schlautman*, L. *Diaz-Garcia*, E. Grygleski, J. Polashock, J. Johnson-Cicalese, N. Vorsa, M. Iorizzo, J. **Zalapa**. 2017. Validating multivariate genomic selection and genome-wide association methods for cranberry breeding. Submitted to PlosOne.
4. Massive phenotyping of multiple cranberry populations reveals QTLs for fruit anthocyanin content and other important chemical traits. To be submitted to Journal of Agricultural Food Chemistry.
5. Image based phenotyping allows the identification of QTL determining fruit size and elongation in American cranberry. To be submitted to Molecular Breeding. Comprehensive analysis of fruit structure development among in cranberry genotypes. To be submitted to HortScience.


## B. Objective 1)

- *We collected three years of phenotypic data (over 30 traits) on three elite bi-parental crosses consisting of 742 individuals useful for breeding and determined the best 2% genotypes.*

**Benchmarks:** Currently, there are no studies that have collected phenotypic data on bi-parental crosses useful for both breeding and genetic studies.
**Target outcome:** This study will collect and analyze over 20 cranberry traits using 742 individuals from three elite breeding/mapping populations to determine the best 2% genotypes for potential release as new cultivars.
**Performance metrics:** The total number of traits collected and populations characterized and number of identified possible new cultivar releases.

**Objective 2)** Develop SSR and SNP markers for molecular mapping.

- *We developed 697, 54, and 61 SSRs and many thousands of SNP markers for molecular mapping in each of the three mapping populations.*

**Benchmarks:** Currently, there are ~100 SSRs and no SNPs developed in cranberry.
**Target outcome:** Develop 500 SSR and 1000 SNP markers for molecular mapping.
**Performance metrics**: The number of markers developed.

**Objective 3) Develop a cranberry high-resolution SSR and SNP molecular map.**

- *We developed three parental consensus maps, one for each elite cross, and a composite high-resolution cranberry map. The composite cranberry map contains 6073 markers (5437 SNPs and 636 SSRs) in 12 linkage groups (LGs) spanning 1124 cM.*

**Benchmarks:** Until now, a cranberry high-resolution map has not been possible due to the lack of large mapping populations.
**Target outcome:** We will construct three molecular maps based on elite breeding populations. We will also integrate the three maps into a cranberry high-resolution map consisting of 1500 markers.
**Performance metrics:** The number of markers developed and number of markers mapped.

**Objective 4) Identify and localize genetic association for economically important traits.**

- *Hundreds of genetic-marker associations were identified and localized and their genetic effects studied for horticulturally important traits in three cranberry molecular maps and the composite, high resolution map.*

**Benchmarks:** Currently, there is little information about genetic effects on traits and their localization in cranberry.
**Target outcome:** We will identify and localize genetic effects for over 20 horticulturally important traits in three cranberry molecular maps and the consensus cranberry map.
**Performance metrics:** The total number of genetic effects identified for each trait and their localization.

**Objective 5) Identify interactions between genetic effects for economically important traits.**

- *Dozens of interactions between of genetic effects and traits were investigated for economically important traits.*

**Benchmarks:** Currently, there are no studies that have studies genetic interactions in cranberry.
**Target outcome:** We will investigate interactions of genetic effects within and among effects in each map and the consensus cranberry map.
**Performance metrics:** The number of genetic interactions identified and their effect.

## IV. Beneficiaries

We are currently moving forward towards the next generation of breeding at USDA-ARS and UW using phenotypic data and molecular data to study the genetic effects and their genomic locations of horticultural and commercially important traits. This project will allow us to use molecular information in conjunction with traditional plant breeding for applications in molecular assisted selection. We will also provide growers and breeders phenotypic data, Valley Corporation (Ed Grygleski) and Cranberry Creek Cranberries, Rutgers (Nicholi Vorsa). Traits data provided to growers and breeders will be used to determine superior individuals to be tested in next 5-10 years to be released to growers. The accumulated information in cranberry regarding phenotypic and genetic associations will make it possible to build an invaluable statistical and genetic model for selection that will significantly reduce the time and effort to breed superior cranberry cultivars. The beneficiaries of this project are the cranberry breeders receiving information from their analyzed populations to best inform their releases, the Wisconsin and the U.S. cranberry industry at large benefiting from the field data and releases, and cranberry scientists that benefit from the accumulation of applied and basic knowledge and data for future studies. Results and

recommendation resulting from this project were disseminated through participation in dozens of extension and technology transfer and advisory meetings and programs for cranberries growers and scientists.

**Extension talks, discussion groups, and technology transfer**

1. Wisconsin Cranberry Research Roundtable. Madison, WI. Presented by J. Zalapa. November 8, 2017. (30 attendees)
2. Wisconsin State Cranberry Growers Association Summer Meeting. Attended. Warrens, WI. August 9, 2017. (~1000 attendees)
3. Wisconsin State Cranberry Growers Association. Advisory Meeting Cranberry Station. Madison, WI. July 31, 2017. (10 attendees)
4. Wisconsin State Cranberry Growers Association. Advisory Meeting Cranberry Station. Madison, WI. June 6, 2017. (3 attendees)
5. *Vaccinium* Research Group. The WI cranberry genetics and genomics program. Kannapolis, NC. April 23-26, 2017. (30 attendees)
6. Wisconsin State Cranberry Growers Association. Phenotyping Presentation Meeting. Madison, WI. March 15, 2017. (20 attendees)
7. Wisconsin State Cranberry Growers Association. Advisory Meeting Cranberry Station. Madison, WI. March 13, 2017. (3 attendees)
8. Wisconsin Cranberry School sponsored by the University of Wisconsin-Extension and the Wisconsin State Cranberry Growers Association. USDA ARS cranberry genetic improvement program update. Stevens Point, WI. Presented by Zalapa lab member. January 19, 2017. (~500 total attendees)
9. Ocean Spray Cranberries. Yield high throughput analysis. Phone call with Babcock, WI. J. Zalapa. December 21, 2016. (5 attendees)
10. Cran Chile Research Meeting. Genetic material for Chile. Madison, WI. Presented by J. Zalapa. December 2, 2016. (5 attendees)
11. Wisconsin Cranberry Research Roundtable. Cranberry genetics update. Madison, WI. Presented by J. Zalapa. November 11, 2016. (30 attendees)
12. Ocean Spray Cranberries. Color testing webinar with GiNA. Babcock, WI. Presented by J. Zalapa and students. October 3, 2016. (10 attendees)
13. Wisconsin State Cranberry Growers Association Summer Meeting. Attended. Black River Falls, WI. August 10, 2016. (~1000 attendees).
14. Ocean Spray Cranberries. Massive phenotyping training webinar using GiNA. Babcock, WI. Presented by J. Zalapa and students. August 5, 2016. (10 attendees)
15. Wisconsin Cranberry Research Roundtable. Cranberry station update. Phone conference with Tomah, WI. Presented by J. Zalapa. July 14, 2016. (20 Attendees)
16. Wisconsin State Cranberry Growers Association. Cranberry station update. Madison, WI. Presented J. Zalapa. May 25, 2016 (20 Attendees)
17. Ocean Spray Cranberries. Massive phenotyping training webinar using GiNA. Babcock, WI. Presented by J. Zalapa and students. May 10, 2016. (10 attendees)
18. Wisconsin State Cranberry Growers Association Spring Meeting. Cranberry Genetics and Genomics Lab Update. Wisconsin Rapids, WI. Presented by J. Zalapa. April 28, 2016. (100 attendees)
19. Wisconsin Board Funding and Reporting Meeting. Cranberry Genetics and Genomics Lab Update. Madison, WI. Presented by J. Zalapa. March 17, 2016. (20 attendees)

20. Wisconsin Cranberry Board Leadership. Acquaint new leaders with the UW, UWEX and ARS. Tour of the Cranberry Genetics and Genomics Lab. Madison, WI. Presented by J. Zalapa. February 16, 2016. (25 attendees)
21. ABCD Group Seminar (USDA-ARS, Vegetable Crops Research Unit). High throughput phenotyping in cranberry. University of Wisconsin, Madison. February 10, 2016. (20 attendees)
22. Wisconsin Cranberry School sponsored by the University of Wisconsin-Extension and the Wisconsin State Cranberry Growers Association. Establishing a marker assisted selection (MAS) program for cranberry genetic improvement. Stevens Point, WI. Presented by Zalapa lab member. January 21, 2016. (~500 total attendees)
23. Wisconsin State Cranberry Growers Association Meeting. Cranberry research round table and research priorities meeting. USDA-ARS Cranberry Genetics and Genomics Update. Madison, WI. Presented by J. Zalapa. November 6, 2015. (30 attendees)
24. North American Cranberry Researcher and Extension Workers (NACREW) Conference. Advances in cranberry high-throughput genotyping and phenotyping for breeding purposes. Bandon, Oregon. Presented by Zalapa lab member. August 24-26, 2015. (50 attendees)
25. Cranberry Institute (CI) Lab Tour. Cranberry genomic and breeding advances. Presented by J. Zalapa and lab members. March 25, 2015. (30 attendees)
26. Cranberry Board Proposal Presentation Meeting. Cranberry Trait Mapping. Wisconsin Rapids, WI. Presented by J. Zalapa. February 2, 2015. (20 attendees)
27. Wisconsin Cranberry School sponsored by the University of Wisconsin-Extension and the Wisconsin State Cranberry Growers Association. Establishing a marker assisted selection (MAS) program for cranberry genetic improvement. Stevens Point, WI. Presented by Zalapa lab member. January 22, 2015. (~500 total attendees)
28. Wisconsin State Cranberry Growers Association. Cranberry research round table and research priorities meeting. USDA-ARS Cranberry Genetic. Madison, WI. Presented by J. Zalapa. November 11, 2014. (30 attendees)

## V. Lessons Learned

Through this project, robust SSR and SNP molecular markers systems were developed. Also, well characterized linkage maps were constructed encompassing different genetic backgrounds, which are available for current and future work. Hundreds of QTLs have been identified and localized within and among genetic backgrounds for total yield, biennial bearing, fruit weight and size, fruit rot, fruit shape, anthocyanin content (mg/100g FW), soluble solids (Brix), titratable acidity, and proanthocyanidin. Such QTL will serve to search for candidate genes to enhance future breeding efforts by pyramiding important traits into elite horticultural backgrounds. The data from these traits will be the bases for determining which of the 742 potential cultivars among the three crosses studied will be advanced for larger area testing and future release as new cultivars in the next 5-10 years. Finally, the phenotypic and genetic data, genetic map, and the genetic signatures associated with desirable and undesirable characteristics in cranberry have very useful immediate research applications to build a valuable statistical model for selection that will significantly reduce the time and effort to breed superior cranberry cultivars in the future.

## VI. Additional Information

None

## VII. Contact Info

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# 3) Enhancing first-to-market potato value with improved vine desiccation strategies (FY14-003)

**Report Date:** December 21, 2016

## I. Project Summary

**A.** Fresh market potato prices are often quite volatile among production seasons and even within a season, but the key to economic profitability is to be first to market. The economic advantage of timing the fresh market appropriately is stark and essential to the long-term solvency of Wisconsin fresh market potato production. The potato plants or "vines" must be desiccated prior to tuber harvest to promote tuber skin set, separate the plant stolon from the marketed tuber, reduce the risk of potato disease spread (such as late blight) and need for additional fungicide, and allow efficient machine harvest. The current industry practice is to apply diquat herbicide twice starting about three weeks prior to anticipated harvest. In many cases, additional herbicides labeled as desiccants are also applied in conjunction with diquat herbicide in a stop-gap approach. In contrast, in Pacific Northwest US potato production potato vines are desiccated with mechanical mowing or flailing. Mechanical vine desiccation presents the advantage of immediate plant death and hastens tuber skin, but this practice has not been widely adopted to date in Wisconsin. Challenges to mechanical desiccation have included our typically humid mid-summer weather that allows cut vine material to remain "green" enough to continue to harbor late blight spores. Pacific Northwest production is in a very arid environment, where humidity remains low and almost all moisture is controlled via irrigation as summer precipitation is minimal.

Potato vine desiccation with herbicides is challenging: contact herbicides that don't move within the plant need adequate coverage, which is difficult with healthy canopies that often exceed 3 feet in plant height, and systemic herbicides are rarely considered as they often end up in the tuber as the resource sink at that time of year, resulting in potential illegal pesticide residue and reduced storability. This conundrum, combined with a lack of new herbicide active ingredients in the age of herbicide-resistant crops, has stymied the ability to register new herbicides as vine desiccants.

Ironically, Wisconsin potato growers have become quite adept at growing very healthy and vigorous potato plants with improved irrigation, fertility and disease management, but these stress-free plants have proven in recent years to be much more difficult to desiccate to a level that promotes skin set and allows for harvest of quality, stolon-free tubers. This situation poses a potato perfect storm of sorts: growers have figured out ways to consistently grow healthy plants that support a tuber yield that is economically viable, Wisconsin growers can realize a significant early harvest price advantage based largely on shorter transportation distance to market relative to western growers, but the current vine desiccation methods aren't allowing harvest in a timely manner. Thus, this research focused on integrating existing herbicides with non-chemical strategies to achieve adequate desiccation while reducing overall herbicide use.

**B.** Project was new and did not build on previous SCBG funds

## II. Project Approach

Field research was conducted as planned in the 2015 and 2016 growing seasons in Hancock, Wisconsin. The studies were conducted with two potato varieties: 'dark red norland', a red-skinned early-market variety; and 'Yukon gold', a highly-desired yellow-fleshed variety. 'Yukon gold' desiccation is particularly challenging given that the potato vines are nearly always at top vigor when the potato tubers are at the most marketable size. The integrated vine desiccation treatments were implemented in July of each year, and potato tubers were harvested in early August. Potato vine and stem desiccation rates, potato tuber skinning and stolon separation and marketable yield were determined at harvest and after three weeks of storage. Data were analyzed separately by year. The graduate research assistant involved in the project has drafted a journal publication summarizing the results and successfully defended his thesis in December 2016. Additionally, this work was shared with growers in a number of venues in both 2015 and 2016, ranging from summer field tours and field days (attendance ranging from about 50 to 250) to several presentations at grower winter outreach meetings (attendance ranging from about 75 to 500). Results have also been summarized in grower newsletters and trade publications.

In both growing seasons and across both potato varieties, integrated vine desiccation treatments were identified that maintained potato tuber skin set and marketable yield when compared to the industry standard two applications of diquat herbicide. The timing of treatment initiation was important in achieving successful desiccation and skin set, where those that began 21 days prior to harvest were more successful than treatments initiated 14 days prior to harvest, without compromising tuber bulking and harvested yield. Vine desiccation treatments that were initiated by mowing or flail-chopping the upper potato plant growth were particularly successful. Based on these observations, this practice has already been adopted by some fresh market potato growers when vigorous vines are challenging to desiccate.

## III. Goals and Outcomes Achieved

**A.** The activities were completed as proposed and described above. The measurable outcomes were clear: potato vine desiccation rate, tuber skin set, tuber stolon separation and marketable yield.

**B.** Across growing seasons and varieties, potato vine desiccation rate, tuber skin set, tuber stolon separation and marketable yield were maintained in integrated vine desiccation treatments while reducing the reliance on diquat applications. In both growing seasons, potato vine vigor was less in our research and commercial production fields than in recent years, and therefore desiccation conditions could have been more challenging, but regardless, the integration of alternatives to diquat was very successful.

These results are important for several reasons:

1) Commercial producers now have evidence-based information available to make vine desiccation decisions in years where potato vine vigor challenges the ability to harvest the crop when growing and economic conditions are favorable. In fact, fresh market producers have already begun to integrate flail mowing as an alternative desiccation method.

2) Organic producers also now have information that allows them to desiccate potato vines with the same success as their conventional neighbors. In our research, we found that flail chopping and flame desiccation were as effective as two applications of diquat herbicide in managing vines, hastening skin set and producing marketable yield.
3) Perhaps most importantly, about midway through this project the Environmental Protection Agency initiated the diquat federal reregistration process. In their initial review, they suggested that reductions in diquat rates, number of applications and use timings may be needed to protect avian reproduction. While the final outcome of this reregistration is still unknown, our research would greatly assist growers in reducing the diquat rate and/or application number without compromising the ability to produce fresh market potatoes.

## IV. Beneficiaries

The beneficiaries of this project include Wisconsin potato growers and packers. Wisconsin ranks third nationally in potato production, with about half of the harvest going to the fresh market. Potatoes are produced on over 60,000 acres annually in Wisconsin. In 2008, about 140 Wisconsin potato growers directly contributed $240 million in annual economic activity and more than 1,600 jobs statewide (Keene and Mitchell, UW Extension, 2010).

## V. Lessons Learned

Like any field research, we can't anticipate what each growing season will hold for production conditions. It happened that because of the growing conditions in 2015 and 2016, potato vines were a bit easier to desiccate than in the most challenging years, but, with that said, the work was still very successful in identifying viable alternatives for growers. Otherwise, the research and outreach plan worked very well.

## VI. Additional Information

N/A

## VII. Contact Info

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# 4) Promoting seedless table grapes for Wisconsin growers and consumers (FY14-004)

**Report Date:** October 31, 2017

## I. Project Summary

**A.** The main purpose of this project was to screen several seedless table grape cultivars for cold hardiness, winter survival, and determine the range in harvest windows for growers. We also wanted to widen the public's awareness of the diverse flavors and qualities among the cultivars of locally grown grapes. This project covered 2015-2016-2017 growing seasons.

Nationally, grapes (wine and table) are the number one non-citrus fruit crop in both value and production terms (NASS 2017). The introductions of several cold-hardy cultivars over the twentieth century and particularly into the early 2000s has helped to propel the expansion of the grape industry to upper Midwestern states, such as Michigan, Minnesota, Illinois, Indiana, Iowa, Ohio, and Wisconsin (Dami et al., 2005; Luby and Mansfield, 2005). Since 2000, the grape industry in 14 non-traditional grape growing states has grown from a few hundred vineyard acres to nearly 5,900 vineyard acres (Tuck and Gartner 2013). Grapes are still a fairly minor fruit crop in Wisconsin, but it is one of the fastest growing agricultural sectors in the state. Wisconsin grape acreage has increased two to three-fold since 2002, with over 100 growers commercially growing grapes as of 2013 and another 300 growers managing small vineyards (USDA-NASS, 2009 and 2014). Although the production of table grapes has not been as significant as wine grape production, interest in growing seedless table grapes in Wisconsin is increasing. School and community gardens with perennial fruit crops are increasingly common and seedless table grapes are a popular fruit choice for kids. Seedless grapes tend to be less hardy than seeded grapes but are more desirable by most people. Since seedless table grapes have an outstanding potential to be developed as a fresh market specialty crop, both for fresh grapes and (to extend shelf life) raisins, we wanted to gather more data to validate risks and develop best management practices for local growers. We investigated cold hardiness of 16 cultivars that were established at three UW agricultural research stations between 2007 and 2012. Major limiting factors we documented were the ability of many cultivars to survive the freezing temperatures of northern regions, late spring frosts, and disease pressure. Additionally, we determined that balanced crop loads increase grapevine persistence. This project has increased awareness to growers and consumers of local seedless table grapes, and currently several cultivars of grapes are being grown across the state for CSA, fresh market, and local food sectors. Raisin making was ultimately too energy intensive for growers to bear but when spread out across consumers it was the best way to preserve the fruit. *Fresh* magazine published a survey showing over 60% of consumers would pay a premium for locally grown produce (Witzling et al, 2017). Having the momentum of local food and sustainable agriculture with us, we increased the awareness through educational outreach and promotion, via field days, vineyard walks, tasting events, and surveys. As enthusiastically noted by survey respondents, the variety of flavors and unique characteristics of these cultivars support the potential for this expanding market.

**B.** Funds were procured from the SCBGP in September 2007 (Award #MSN 102705) 'Table Grape Trials for Fresh Market Production') to establish vineyards at three locations in Wisconsin: 15 seedless table grape cultivars were established at West Madison Ag Research Station (WMARS) in USDA Plant Hardiness Zone 5a and a subset of these (in addition to several seeded cultivars) were established at Peninsular ARS (PARS), Zone 5b and Spooner ARS (SARS), Zone 3b. Three cultivars at WMARS were removed in 2010 ('Saturn', 'Concord Seedless', and Glenora') because they produced seeds or did not survive the winter. In 2011, four more cultivars were added ('Montreal Blue', 'Suffolk Red', 'Jupiter', and 'Thomcord') for a net of 16 seedless cultivars at WMARS. The vines included six blue cultivars: 'Trollhaugen', 'Montreal Blue', 'Mars', 'Venus', 'Thomcord', and 'Jupiter'; six red cultivars: 'Somerset Seedless', 'Reliance', 'Einset', 'Vanessa', 'Candadice', and 'Suffolk Red'; and four green cultivars: 'Himrod', 'Marquis', 'Lakemont', and 'Interlaken'. Having these vines already established for 3 or more years surely enhanced the current project because all vines were in fruit-bearing stages for immediate collection of yield and quality data. Furthermore, we were able to screen many varieties since 2007 to feel more confident in our recommendations moving forward.

## II. Project Approach

For this project, our focus was on seedless table grapes as "no one wants to eat seeds", as emphasized by a current MN grape breeder, and since all remaining cultivars at SARS and several at PARS were seeded, most of the data in this report is from WMARS with supplemental information from the three seedless cultivars at PARS. The 16 cultivars planted 2007-2011 were productive for several years until the severe cold back-to-back winters of 2013-14 and 2014-15. These extremely cold winters reduced the surviving 'super-cold hardy' group of seedless cultivars to only seven at WMARS, three at PARS, and none at SARS. We established that only three seedless cultivars survived at PARS ('Einset', 'Reliance', 'Mars'), plus four additional cultivars at WMARS ('Somerset Seedless', 'Trollhaugen' 'Montreal Blue', and 'Himrod', as well as 'Einset', 'Reliance', 'Mars'), with 'Himrod' and 'Reliance' being only marginally hardy.

**Observations.** All cultivars were evaluated for cold persistence, cold hardiness and winter injury, wood and fruit production, fruit chemistry, berry and cluster attributes, and relative disease pressure susceptibility after regular fungicide applications. Grapes and raisins were also evaluated via consumer surveys.

***Cold persistence.*** We tracked the winter temperatures from 2009 to 2017 at WMARS and tallied the number of days below certain temperature ranges (Table 1). All 7 cultivars survived these very cold winters, surviving temperatures that reached -16°F and -21°F below zero in 2009 and 2014, respectively, but sustained significant bud damage. As shown in Table 1, the winter (January) of 2014 exhibited the coldest temperatures in the nine-year span we tracked, with three consecutive days of temperatures dipping below -17°F. As seen in the subsequent growing season, although there was significant bud damage, there was sufficient root survival for recovery.

**Table 1. Number of days in selected temperature (Fahrenheit) range with average lows for 2009-2017 (Dec 1-Feb 28) at WMARS. Year label denotes Jan/Feb**

| Temperature range (F) | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 |
|---|---|---|---|---|---|---|---|---|---|
| | ----------# of days in temperature range---------- | | | | | | | | |
| 0 to -9 | 16 | 10 | 9 | 5 | 8 | **32** | 23 | 10 | 8 |
| -10 to-19 | 5 | 0 | 4 | 0 | 0 | **6** | 3 | 0 | 0 |
| -20 to-29 | 0 | 0 | 0 | 0 | 0 | **2** | 0 | 0 | 0 |
| below -30 | 0 | 0 | 0 | 0 | 0 | **0** | 0 | 0 | 0 |
| Low Temp | -16 | -8 | -11 | -4 | -9 | **-21** | -12 | -9 | -8 |

***Cold hardiness and winter injury***. Grapevines are a very complex plant with compound buds made up of primary, secondary, and tertiary buds. It is the primary buds, and to a lesser extent, the secondary buds, that determine the fruiting ability, while the tertiary buds typically only produce vegetative growth. These cane buds are at risk of cold injury every winter. Vine balance is key to proper overwintering success because too much fruit can lead to reduced reserves needed for the vine's preparedness for winter survival. Winter bud injury was assessed in March or April each year to predict potential crop load and canopy management.

Significant winter damage occurred to the cane buds during the extremely cold January/February 2014 before this project began. Hence no bud injury data was collected for 2014; the resulting fruit loss that year was severe (no data available). During this project's timeframe, winter injury was most severe after the harsh January of 2015 compared to 2016 or 2017, with up to 60% winterkill of the fruit buds at the two sites (Figures 1a and1b). There was 10-30% primary bud death after the 2016 and 2017 winters (Fig. 1c-d-e), which is considered incidental damage in the industry. 'Reliance' and 'Himrod' had the highest bud mortality in 2015 with more than 50% of primary, secondary and tertiary buds killed at WMARS. Likewise, significant damage occurred at PARS that season to all three cultivars (Fig 1b) there perhaps more due to a combination of a shorter growing season and a severely cold winter. Over the past six years, 'Himrod' was most sensitive to winter injury and is considered a marginally-hardy variety for Wisconsin. We observed 'Reliance' as also being marginally hardy, as over 50% of buds were killed at both sites in 2015 (Figure 1a-b), and this may be related to its high vigor, making it easy to over crop it.

Though (January and February) 2016 was a mild winter relative to the previous two winters, a late spring frost on May 15 did some damage to newly transplanted vines, killing primary shoots that were emerged at WMARS. However, most vines survived and pushed secondary shoots out within a few weeks. They survived the 2017 winter and are still growing. No damage was noted

at PARS because the buds were still dormant at the time of the sub-freezing temperatures. Many growers also reported their vines making it through the winter only to have new shoots killed by spring frosts.

Figure 1a-1e: P=Primary Bud; S=Secondary Bud; T=Tertiary Bud

**Figure 1a. April 2015 bud injury assessment at WMARS**

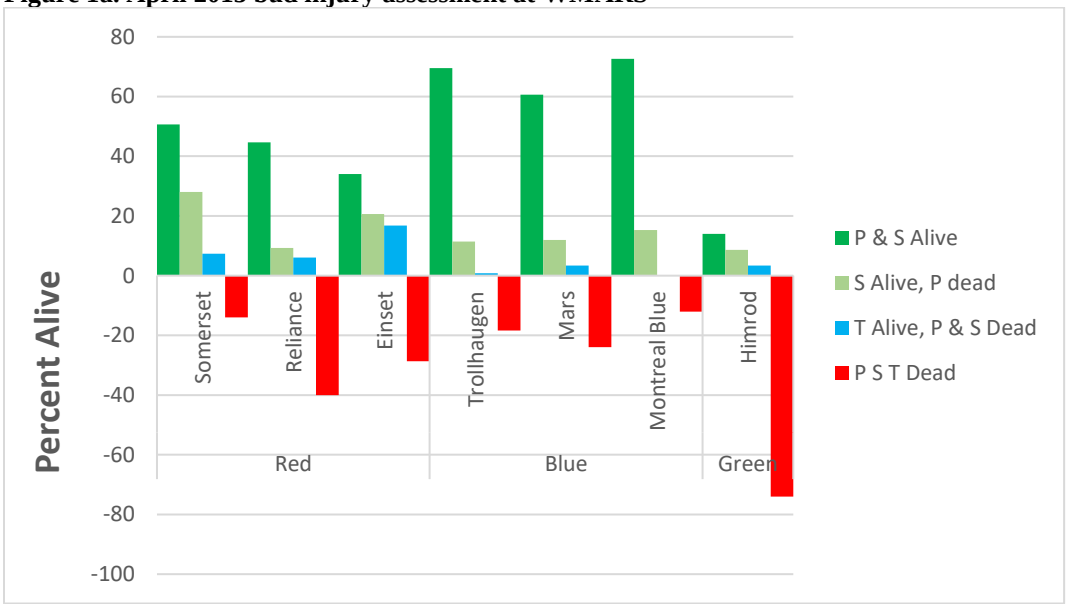



Figure 1b. April 2015 bud injury assessment at PARS

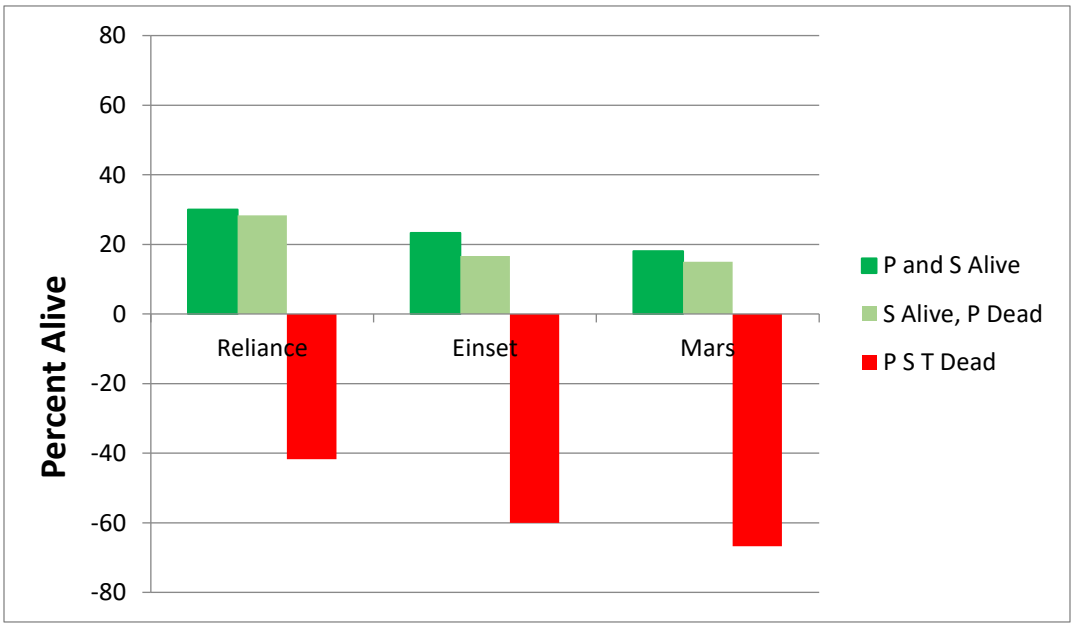
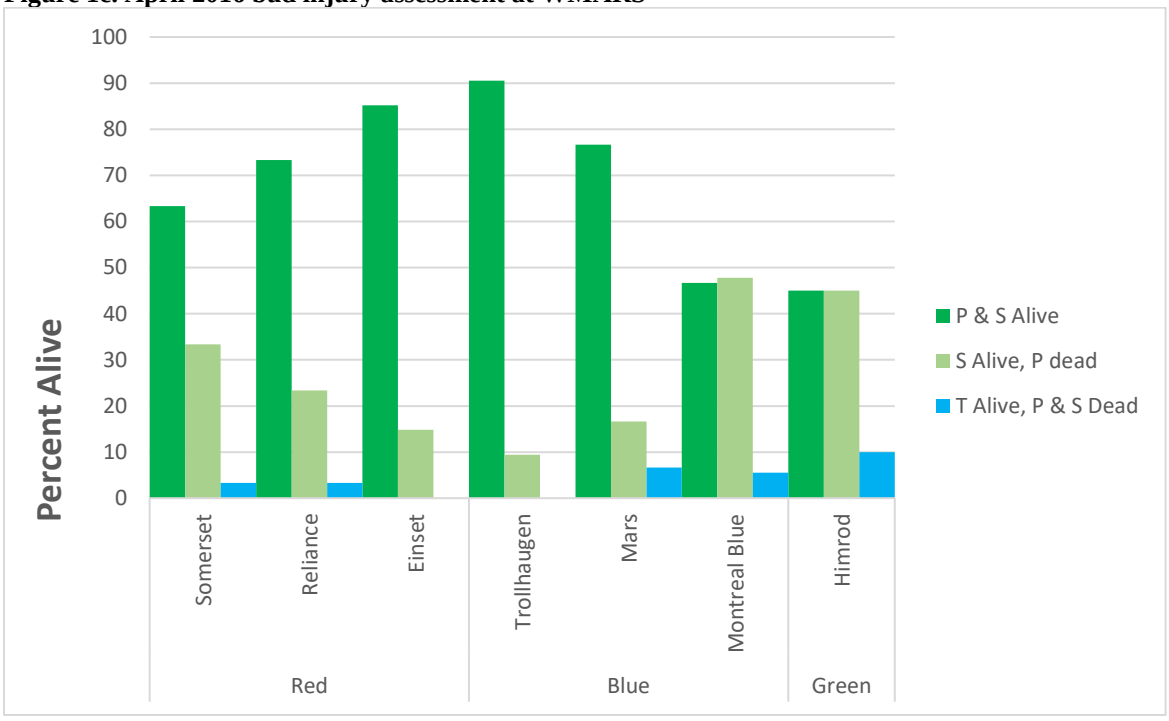


**Figure 1c. April 2016 bud injury assessment at WMARS**




*No data for 2016 bud injury at PARS*

**Figure 1d. March 2017 bud injury assessment at WMARS.**

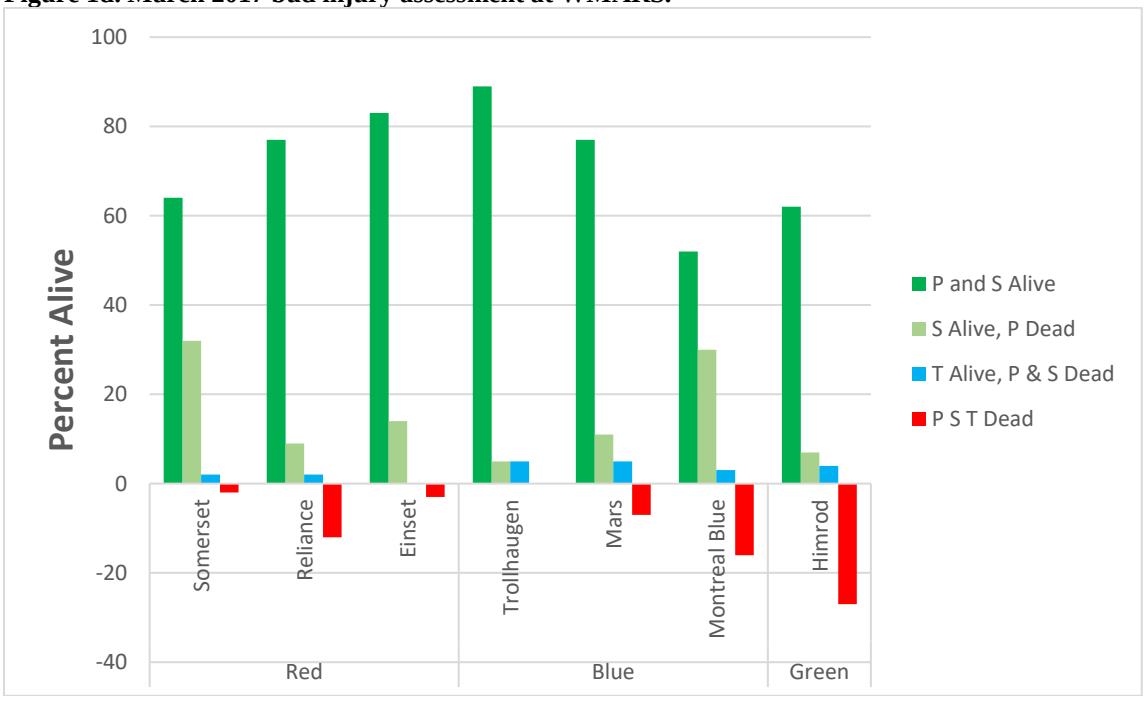
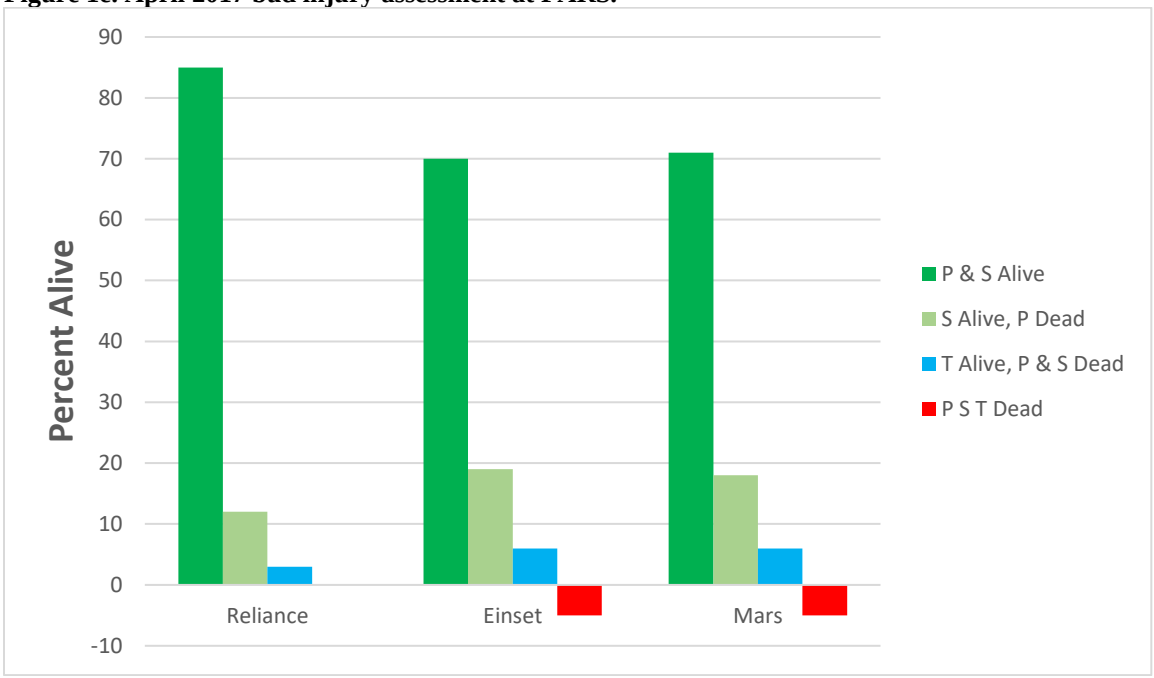
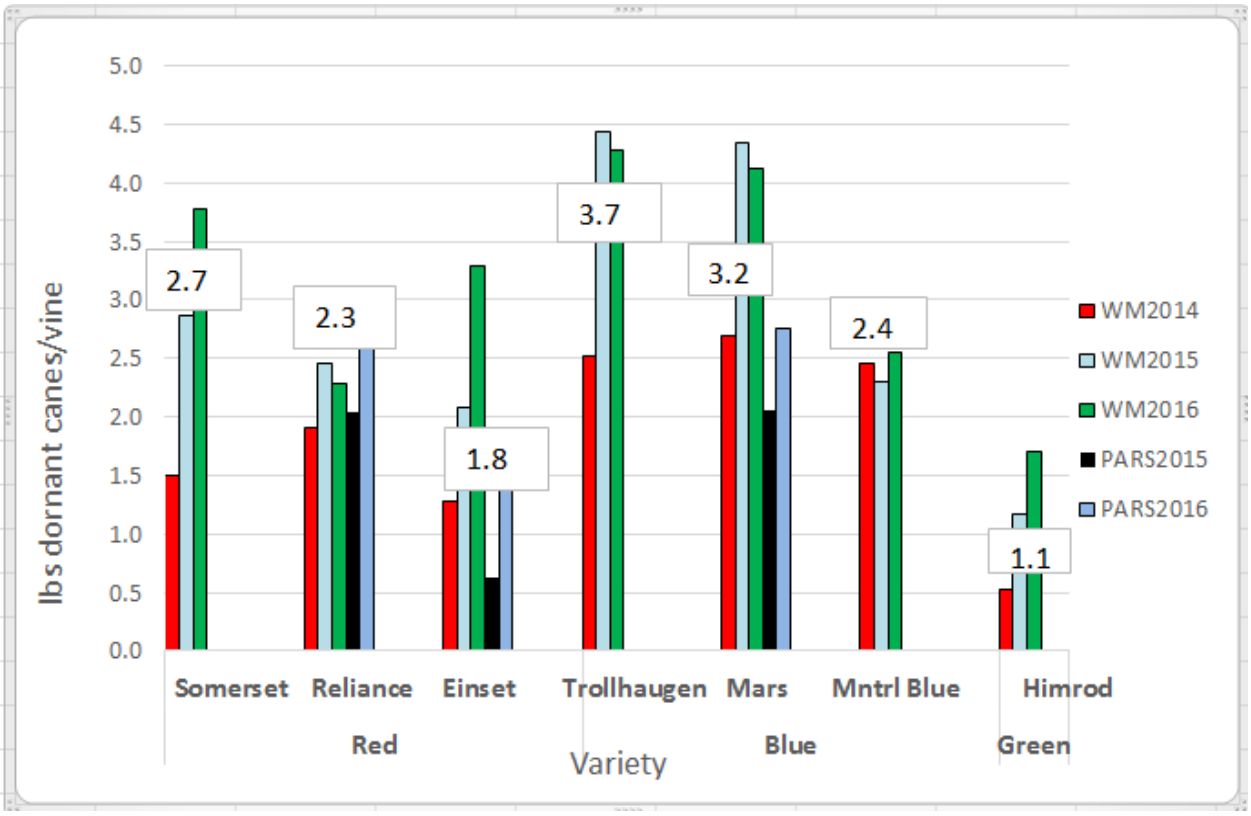


**Figure 1e. April 2017 bud injury assessment at PARS.**




***Cane production*.** To assess vine vigor, pruning weights of one-year old canes were collected each March and used to determine the shoot density and thus cropping load for the new season. Figure 2 shows the impact of both the previous season's fruit load and winter injury on cane biomass. Since 2014's extremely cold weather, the cultivars have shown a continued recovery each year. Based on a 3-yr average of cane biomass, the cultivars fell into three categories of vigor: High (>3 lbs/vine) = 'Trollhaugen' and Mars; Medium (2-3 lbs/vine) = 'Somerset Seedless', 'Montreal Blue', 'Reliance'; Low (<2 lbs/vine) = 'Einset' and 'Himrod'. To date, from our data, the blue grape cultivars seem to have more vigor than the red or green cultivars. According to the Midwest Grape Production Guide (2005) if the same season's fruit yield:cane biomass ratio (i.e. the Ravez Index) was above 10, it was likely over-cropped, while undercropping (a Ravaz index number under 5) may lead to unproductive, large woody canes, which do not overwinter well. If the Ravez index indicated overcropping, then the shoot density was reduced for the coming season.

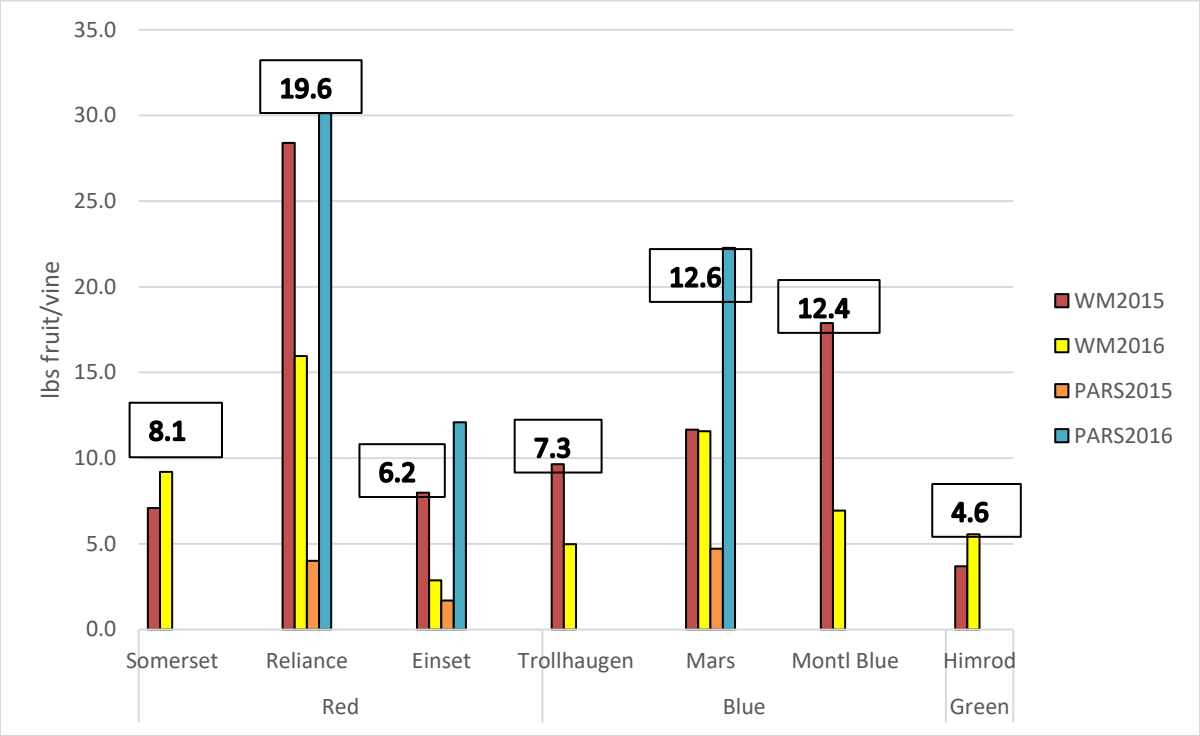
**Figure 2. 2014-2016 dormant cane biomass. Number in boxes show overall average (3-8 vines per variety x 3 to 5 site-yrs).**




***Fruit production.*** In May each year at WMARS, depending on each vine's cane biomass, we thinned the shoots between 4 and 7 shoots/ft of cordon, which calculates approximately to 40 to 80 clusters per vine. Ultimately, we were closer to 40 clusters per vine for most cultivars. 'Reliance' had the highest number of clusters in any given year. From our trial, harvest began in mid-to-late August for 'Somerset Seedless'; late August to early September for 'Trollhaugen' and 'Reliance'; early September for 'Einset' 'Himrod', and 'Montreal Blue'; and lastly, mid-to-late September for 'Mars' which needed the full season to accumulate sugars. We noted about a three to four-week harvest window between the first cultivar harvested to the last. This is convenient for growers to have fresh fruit available on a staggered schedule to expand the marketing while spreading out labor and supplies. Ultimately, weather, pests, disease, sour rot, and development of off flavors in berries will dictate the harvest window.

In the past 4 site-years (PARS 2015-2016, WMARS 2015-2016), 'Mars' and 'Reliance' yielded the highest while 'Himrod' and 'Einset' the lowest (Fig. 3). In 2017, we renovated the cordons at WMARS so yields were low (data not shown). No data was collected at PARS in 2017.

**Figure 3. 2015-2016 fruit yield at WMARS and PARS. Number in boxes show 3-year average over 2 sites (3-8 vines per variety).**




***Fruit chemistry.*** Sugar and acid levels were tracked biweekly, from veraison until harvest; acids tended to decline quickly, although acidity in 'Montreal Blue' declined at a much slower rate. Harvest was planned when Brix (soluble sugars) reached 18° and titratable acidity neared 10 g/L. Some years there were sour rot issues or pest pressure which forced us to harvest earlier than desired. Harvest chemistry data from the past three years is shown in table below (Table 2). Over the three years, 'Mars' was the least sweet (lowest Brix) and the latest to ripen. 'Montreal Blue' had the highest acids while 'Himrod' and 'Einset' had quite low acids. In 2016, we left 'Mars' on vine to further ripen, but noticed strong off flavors developed, perhaps methyl anthranilate, which naturally occurs in Concord grapes and its relatives.

**Table 2. 2015-2017 WMARS fruit chemistry at harvest.**

| Cultivar | Harvest/ Sample Date | Avg Brix | Avg pH | Avg TA g/L |
|---|---|---|---|---|
| Einset | 9/8/2015 | 18 | 3.1 | 4.9 |
| | 9/5/2016 | 18.5 | 3.3 | 5.6 |
| | 9/9/2017 | 18.2 | 3.2 | 7.4 |
| | | | | |
| Himrod | 9/8/2015 | 18.6 | 3.3 | 5.1 |
| | 9/6/2016 | 17.6 | 3.3 | 5.5 |
| | 8/24/2017 | 15.9 | 3.1 | 9.3 |
| | | | | |
| Mars | 9/8/2015 | 14.8 | 3.1 | 8.3 |
| | 9/20/2016 | 17.4 | 3.2 | 6.2 |
| | 9/14/2017 | 16.9 | 3.2 | 9.0 |
| | | | | |
| Montreal Blue | 9/8/2015 | 17.3 | 3.0 | 12.7 |
| | 9/1/2016 | 17.8 | 3.1 | 15.0 |
| | 8/30/2017 | 18.6 | 3.0 | 15.3 |
| | | | | |
| Reliance | 9/8/2015 | 16.1 | 3.0 | 6.3 |
| | 8/29/2016 | 18.1 | 3.2 | 6.7 |
| | 8/30/2017 | 17.5 | 3.1 | 9.9 |
| | | | | |
| Somerset Seedless | 8/28/2015 | 20.4 | 3.4 | 10.0 |
| | 8/19/2016 | 18.6 | 3.0 | 10.9 |
| | 8/28/2017 | 19.7 | 3.4 | 10.7 |
| | | | | |
| Trollhaugen | 8/31/2015 | 17.1 | 3.3 | 8.9 |
| | 8/29/2016 | 18.0 | 3.2 | 7.5 |
| | 9/9/2017 | 17.9 | 3.3 | 10.5 |

***Berry and cluster characteristics.*** Berry diameters and weights were collected, along with cluster counts, weights and lengths over the 3 years. Berry sizes ranged from 0.45-0.73 inches in diameter. The average green grape in grocery stores was observed to be oblong, versus a more rounded berry of the cultivars we grew, and was about 1 inch long, 2-3 times bigger than some of these local cultivars. 'Mars' had very large berries while 'Somerset' and 'Trollhaugen' had tiny berries, about the size of a pea. Although individual years showed diameter changes, the relative sizes remained consistent. For the two years we had diameter data, we classified 'Somerset' and 'Trollhaugen' as small berries; 'Himrod', 'Einset', 'Reliance', and 'Montreal Blue' were

considered medium; and ‘Mars’ was classified as large. Berry weights, measured in groups of 10 berries, exhibited the same groupings as the diameter classes, except for ‘Himrod’, which varied between light-weight and medium-weight depending on the year. Cluster lengths and weights, along with photographs, revealed that ‘Himrod’ and ‘Einset’ had loose open clusters, while ‘Somerset’ and ‘Trollhaugen’ had relatively tight clusters. The cluster lengths averaged 6.3 inches across 2016 and 2017 at WMARS, ranging from 5.4 to 9.4 inches, with ‘Somerset’ and ‘Himrod’ having the shortest and longest, respectively. The cluster weights averaged 4.0 ounces, ranging from 1.9 and 7.8 ounces, with ‘Trollhaugen’ and ‘Reliance’ weighing the least and most, respectively. The range in both cluster weights and berry size adds appeal for consumers demanding different characteristics.

***Disease*.** Using weather data such as temperature, leaf wetness, and humidity, a fungicide spray schedule was followed according to software-predicted disease infections. Cultivars at WMARS were tracked to determine if any of them were still susceptible despite the pesticide applications. Cultivars were scored weekly for disease on canes and leaves on a 1 to 4 scale with 1 being no disease, 2= ‘minor’ (25% incidence), 3=’moderate’ or 26-50% incidence, and 4= ‘severe’ at >50% incidence. Mars had the least disease issues over the course of the season. ‘Einset’, ‘Reliance’ and ‘Trollhaugen’ had moderate *Phomopsis* on leaves and canes throughout the season. ‘Reliance’ did have evidence of anthracnose spores diagnosed by the UW Plant Disease Diagnostic Clinic. Montreal Blue has declined over time with one vine being removed due to some disease (undiagnosed by the disease diagnostic lab) and a second vine being affected in 2017 (also undiagnosed by diagnostic lab). Downy mildew and black rot were common on the foliage but only at minor levels for most cultivars except ‘Einset’ which seemed to be highly susceptible to both downy mildew and black rot. To reduce potential disease pressure, we applied a dormant lime-sulfur spray to the canes in April of 2016 and 2017.

***Insects*.** Phylloxera was not a problem with the table grape cultivars however Japanese beetles were tenacious in both 2016 and 2017 summers getting an early start in late June and lasting into August defoliating the youngest leaves. ‘Himrod’ seemed to be a preferred variety among the Japanese beetles. Insecticides were sprayed weekly through July to reduce pressure.

***Raisins*.** In a food safe kitchen, grapes were blanched in 0.3% lye solution at 203°F for 5 seconds, to perforate skin and sanitize the grapes. The grapes were immediately plunged into an ice bath and then into a second water bath. Subsequently, berries were destemmed and placed in a table dehydrator and dried at 135°F from 24 to 48 hours based on berry size. Water activity, a measurement to determine safe storage, was collected and ranged from 0.351 to 0.564, with ‘Somerset’ and ‘Mars’ being the low and high endpoints, respectively. A water activity value below 0.60 is considered safe for storing raisins, as yeast, molds, and bacteria are active in foods above 0.60 (Murano, 2003).

## III. Goals and Outcomes Achieved

### A. Outreach

During the course of this grant, outreach to growers and consumers was a major effort and included 26 garden tours/vineyard walks, five station field days, and both a radio and TV interview/promotion of grapes. We also promoted Wisconsin seedless table grapes at several off-

station events including Farm Progress Days, Wisconsin Fresh Fruit and Vegetable Growers Conference, the Organic Farming Conference, and WPT's 'Garden Expo'. Nine different tasting events were held to capture consumer input on fresh grapes and raisin flavor/texture. Over the course of this 3-yr grant, we reached over 2,600 people directly and countless tens of thousands indirectly via our website, radio and TV publicity, and self-guided tours of the gardens/vineyards at West Madison Ag Research Station (Table 3). One goal we did not achieve was promoting the grapes at the farmers' markets because of the complicated planning and coordination involved to set up a booth. A second goal we missed was promotion of seedless table grapes in school programs due to the lack of labor during the school semesters.

**Surveys**
Grape tastings and surveys were offered on many occasions each harvest season, for both fresh grapes and raisins. We found many different preferences among tasters, which emphasized to us the importance of offering as diverse a selection as possible. Each year, over 200 surveys were filled out by consumers. Over the 3-yr project, 430 surveys were filled out on fresh grapes and 240 on raisins. Survey comments showed enthusiasm and support for the raisins: One person that initially said they didn't like raisins later commented in the survey that they "might have to change their mind on the matter"; another would eat more raisins if they were like these; one person found them superior to the "run of the mill" raisin; "tasted like dried cherries, which are delicious and expensive!", exclaimed another. While the opinions were mixed, over 70% of those surveyed said they like the raisin offered. When offered to colleagues without surveying them, a "foodie" raved of 'Reliance' in particular, wanting more so he could do his holiday baking with these quality fruits. Another used the raisins in a chutney. One consumer also commented that mixing all the varieties would be a nice treat.

**B.** Everything was accomplished other than the on-farm solar dryer prototype. The potential grower-collaborator decided it was not in their best interest to grow grapes on their farm so that resulted in cancelation of an on-farm field day and the building of the prototype geo-thermal dryer. We instead used tabletop dehydrators to make raisins and through this experience, we learned this was labor and energy intensive and probably not something a grower could afford to do. Potential application for small CSAs is still an option.

All super-hardy cultivars were duplicated with a second planting at WMARS in 2015 so that future experiments could be conducted with an improved experimental design and more vines per variety. A novel cultivar we added was 'Petite Jewel' which some growers prefer over 'Somerset Seedless'.

We propagated several vines of 'Reliance', 'Somerset', and 'Trollhaugen' in spring of 2017, and then planted them at Park Falls Flambeau Educational Garden (USDA hardiness Zone 3) the summer of 2017. These vines will be monitored for persistence and production over the coming years.

## IV. Beneficiaries

Besides the thousands of consumers, countless (more than 400) WGGA and grape growers benefited from our research project from the data and results and field days we hosted and with presentations given at various conferences. See Table 4 which quantifies our outreach.

In addition to consumers and growers that benefited from this grant, several UW-Madison students benefited from this project. Over the 3-yr study, 15 WMARS undergraduate interns learned the timeline and methods/protocols of various management tasks necessary for successful grapevine persistence and production. This included offseason pruning techniques and winter bud injury assessment; shoot thinning and training; leaf and lateral removal/thinning; hedging, netting, and finally harvest. Four graduate students also worked closely with table grapes to collect and analyze data and share their observations with audiences at conferences and vineyard walks as well as networking with growers to share their insights. Students also learned scouting skills for pest and diseases and thresholds for taking action. Collectively, nearly 20 students were exposed to and trained on various aspects of table grape production. Additionally, as listed in Table 3, we exposed hundreds of undergraduate students, via tastings and kitchen labs, to Wisconsin grown grapes.

Park Falls Educational Garden benefitted from the transplanted vines we propagated and planted this season. If the vines survive, this is expected to benefit many users (over 50), as educational workshops held at the garden can demonstrate proper training and pruning techniques, and users of the garden will have access to the fruit.

**Table 3. Log of public outreach events (with location)**

| Name of event | Date | # of people |
|---|---|---|
| westmadison.ars.wisc.edu | 2015 | 8316 |
| westmadison.ars.wisc.edu | 2016 | 11947 |
| westmadison.ars.wisc.edu | 2017 | 8500+ |
| Wi Fresh Fruit & Veg Conference (growers), WI Dells | Jan 26-27, 2015 | 150 |
| Midwest School for Beginning Grape Growers, WMARS | March 29-31, 2015 | 25 |
| UW Extension Vineyard Walk, WMARS | 7/29/2015 | 30 |
| Urban Hort Day, open house, WMARS | 8/15/2015 | 270 |
| Student mixer wine/cheese tasting, UW-Madison campus | 9/6/2015 | 30 |
| Dane County Chapter, Wis Farmers' Union, tour/tasting, WMARS | 9/10/2015 | 15 |
| UW-Madison Hort 120 'Survey of Horticulture' fresh grapes, UW-Madison campus | Sept 10-11, 2015 | 80 |
| UW-Madison Hort 120 'Survey of Horticulture' raisins, UW-Madison campus | Sept 18-19, 2015 | 80 |
| WI Historical Society book launch w Jerry Apps – grape tasting event, WMARS | 9/12/2015 | 130 |

| | | |
|---|---|---|
| Sunset Garden Club, WMARS | 9/15/2015 | 15 |
| Greentree Garden Club, WMARS | 9/21/2015 | 20 |
| Garden Expo (backyard growers), Madison, WI | Feb 12-14, 2016 | 50 |
| Organic Farming Conference (growers), La Crosse | Feb 25-27, 2016 | 70 |
| Wright Middle School tour, WMARS | 3/11/2016 | 8 |
| UW-Madison Hort 345 Fruit Crop Production Field Trip, WMARS: Grape pruning experience | 4/1/2016 | 20 |
| WI Dells Garden Club, WMARS | 5/17/2016 | 12 |
| Madison Home Schoolers tour, WMARS | 6/8/2016 | 15 |
| Columbia County Master Gardeners, WMARS | 6/28/2016 | 35 |
| UW Extension Vineyard walk, WMARS | 7/7/2016 | 15 |
| WI Farm Technology Days (general public), Delavan | July 19-20-21, 2016 | 103 |
| YouthWorks Missions, WMARS | June, July 2016 | 111 |
| 'Garden talk with Larry Mueller', phone call-in show, WI Public Radio, statewide | 8/5/2016 | countless 1000s |
| Urban Hort Day open house, WMARS | 8/20/2016 | 140 |
| All-America Selections Garden Summit, WMARS | 8/25/2016 | 50 |
| Indian Hills Garden Club, WMARS | 8/29/2016 | 15 |
| News3-Morning Show Live Channel 3 TV, statewide | 9/6/2016 | countless 1000s |
| Vineyard walk -table grape tasting, WMARS | 9/7/2016 | 10 |
| Horticulture Showcase (fruit/veg), UW-Madison | 9/15/2016 | 75 |
| Dane County Chapter, Wis Farmers' Union, WMARS | 9/25/2016 | 15 |
| UW-Madison grape and raisin taste trials with UW students/staff, UW-Madison campus | Sept, Oct, 2016, 8x | 405 |
| pruning workshop, WMARS | 4/11/2017 | 10 |
| Cambridge High School, WMARS | 5/10/2017 | 10 |
| 4-H home schooled Crawfish River Club, WMARS | 6/5/2017 | 12 |
| Nuffield International Scholars Farming Tour 2017, WMARS | 6/21/2017 | 12 |
| Kiwanis West garden tour, WMARS | 6/30/2017 | 27 |
| WI Farm Bureau Ag in the Classroom Training, WMARS | 7/6/2017 | 31 |
| YouthWorks Missions, WMARS | 7/11/2017 | 6 |
| YouthWorks Missions, WMARS | 7/14/2017 | 6 |
| CALS Emeritis garden tour, WMARS | 8/1/2017 | 40 |
| Commercial Flower Growers of Wi tour, WMARS | 8/11/2017 | 35 |
| Urban Hort Day, open house, WMARS | 8/12/2017 | 154 |

| | | |
|---|---|---|
| Madison Area Master Gardener Association, WMARS | 8/16/2017 | 35 |
| River Valley Area Community Gardens, Incorporated, WMARS | 8/19/2017 | 7 |
| Waunakee FFA Officer Training, WMARS | 8/21/2017 | 50 |
| Dane Co FSA veggie inspectors/adjustors, WMARS | 8/23/2017 | 5 |
| Boy Scouts, WMARS | 8/30/2017 | 25 |
| Rock County Master Gardeners tour, WMARS | 9/14/2017 | 15 |
| Middleton-Cross Plains Garden Club tour, WMARS | 9/14/2017 | 12 |
| Attic Angels garden tour, WMARS | 9/18/2017 | 10 |
| UW-Madison grape and raisin taste trials with UW students/staff, UW-Madison campus | Sept, Oct 2017, 4x | 72 |
| UW-Madison Horticulture Dept "Fruit Fest" – samples of raisins available to taste; and comments were requested | 10/20/2017 | 30 |

## V. Lessons Learned

Understanding grape lineage is important for correct fungicide applications. Cultivars with concord backgrounds are often injured by fungicides. 'Flint' fungicide was noted to be damaging to foliage of several cultivars leaving a metallic brown color on the leaves. To avoid some of this, we applied lime-sulfur to the vines during the dormant season to clean them up from carryover pathogens.

Seedless table grapes need more plant breeding to improve winter hardiness relative to seeded cultivars. Anecdotally, seeded grapes have more winter hardiness than seedless, as seen in over 20 seeded cultivars over three Ag research stations; so breeding that involves crosses with these may help. Open and well-ventilated sites are ideal, but may expose the vines to harsh winter winds. Proper vine balance becomes important as it affects the vine's ability to prepare for winter.

Rainy seasons and heat can exacerbate decreasing fruit quality seemingly related to thin skinned berries. Thinner skins can lead to sour rot, invite wasps, beetles, birds, and bacteria, reducing quality and longevity, forcing early harvests and more labor to clean the clusters up. Also, delaying harvest or leaving fruit on the vine too long to gain sugars will ultimately result in loss due to pests or shatter. Hot weather late in the season can turn fruit into raisins very quickly. Nets are necessary protection from birds and pests; we noted the nets also safeguarded the fruit during a large hail storm.

Storage ranged from a few weeks to a month in cold storage, but was affected by the quality of the clusters at the start.

Talking to growers is important to gain their insights and compare notes. Being a member of the WGGA list proved valuable for networking, sharing ideas/results, and reaching many. About 10 growers responded and overall, most had planted 'Mars' and 'Somerset Seedless' and a few had

'Montreal Blue' and 'Reliance'. All commented positively about their cultivars' performances. Most noted sour rot issues and similar experience with winter-killed cultivars that we had experienced over the years ('Lakemont', 'Venus' and 'Vanessa' had also been removed from grower's collections). Common pest issues were similar to ours including birds, insects (wasps, Japanese beetles, lady bugs, fruit flies), and downy mildew and black rot disease.

Students loved being involved in grape and raisin surveys, while the public was a bit harder to engage in survey taking. As reflected by the surveys, the grapes appealed to people's varying tastes because of the wide variety of tastes and textures among the cutlivars. Some people liked the more-sour grapes, others like them sweet.

## VI. Additional Information

A one-page flier was developed showcasing the seven cultivars and their characteristics that have survived at WMARS http://westmadison.ars.wisc.edu/wp-content/uploads/sites/68/2017/09/TG_flier.pdf

Fresh and Dried Table Grapes in Wisconsin (published in Fresh Magazine April 2017; Volume 8, Issue 2; pg 6-8) by Jean Riesterer-Loper, Sara Patterson and Amaya Atucha

We also posted pictures and information of the cultivars on the West Madison Ag Research Station website: http://westmadison.ars.wisc.edu/2017/09/27/seedless-table-grape-varieties/

A peer-reviewed publication was achieved that included grapes for modeling fruit drop (abscission): Patterson, S.E., J.L. Bolivar-Medina, T.G. Falbel TG, J.L. Hedtcke, D. Nevarez-McBride, A.F. Maule and J.E. Zalapa. 2016. Are we on the right track: can our understanding of abscission in model systems promote or derail making improvements in less studied crops? *Front. Plant Sci.* **6**:1268. | http://dx.doi.org/10.3389/fpls.2015.01268

**Citations:**


Dami, I., B. Bordelon, D.C. Ferree, M. Brown, M.A. Ellis, R.N. William and D. Doohan. 2005. Midwest Grape Production Guide. Bulletin 919. Ohio State University Extension, Columbus, Ohio.

Luby, J.J. and A.K. Mansfield. 2005. Development and evaluation of cold hardy wine grape breeding selections and cultivars in the upper Midwest. Interim Research Progress Report for 2004 to the Viticulture Consortium-East Geneva, NY: New York State Agricultural Experiment Station.

Murano, P. 2003. *Understanding Food Science and Technology*. Thomson/Wadsworth, Belmont, CA.

Riesterer-Loper, J., S. Patterson, A. Atucha. (Ed. A. Maenner). Reindl Printing Inc. 2017. Sur la Table: Fresh and Dried Table Grapes in Wisconsin. *Fresh: A Wisconsin Perspective*. Vol 8, Issue 2, pp6-8.

Tuck, B. and W. Gartner. 2013. Vineyards and Grapes of the North: A status report. University of Minnesota Extension. http://www.extension.umn.edu/community/economic-impact-analysis/reports/docs/2013-Vineyards-Grapes-North.pdf. Accessed 30 December 2014; verified 18 March 2015.

USDA- National Agricultural Statistics Service. 2014. 2012 Census of Agriculture. Wisconsin state and county data Vol. 1 Part 49. AC-12-A-49. http://www.agcensus.usda.gov/Publications/2012/Full_Report/Volume_1,_Chapter_1_State_Level/Wisconsin/st55_1_039_039.pdf. Accessed 2 January 2015; verified 18 March 2015.

USDA- National Agricultural Statistics Service. 2009. 2007 Census of Agriculture. Wisconsin state and county data Vol. 1 Part 49. AC-07-A-49. http://www.agcensus.usda.gov/Publications/2007/Full_Report/Volume_1,_Chapter_1_State_Level/Wisconsin/wiv1.pdf. Accessed 2 January 2015; verified 18 March 2015.

Witzling, L., B. Shaw, D. Trechter. Ed. A. Maenner. Reindl Printing Inc. 2017. New Recommendations for Marketing Local Produce in Wisconsin. *Fresh: A Wisconsin Perspective*. Vol 8, Issue 2, pp3-5.

## VII. Contact Info

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# 5) Wisconsin Pollinator Plan Development (FY14-005)

**Report Date:** May 23, 2016

## I. Project Summary

**A.** Insect pollinators are an important part of food production and plant reproduction in Wisconsin. There are a wide range of native pollinators, but managed and wild bees are the most efficient and important pollinators of our food crops, including many specialty crops. In addition, Wisconsin ranks in the top 11 honey producing states with beekeepers producing 3.48 million pounds of honey in 2015 valued at $8.4 million. In the United States, the estimated annual value of honey bee pollination for food production is approximately $15-18 billion, while that of wild and native pollinators is estimated at $3 billion.

Wisconsin honey bees contribute to both domestic crop production and are also shipped to other states for specialty crop pollination services. A wide variety of Wisconsin specialty crops are dependent on pollination by both honey bees and native pollinators for their success, including cranberries, cherries, apples, cucumbers and other fruits and vegetables. The value of Wisconsin cranberry production alone exceeded $138 million in 2015. However, recent declines of managed honey bee populations along with threats to native and wild bees have raised concerns about how best to maintain and enhance these key components of our agricultural sector. Agricultural practices, including the use of agrochemicals, simplification of agricultural landscapes, declines in bee forage crops, honey bee diseases and poor apiary management have all been implicated in pollinator declines.

This project specifically sought to identify and quantify the type and magnitude of threats faced by Wisconsin honey bees and native and wild pollinators. With that information, we worked with concerned stakeholder groups (e.g. beekeepers, fruit growers, cranberry producers, conservation groups, cooperating state and federal agencies, etc.) to formulate best management practices (BMPs)to minimize pollinator risk factors while continuing to support agricultural production. Finally, a comprehensive statewide Pollinator Plan was developed as a guide to future activity.

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

## II. Project Approach

- An outline of the plan was shared with the stakeholder group on October 13, 2015.
- Contracted project partner Christina Locke delivered the completed draft plan to the stakeholder group on November 12th, in preparation for the third stakeholder meeting.
- On November 18th, Mike Murray and Liz Meils presented to the DATCP Board on the pollinator protection plan; explaining why the plan was being developed, who was involved, the process used and the planned public comment period.
- The third, and final, stakeholder meeting was held on November 24, 2015, at the Arlington Research Station. We discussed plan dispersal, implementation, evaluating

effectiveness and future revisions. (Click here for attendees and meeting notes.) Final feedback on the draft plan from the stakeholder group was due December 4th.

- Late December-early January the DATCP Graphic Artist provided layout design assistance and put it into the final formatting.
- The draft plan was updated and made available for public comment from January 19 – February 19, 2016.
    - A mass media press release was issued announcing the public comment period.
    - Public comments were assessed and incorporated into the final plan, as applicable. (Click here for a summary of public comments.)
- The finalized Wisconsin Pollinator Protection Plan was published and made available online on April 22, 2016. (Attached, or click here for the complete plan.) A mass media press release was issued announcing it's completion.

## III. Goals and Outcomes Achieved

Three facilitated stakeholder meetings were held from August – November, 2015. A draft of the plan was written and made available for public comment. Public comments were assessed and incorporated, as appropriate. The final Pollinator Protection Plan was published on April 22, 2016.

**B.**

| *Goals and Outcomes* | *Actual Accomplishments* |
|---|---|
| Three statewide stakeholder meetings to gather comments, ideas and suggestions from concerned parties. | Three statewide stakeholder meetings held to gather comments, ideas and suggestions from concerned parties. |
| Best management practices formulated for Wisconsin stakeholders. | Four tailored sets of Best management practices formulated for Wisconsin stakeholders and residents. |
| Detailed draft Pollinator Plan developed and submitted for official review and approval. | Detailed draft Pollinator Plan developed, submitted and approved through official review process. |
| Dissemination of final Pollinator Plan direcly to concerned stakeholder groups and individuals. | Final Pollinator Plan direcly disseminated to stakeholder groups and the public. |

## IV. Beneficiaries

The Pollinator Protection Plan will potentially benefit and impact a wide range of agricultural stakeholders and groups across Wisconsin, including beekeepers, fruit growers, private and commercial pesticide applicators, field and commodity crop farmers, commercial flower growers, tree nursery growers, landscape maintenance companies, conservation groups, government agencies and others.

Almost every sector of Wisconsin specialty crop production may directly benefit from this project. Over 3,500 small to mid-sized farms in this state grow crops such as apples, various berries, cherries and other tree fruits that depend on insect pollinators for successful fruiting. In

addition, large scale commercial producers of cranberries and vegetable crops can use this information to improve timing for pollination and pesticide application activities.

Here is a list of the Pollinator Protection Plan Stakeholder Group (Names in parentheses indicate invited stakeholders who were unable to attend meetings)

| Organization | Representative |
|---|---|
| American Transmission Company | Johanna Sievewright |
| Butterfly Gardens of Wisconsin | Jack Voight, Larry Cain |
| Commercial Beekeeper | Doug Hauke |
| Cooperative Network | John Manske |
| CropLife America | Amy Winters |
| US Environmental Protection Agency | Dan Hopkins |
| Gathering Waters: Wisconsin's Alliance for Land Trusts | Meg Domroese (Mike Carlson) |
| The IPM Institute of North America | Thomas Green |
| Menominee Tribal Enterprises | (David L. Mausel) |
| Midwest Organic and Sustainable Education Service | (Harriet Behar) |
| Pheasants Forever - Wisconsin | Erin Holmes (Adam Hanson) |
| St. Croix Tribal Environmental Services | (Jon Knight) |
| Stockbridge-Munsee Community | Randall Wollenhaup (Jo Ann Schedler) |
| Syngenta Crop Protection LLC | David Flakne |
| US Fish and Wildlife Service | Kurt Waterstradt |
| USDA-Natural Resources Conservation Service | Steve Bertjens |
| University of Wisconsin Extension Specialist | Russell Groves (Christelle Guédot) |
| University of Wisconsin Extension (Facilitator) | John Exo |
| University of Wisconsin, Madison | Christina Locke |
| Wisconsin Agribusiness Association | Mike Dummer |
| Wisconsin Apple Growers Association | Sara Ecker |
| Wisconsin Farm Bureau | Karen Gefvert |
| Wisconsin Green Industry Federation | Brian Swingle, Brad DeBels, Ed Knapton |
| Wisconsin Honey Producers Association | Gordon Waller, Dan Ziehli |
| Wisconsin Pest Control Association | Mike Werner |
| Wisconsin Potato and Vegetable Growers Association | Andy Wallendal |
| Wisconsin State Cranberry Growers Association | Tom Lochner |
| Wisconsin Dept. of Agriculture | Liz Meils, Mike Murray |
| Wisconsin Dept. of Natural Resources | Jay Watson, Rich Henderson |
| Wisconsin Dept. of Transportation | Christa Wollenzien |
| The Xerces Society for Invertebrate Conservation | Thelma Heidel-Baker (Sarah Foltz Jordan) |

- DATCP staff provided outreach by presenting/exhibiting at many conferences/events throughout the duration of the grant:
    - Farm Tech Days, Sun Prairie, July 2015 - Pollinator booth
    - Horticulture Inspection Society Fall Conference, Wis Dells, Oct 2015 - Pollinator protection talk
    - WI Honey Producers Association conference, Stevens Point, Nov 2015 - Pollinator protection talk
    - WI Crop Management conference, Madison, Jan 2016 - Pollinator protection talk and booth
    - WI Fresh Fruit and Vegetable Conference, Wis Dells, Jan 2016 - Pollinator protection talks (2 tracks) and booth
    - WI Ag Coalition, Madison, Jan 2016 - Pollinator Protection Plan talk
    - WI Pest Control Association Conference, Wis Dells, Feb 2016 - Pollinator protection talk and booth
    - WI Chapter-American Association of Landscape Architects Conference, Madison, Feb 2016 - Pollinator protection talk
    - DATCP Board - Pollinator Protection Plan update, November 2015 and May 2016
    - Upper Midwest Forest Health Cooperators Meeting, Madison, March 2016 - Pollinator Protection Plan talk
    - Midwest Organic and Sustainable Education Service (MOSES) Conference, La Crosse, Feb 2016 - staffed booth

## V. Lessons Learned

We learned that the community of specialty crop farmers may not be as ready for more advanced sales contracting materials as we had anticipated. Buying and selling is still a very informal enterprise with very little paperwork. We thought there might be more appetite for creative arrangements such as contracting ahead of production or for farmers selling their labor to produce a product rather than the product already grown. This wasn't exactly the case. To better satisfy the demand among specialty crop growers, we modified our approach slightly by emphasizing invoices and availability sheets. IN the future, we anticipate the market will be more ready for more complex sales relationships- hopefully ones that provide greater security to both parties.

## VI. Additional Information

The final Wisconsin Pollinator Protection Plan can be found on our website at: http://datcp.wi.gov/Farms/Bees_and_Honey/index.aspx?Id=225

## VII. Contact Info

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# 6) Minimizing Pesticide Residues on Ginseng Root to Remove Export Barriers or Wisconsin Growers (FY14-006)

**Report Date:** May 27, 2016

## I. Project Summary

**A.** The project funded in the FY2014 Specialty Crop Block Grant has incorporated most aspects of ginseng cultivation, from seeding to harvest. In particular, the research conducted on seed treatments will help ensure growers use products that are safe and effective, resulting in the establishment of healthy gardens. The use of compost materials was little understood prior to the work funded in this grant. Results from greenhouse experiments have resulted in the recommendation that only compost materials that have been tested should be considered. The efficacy of biocontrol products against Alternaria blight was tested with disappointing results. However, newly registered products were tested and shown to be highly efficacious. Residues of certain products, such as Endura and Quadris, even when applied at the labeled rates and intervals, resulted in residues over the maximum residue limits (MRLs). Participation from the industry continues to be strong with over 100 attendees at the 2015 Ginseng Field Day and the 2016 Winter Research Meeting.

The Ginseng Board of Wisconsin (GBW) submits this grant to the FY14 Wisconsin Department of Agriculture, Trade and Consumer Protection's Specialty Crop Block Grant program to: 1) Partner with industry experts to monitor Maximum Residue Limits among international ginseng markets, 2) Test seed treatments and biologically active mulch as a means to exclude pests, and 3) Develop pesticide recommendations for growers that protect the crop AND allow it to be exported with minimal or no chemical residues. Successful completion of this project will result in increased exports of Wisconsin ginseng and enhanced profitability and expansion of this specialty crop.

The GBW is comprised of seven ginseng producers who are nominated and elected by growers. In 2004, industry representatives and researchers from Michigan and Wisconsin developed the first Pest Management Strategic Plan (PMSP) for ginseng. This PMSP was revised in 2007 and then in 2011. The following priorities were identified: a) Identify new active ingredients effective against grubs, cutworms, and wireworms, b) Develop management strategies for root rot diseases, including *Phytophthora*, *Cylindrocarpon*, and *Fusarium*, especially during the harvest year, c) Develop management strategies for foliar blights, including *Alternaria*, d) Identify effective seed treatments.

and Consumer Protection (2012 Specialty Crop Block Grant program, Refined Pest Management Strategies for Ginseng Growers), reliance on pesticides was reduced, reduced-risk pesticides were implemented, and alternative mulches were observed. The initial proposal described herein used this previously funded project as a foundation to address a new and critically important issue to Wisconsin ginseng growers related to increasing exports. In the fall of 2013, roots from fungicide efficacy trials were collected, dried, and sent to an analytical lab for testing (results pending). This residue information will be used as preliminary data to help set the protocols described in this proposal. Seed testing data was also initiated in the fall of 2013 by collecting untreated stratified and green (non-stratified) seed from growers and applying various registered and unregistered seed treatments. These seeds are currently undergoing testing for pathogen incidence and viability (% germination).

Consumers within the U.S., as well as internationally, are increasingly concerned with pesticide residues in their food. Within the U.S., the Environmental Protection Agency (EPA) sets limits known as the Maximum Residue Limit (MRL) on how much of a specific pesticide residue is safe to be present in a particular food. However, MRLs across countries are not uniform, which poses a challenge to Wisconsin growers exporting ginseng. For example, growers use the reduced risk fungicide azoxystrobin to control Alternaria leaf blight, a yearly threat in Wisconsin. According to U.S. guidelines, a MRL of 0.5 ppm azoxystrobin is allowed on dried ginseng root. However, Taiwan has not established a MRL for that fungicide on ginseng. This makes even the smallest trace of azoxystrobin unacceptable to the Taiwan Food and Drug Administration (TFDA). In the project previously funded through the 2012 Specialty Crop Block Grant program, ginseng growers implemented reduced risk pesticides such as azoxystrobin. Pest management programs must be refined with a focus not only on product efficacy and safety but also on residues. Countries importing Wisconsin ginseng do not distinguish among residue types; residues are not acceptable unless there is a MRL, even if the pesticide is a reduced risk product.

The Wisconsin ginseng industry has key export markets in Taiwan, China/Hong Kong, Japan, and Singapore. The TFDA recently intensified their investigation of imported products due to consumers' food safety concerns and targeted ginseng tea. The TFDA does not have the necessary MRLs established for ginseng root to be consumed as a food. A media outlet in Taiwan discovered this and publicized allegations that Wisconsin ginseng is unsafe because of higher than allowed pesticide residues. However, there are no MRLs established in Taiwan, so anything higher than a zero is considered unsafe. As a result, exports of Wisconsin ginseng to Taiwan have dropped by 94% (by volume) from 2011-2012. To compound this difficult situation, the equipment used to analyze pesticide residues continues to become more refined; residue levels to the level of parts per billion can now be routinely determined.

The GBW seeks to re-establish and grow the exports of Wisconsin ginseng by partnering with industry consultants and University researchers to monitor the MRLs in their target foreign markets and develop strategies that reduce or eliminate pesticide residue. Currently, pesticides are needed to grow ginseng; to limit disease, fungicides may be applied weekly from May-September. Ginseng growers rely on mancozeb and chlorothalonil, fungicides that the EPA classifies as probable human (B2) carcinogens. The strobilurin fungicides (i.e., azoxystrobin) are now also used and are considered environmentally friendly but is one of the products cited by the TFDA as a problem residue on ginseng. It is critical that ginseng growers reduce fungicide use to reduce the likelihood of residues. However, in the absence of effective treatments for Alternaria blight, for example, growers could potentially lose $5,637/A in root revenue due to repeated crop defoliation and an additional $16,500/A in seed revenue. Further, *Alternaria panax*, *Phytophthora cactorum* and *Cylindrocarpon destructans*, can be carried on Wisconsin ginseng seed as demonstrated by MSU studies. Planting contaminated seed increases the need for fungicide applications and jeopardizes a growers' ability to produce a quality crop. Ginseng growers harvest their own seed for planting; they also sell seed to other growers. Seed treatment is not widely used by the ginseng industry due to concerns of phytotoxicity or delayed germination. Only fludioxonil (Maxim 4FS, Syngenta Crop Protection) and mefenoxam (Apron XL Syngenta Crop Protection) are registered for ginseng seed. Registrants have indicated that with efficacy/phytotoxicity data they would add ginseng to additional seed treatment labels.

**B.** The research funded in the FY2014 Specialty Crops Block Grant has been, in some part, a continuation of previously funded projects and has been helpful in building momentum within the industry. This momentum is evident as we continue to have outstanding participation from grower cooperators and attendance at the various research meetings. With the new implementation of reduced-risk fungicides, we have been able to move growers away from products that result in pesticide residues. Data collected from the efficacy trials has also been helpful in the process of registering new products that will replace those with residue issues. Due to the perennial nature of ginseng, the importance of multi-year study funding cannot be understated.

## II. Project Approach

**Test seed treatments as a means to exclude pests.**

A large-scale seed treatment trial was conducted with a cooperator's farm in Marathon County, WI. Using a modified cement mixer, materials were applied according to manufacturers' labels to untreated stratified ginseng seeds on 5 Aug 2014. A colorant was added to each treatment to ensure full coverage of the seeds. Each treatment was applied to 15 lb. of seed. After all of the treatments were applied, the seeds were immediately moved to the planting site. Each treatment was replicated three times in a randomized block design with each replicate consisting of a 50-ft length of a single raised bed. Each bed was 4-ft wide and a 2-ft buffer between treatments (Figure 1). Insect, disease, and weed control was managed by the grower cooperator in accordance to industry standards. The number of emerged and damped-off seedlings in two, one square meter sections, in the center of each bed were counted every two weeks beginning on June 24th through August 18$^{th}$, 2015. An early season count was conducted on the two-year-old plants on May 17$^{th}$, 2016. Data were analyzed using SAS PROC GLM and statistical differences were compared using the Fisher's Protected Least Significant Differences test ($P$=0.05). A second seed treatment trial was conducted by a different grower cooperator in Marathon County, however, due to extreme frost damage at the site, we were unable to conduct any meaningful ratings.

Quadris and oxathiapiprolin had consistently higher seedling emergence numbers throughout the season when compared to the untreated control (Table 1). All other treatments resulted in counts statistically similar to the untreated control for all dates. It should be noted that the grower standard treatment resulted in relatively low counts in 2015, which correlated to the lowest count compared to all other treatments in 2016. No treatments significantly reduced damping off compared to the untreated control, however, Wrangler and OXTP resulted in the lowest rates. Damping off does not appear to be the main factor in the differences observed in seedling germination, but rather was more often associated with drip lines in the canopy contributing increased moisture in certain plots. *Pythium* spp, *Fusarium* spp, *Phytophthora* spp and *Rhizoctonia* spp. were found associated with damped off seedlings, however, there was no significant correlation between microorganisms isolated and treatments. A significant negative effect on emergence was not observed to be associated with any of the seed treatments when compared to the untreated control.

The data from this trial will be used by the manufacturers to include ginseng on future registration expansions. In particular, the oxathiapiprolin product from Syngenta Crop

Protection, Inc., is now labeled and is expected to be widely used by growers in 2016. This large-scale seed treatment trial was a stop at the 2015 Ginseng Research Field Day and data tables and graphs were presented at the March 2016 Spring Grower Meeting. Although many growers believe that seed treatments have a negative effect on seed germination, the data from this trial exhibited that when the treatments were applied at the correct rate, these treatments are safe and effective.

**Table 1. Results of the large-scale seed treatment trial located in Marathon County, WI.**

| Treatment and rate/100 lb. seed | Emerged plants (no.) | | | | | | |
|---|---|---|---|---|---|---|---|
| | Seedlings (2015) | | | | | | 2-year-old plants |
| | June 8 | | July 7 | | August 18 | | May 17 (2016) |
| Untreated control | 277.33 cd[x] | | 277.67 | c | 273.00 | c | 124.00 a-d |
| Grower standard | 279.50 cd | | 275.50 | c | 282.17 | c | 99.17 d |
| Wrangler 5 oz. | 266.00 d | | 286.00 | c | 275.67 | c | 131.17 a-d |
| Fontelis 1 oz. | 300.67 bc | | 302.83 | a-c | 292.33 | bc | 150.00 a-c |
| Oxathiapiprolin 1 oz. | 336.00 a | | 330.83 | a | 326.00 | a | 156.00 ab |
| Presidio 1 oz. | 302.00 bc | | 305.67 | abc | 296.17 | a-c | 151.17 a-c |
| V-10208 0.6 fl oz. | 300.50 bc | | 298.83 | bc | 289.33 | c | 111.67 cd |
| Captan 3.3 oz. | 296.83 cd | | 302.50 | a-c | 286.33 | c | 137.67 a-d |
| Apron MAXX 5 fl oz. | 284.83 cd | | 291.33 | c | 266.37 | c | 115.67 b-d |
| Quadris 1 fl oz. | 332.33 ab | | 326.00 | ab | 320.00 | ab | 158.00 a |
| Actinovate AG 6 oz. | 292.50 cd | | 286.00 | c | 276.83 | c | 142.67 a-c |

[x] Column means with a letter in common are not significantly different (Fisher's LSD; $P$=0.05).

**Figure 1. A 1m$^3$ section of a bed marked for counting the number of emerged seedlings.**

**Test compost and other biorational materials against root rot organisms.**

A single, large, greenhouse trial was initiated in May 2015 to determine the effect of various compost materials and soil types on ginseng seedling health and development. A sandy loam soil was collected from an agricultural field site and autoclaved twice for 45 min. Four compost types were sent from various companies in Wisconsin. The senders, to reduce any chance of bias occurring during the experiment, coded these compost materials as CC, BB, LF, or IG. The compost materials were individually mixed at a 1:2 v/v ratio with the autoclaved soil and placed

into 6-cell pack pots. Stratified ginseng seeds were mixed in silica sand and stored at 38°F 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. The bare-rooted plants were then transplanted into the 6-cell packs containing the various soil treatments. Each soil type treatment was replicated five times in a completely randomized design. Preliminary studies have shown the difficulty in determining the effects of compost on ginseng. To combat the problems associated determining differences with ginseng soil treatments, each treatment was repeated three times in the experiment. The foliage health (1-5; 1=healthy, 2=chlorosis, 3=minor wilting, 4=moderate/severe wilting, 5=plant death) and plant death (%) was noted on 11, 16, and 29 Aug. On the 29 Aug, the plants from each cell-pack were collected and washed. The foliage was separated from the roots and weighed (g). The roots were rated for health (1-5; Root health rating is 1 to 5; 1=healthy, 2=chlorosis, 3=minor wilting, 4=moderate/severe wilting, 5=plant death) and weighed (g). Data were analyzed using SAS PROC GLM and statistical differences were compared using the Fisher's Protected Least Significant Differences test ($P$=0.05).

Plant mortality was high in this trial with approximately 1/3 of plants in the control soil dead by the 29 Aug. A significant difference was observed between the plants in the various compost materials. Seedlings transplanted into the BB compost/soil, on average, received the best foliar and root health ratings, and had the lowest percentage of plant death. An increase in seedling root and foliage fresh weight, when compared to the control soil and LF compost was observed with ginseng grown in the BB compost mixture. Compost CC was the next most effective mixture with root and foliar health ratings better than the control soil and the LF and IG composts. The LF compost had a significant negative effect on seedling health compared to all other treatments.

The compost analysis does give some insight on the association of plant health and yield of the various compost treatments (Table 4). In particular, the BB compost, which resulted in the best plant health ratings, had significantly less iron (ppm) when compared to the other materials. In studies conducted in Canada, iron has been associated with an increase of Cylindrocarpon severity on ginseng. The BB compost also had the lowest percentage of moisture, organic matter and carbon. If growers use compost treatments, they may want to consider testing the material prior to application and only apply products at or below the levels of the BB composts used in this experiment. If a compost analysis is not available, we do not recommend using the material as some products may result in much higher infection rates and reduced yields. The results of this experiment, including the compost analysis, was presented to growers at the 2016 Ginseng Winter Research Meeting.

**Table 2: Foliar plant health and plant death (%) of ginseng seedlings transplanted into various compost/soil mixtures.**

| Soil type | Foliar plant health* | | | Plant death (%) | | |
|---|---|---|---|---|---|---|
| | 6/11 | 6/16 | 6/29 | 6/11 | 6/16 | 6/29 |
| Control soil #1 | 3.6 c-e** | 3.7 b-e | 3.9 cd | 62.8 c-e | 62.8 b-d | 66.0 c-e |
| Control soil #2 | 3.0 a-d | 3.0 ab | 3.6 a-c | 49.8 b-e | 46.6 ab | 56.4 a-d |
| Control soil #3 | 3.2 b-e | 3.4 a-d | 4.0 c-e | 50.0 b-e | 53.2 a-c | 63.0 b-e |
| CC #1 | 2.9 a-d | 3.1 a-c | 3.2 a-c | 39.8 a-c | 46.4 ab | 43.0 a-c |
| CC #2 | 3.1 a-d | 3.1 a-c | 3.6 a-c | 53.0 b-e | 53.0 a-c | 59.8 a-d |
| CC #3 | 3.1 a-d | 2.9 ab | 3.4 a-c | 43.2 bc | 43.4 ab | 49.8 a-c |
| BB #1 | 2.4 ab | 3.1 a-c | 2.9 a | 33.2 ab | 49.8 ab | 39.8 ab |
| BB #2 | 2.2 a | 2.4 a | 3.0 ab | 16.8 a | 29.8 a | 36.6 a |
| BB #3 | 3.0 a-d | 3.1 a-c | 4.0 c-e | 40.0 a-c | 49.8 ab | 59.8 a-d |
| LF #1 | 3.8 de | 4.0 c-e | 4.5 d-f | 56.4 b-e | 69.6 b-d | 79.6 d-f |
| LF #2 | 4.2 e | 4.6 e | 4.8 ef | 69.8 de | 86.4 d | 86.4 ef |
| LF #3 | 4.2 e | 4.3 de | 5.0 f | 72.8 e | 79.6 cd | 93.2 f |
| IG #1 | 3.4 b-e | 3.5 b-d | 3.8 b-d | 53.0 b-e | 59.4 b-d | 59.6 a-d |
| IG #2 | 2.7 a-c | 3.0 ab | 3.5 a-c | 36.4 ab | 43.0 ab | 53.2 a-c |
| IG #3 | 3.1 a-d | 3.2 a-c | 3.9 b-d | 46.4 b-d | 49.6 ab | 59.6 a-d |

*Foliar plant health rating is 1 to 5; 1=healthy, 2=chlorosis, 3=minor wilting, 4=moderate/severe wilting, 5=plant death.

**Column means with a letter in common are not significantly different (LSD t Test; *P*=0.05).

**Table 3: Root health, and foliar and root fresh weight of ginseng seedlings transplanted into various compost/soil mixtures.**

| Soil type | Root health rating* | | Foliage weight (g) | Root weight (g) |
|---|---|---|---|---|
| Control soil #1 | 4.0 | b-e** | 0.27 c-f | 0.23 b-e |
| Control soil #2 | 3.9 | b-e | 0.29 c-e | 0.27 b-d |
| Control soil #3 | 4.2 | d-f | 0.22 c-f | 0.14 de |
| CC #1 | 3.5 | a-c | 0.44 bc | 0.41 a-c |
| CC #2 | 3.4 | a-c | 0.42 bc | 0.37 a-d |
| CC #3 | 3.8 | a-d | 0.48 abc | 0.26 b-d |
| BB #1 | 3.1 | a | 0.74 a | 0.53 a |
| BB #2 | 3.3 | ab | 0.66 ab | 0.45 ab |
| BB #3 | 4.1 | c-e | 0.33 cd | 0.25 b-e |
| LF #1 | 4.6 | ef | 0.12 d-e | 0.21 c-e |
| LF #2 | 4.9 | f | 0.05 ef | 0.03 e |
| LF #3 | 4.9 | f | 0.02 f | 0.02 e |
| IG #1 | 4.0 | b-e | 0.31 c-e | 0.19 c-e |
| IG #2 | 3.6 | a-d | 0.46 bc | 0.25 b-e |
| IG #3 | 4.0 | b-e | 0.28 c-e | 0.22 b-e |

*Root health rating is 1 to 5; 1=healthy, 2=chlorosis, 3=minor wilting, 4=moderate/severe wilting, 5=plant death.

**Column means with a letter in common are not significantly different (LSD t Test; *P*=0.05).

**Table 4: Analysis of compost materials tested on ginseng in the greenhouse**

| Sample ID | Nutrient analyses (%) | | | | | | |
|---|---|---|---|---|---|---|---|
| | Nitrogen | Phosphorus | Potassium | Calcium | Magnesium | Sodium | Sulfur |
| BB | 0.32 | 0.05 | 0.08 | 0.27 | 0.07 | 0.01 | 0.04 |
| CC | 0.43 | 0.03 | 0.03 | 0.18 | 0.05 | 0.01 | 0.04 |
| LF | 0.36 | 0.07 | 0.19 | 0.83 | 0.24 | 0.01 | 0.05 |
| IG | 0.39 | 0.03 | 0.04 | 0.25 | 0.06 | 0.01 | 0.06 |

| Sample ID | Nutrient analyses (ppm) | | | | | |
|---|---|---|---|---|---|---|
| | Iron | Zinc | Manganese | Copper | Boron | Aluminum |
| BB | 1869 | 24 | 92 | 4 | 2 | 2450 |
| CC | 2367 | 11 | 27 | 3 | 2 | 2872 |
| LF | 2593 | 25 | 81 | 7 | 8 | 2555 |
| IG | 2672 | 12 | 44 | 3 | 1 | 2795 |

| Sample ID | Other analyses | | | |
|---|---|---|---|---|
| | % Moisture | % Organic matter | Carbon % | Carbon:Nitrogen |
| BB | 19.2 | 5.8 | 3.4 | 10.5 |
| CC | 20.4 | 8.8 | 5.1 | 11.9 |
| LF | 23.9 | 7.9 | 4.6 | 12.7 |
| IG | 18.7 | 7.2 | 4.2 | 10.7 |

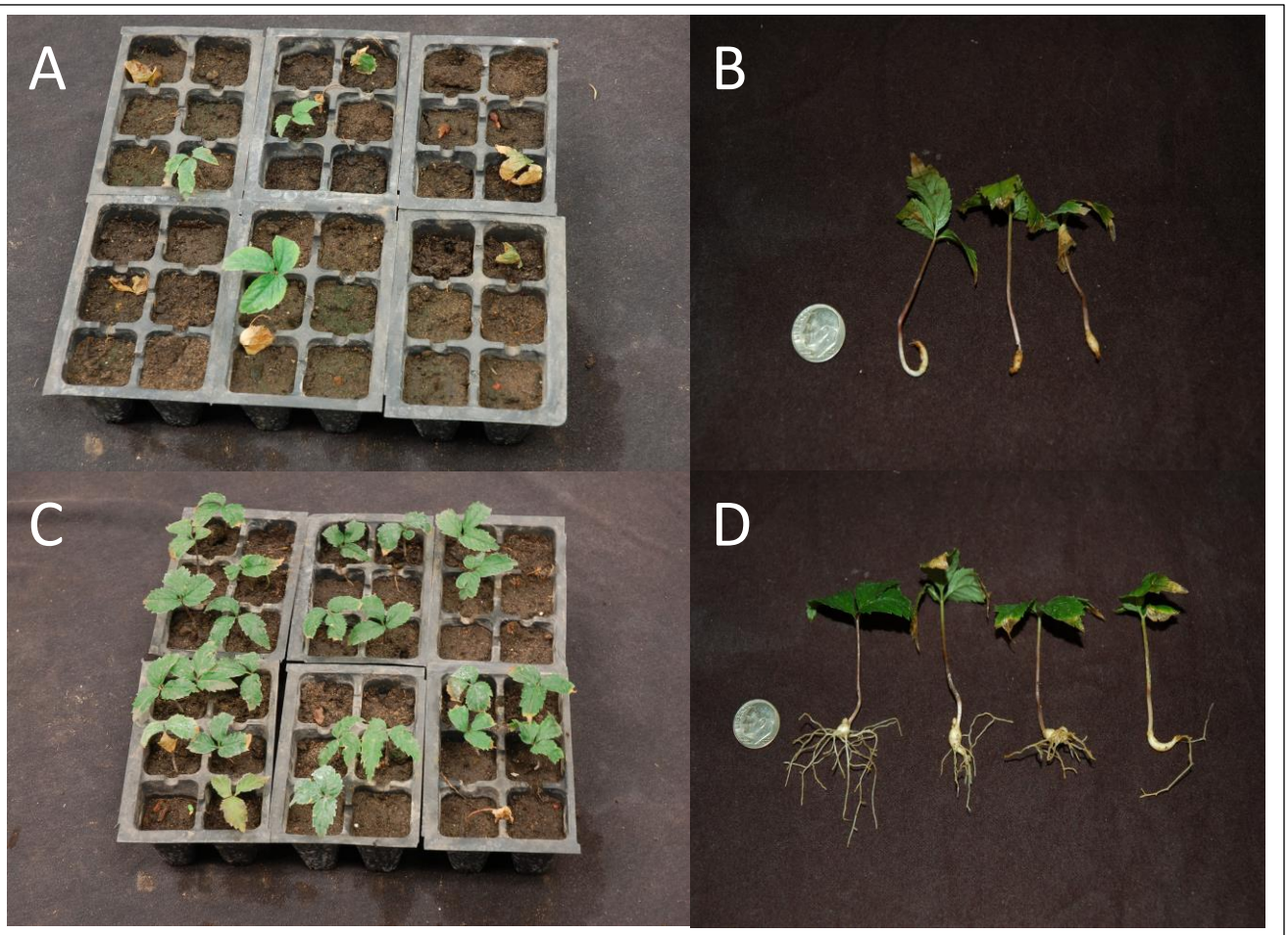


**Figure 2. The addition of the compost material LF resulted in a high percentage of plant death (A) and diseased roots (B). Compost material BB was beneficial and both the foliage (C) and roots (D) were healthier.**

**Develop pesticide recommendations for growers that protect the crop AND allow it to be exported with minimal or no chemical residues at harvest.**

To determine how pesticide residues accumulate in ginseng roots, trials were initiated in 2014 and continued in 2015. Applications were initiated in 2015 on 25 May and were reapplied at 7-, 14-, or 21-day intervals through August (Table 5). At each location, treatments were replicated four times with each replication consisting of a 20 ft. bed length. Insecticide treatments were applied based on grower use patterns. In mid-September, roots from 3 replications of each treatment were harvested from the 2- and 3-year-old ginseng plots. Roots were cooled for two weeks in accordance to processing standards and the 3-year-old roots were dried to 70-90% dry matter. The roots were transferred to the Michigan State University Analytical Testing Lab for residue testing. The two-year-old roots were delivered to the testing facility as fresh root (non-dried). The samples were subsampled and ground with Dichloromethane, Magnesium sulfate, and sodium chloride. Samples were then shaken and poured through a paper filter with sodium sulfate and collected in a round bottom flask, then a roto vap was used to dry and brought up in acetonitrile for analysis on either the GC or HPLC coupled to mass spectrometry.

Results from the residue testing are concerning for the industry as products such as Endura (boscalid) and Quadris (azoxystrobin) were detected at levels over the maximum residue limits (MRLs) set by the EPA. These levels were detected despite being applied at labeled rates and within the maximum number of applications allowed per season. In particular, it should be noted that Endura was detected, in some cases, at levels over 14x the MRL (1 ppm). The detection of Lorsban (chlorpyrifos) in roots after just a single application to the 3-year-old plants reinforces the recommendation by industry groups to no longer apply the product for insect control. Overall, the residue testing results have been helpful when recommending disease and insect control plans for the 2016 growing season. Endura is no longer being recommended to growers based on the residue issues and the overall efficacy displayed in recent years. Although Quadris residues, were in some cases over the MRL, we will still include the product in a rotational program that will limit the overall number of applications. Growers have also switched to insecticide products, such as Bifenture and Sevin, which do not appear to have the residual properties associated with Lorsban. The results of the residue study were presented to growers at the 2016 Ginseng Winter Research Meeting.

**Table 5. Residues of various fungicides and insecticides detected on 2- and 3-year-old ginseng.**

| Treatment and rate/ 50 gal | Spray Schedule | Applications applied in 2015 | 2-year-old garden residues (ppm)* | 3-year-old garden residues (ppm)* |
|---|---|---|---|---|
| Untreated Control | -- | -- | -- | -- |
| Endura WG 4.5 oz. | 7-day | **5** | **0.06-4.86**** | **4.05-8.17** |
| Endura WG 4.5 oz. | 14-day | **5** | **0.0-14.7** | **0.0-13.0** |
| Endura WG 4.5 oz. | 21-day | **5** | **0.05-2.33** | **0.0-5.98** |
| Bravo WeatherStik SC 2 pt | 7-day | **14, 8*** | **0.0** | **0.0** |
| Bravo WeatherStik SC 2 pt | 14-day | **8** | **0.0** | **0.0** |
| Bravo WeatherStik SC 2 pt | 21-day | **5** | **0.0** | **0.0** |
| Captan 80WDG 2.5 lb. | 7-day | **8** | **0.0-2.12** | **0.0** |
| Captan 80WDG 2.5 lb. | 14-day | **8** | **0.0-2.14** | **0.0** |
| Captan 80WDG 2.5 lb. | 21-day | **5** | **0.0** | **0.0** |
| Quadris SC 15.5 fl oz. | 7-day | **8** | **0.06-0.11** | **0.31-0.62** |
| Quadris SC 15.5 fl oz. | 14-day | **8** | **0.04-0.19** | **0.27-0.7** |
| Quadris SC 15.5 fl oz. | 21-day | **5** | **0.02-0.10** | **0.14-0.23** |
| Lorsban 15G 13.5 lb. | 1 app | **1** | **0.0** | **0.0-6.89** |
| Sevin XLR 2 qt | 14-day | **3** | **0.0** | **0.0** |
| Bifenture EC 6.4 fl oz. | 14-day | **5** | **0.0** | **0.0** |
| Sevin G 30 lb. | 14-day | **3** | **0.0** | **0.0** |

*Residue levels shown as the range of the three replications tested per treatment.
**Residues numbers in red indicate residues over the EPA established maximum residue limits (MRLs).

To determine if fungicide residues could be lowered by implementing a disease control program that utilizes several different active ingredients, a trial was initiated in 2015 on 3-year-old ginseng. Applications were started the week of May 18th and continued until the end of August. In mid-September, roots from 3 replications of each treatment were harvested. A calendar based 7-day spray program was compared with two programs (10 DSV and amended 10 DSV) that utilized environmental parameters (leaf wetness and temperature) to determine when fungicide applications would be applied (Table 6). Although the 10 DSV treatment threshold did prove to be effective in previous experiments, a treatment with an amended formula was included in this trial with a lower temperature threshold for DSVs. To determine efficacy of the treatments for control of Alternaria leaf blight, number of infected plants per plot (incidence) and disease severity (rating scale 1-10: 1=0-10% foliage in plot covered in lesions, 2=11-20%, 3=21-30%, 4=31-40%, 5=41-50%, 6=51-60%, 7=61-70%, 8=71-80%, 9=81-90%, 10=91-100%) were recorded biweekly throughout growing season (Tables 7).

The results of this trial may give some insight on the ability of growers to use the TOMCAST system (DSVs are available to growers on the GBW website) to decrease the overall number of Alternaria blight applications applied each year. In particular, 15 sprays were applied the plots treated every 7-days, in accordance to standard protocol, while only 7 sprays were applied to the 10 DSV threshold plot. The 10 DSV plot and the 7-day interval plots had statistically similar disease incidence and severity. The amended 10 DSV plot received 12 applications while also limiting infection to amounts similar to the 7-day schedule. It should be noted that no pesticide residue was detected on any of the treated sample in this experiment. Growers were able to observe this experiment at the 2015 Ginseng Field Day.

**Table 6. Treatment and rates for TOMCAST trial applied at 7-day, 10 DSV, or amended 10 DSV.**

| Treatment | A.I. | Company | Rate/ 50 gal |
|---|---|---|---|
| Bravo WeatherStik | chlorothalonil | Syngenta | 2 pt |
| + Quadris | azoxystrobin | Syngenta | 15.5 fl oz. |
| alt. Endura | boscalid | BASF | 4.5 oz. |
| + Roper | mancozeb | Loveland | 2 lb. |
| alt. Bravo WeatherStik | chlorothalonil | Syngenta | 2 pt |
| + Scala | pyrimethanil | Bayer | 18 fl oz. |
| alt. Switch | cyprodinil/ fludioxonil | Syngenta | 14.0 oz. |
| alt. Merivon | pyraclostrobin/fluxapyroxad | BASF | 5.5 fl oz. |
| alt. Omega | fluazinam | Syngenta | 1.5 pt |
| +Fontelis | penthiopyrad | DuPont | 16 fl oz. |

**Table 7. Efficacy results table from comparison of 7-day calendar-based spray program and those utilizing environmental parameters.**

| Spray Schedule* | Number of applications | Plant Disease Incidence Aug 18 | Plant Disease Severity Aug 18 | Fungicide Residues Detected |
|---|---|---|---|---|
| Untreated | -- | 91.42 a** | 4.92 a | None |
| 7 day | 15 | 10.33 b | 2.00 c | None |
| 10 DSV | 7 | 27.17 b | 2.83 b | None |
| 10 DSV-Alt. | 12 | 13.58 b | 2.33 bc | None |

*Fungicide treatments and rate are described in Table 6.

**Column means with a letter in common are not statistically different (*P*=0.05; Fisher's LSD)

To determine the effect of different fungicides on development of seed heads, 14 different products were tested in 2015 at two sites, replicated three times at each site (Table 8). At the center of each 20 ft. bed, one square meter was measured and every seed head in that quadrant was collected in late August. Seeds were weighed immediately and visually assessed for quality. A categorical scale from 1-5 was used to rate the berries: 1=seed heads intact and ripened, 2=seed heads intact but some still green or small, 3=seed heads appear disease free but crumble when picked, underdeveloped berries, aborted, 4=some visible sign of disease, 5=seed head completely diseased (Figure 3). The percentage of seed heads in each category was recorded for each quadrant.

The two protectant fungicides, Bravo WeatherStik and Roper, resulted in the highest seed head yields of any product (Figure 4). Seed heads of category 1 (seed heads intact and ripened) quality were rare—Roper, Cabrio, Omega, and Fontelis all resulted in a greater percentage of category 1 seed heads than the other products. Quadris, Roper Quadris Top and Fontelis all had a significantly greater percentage of category 2 (seed heads intact but some still green or small) seed heads than the control. Only Bravo WeatherStik showed a significantly different percentage (47%) of category 3 (seed heads appear disease free but crumble when picked, underdeveloped berries, aborted) seed heads than the control (19%). Untreated, Endura and Quadris plots all produced significantly similar percentages of category 4 (some visible sign of disease) seed heads, while Roper had the fewest category 4 seed heads. Regalia and Tanos produced significantly similar percentages of category 5 (seed head completely diseased) as the

control (Figure 5). High percentages in categories 4 and 5 signify that disease played a significant role in the reduced quality of seed heads. Category 3 is less clear as to whether the poor quality is due to disease or some other phenomena.

In this experiment, five of the six treatments with the highest seed yield were protectant fungicides (Omega, Scala, Bravo, Fontelis, and Roper). Quality of seed was also notable in these protectant fungicides with all treatments having more category 1 seeds compared to the majority of other treatments. Although products Quadris and Endura have been effective in controlling infection from Alternaria blight in previous experiments, high disease incidence was observed on plants treated with these products and grower recommendations have been amended to no longer apply these products as stand-alone treatments. The ability of certain treatments to offer the possibility of increased seed production is extremely interesting to the industry as seed prices have increased in recent year. This experiment was observed at the 2015 Ginseng Field Day and the tables and graphs were presented at the 2016 Winter Research Meeting.

**Table 8. List of fungicides applied to test for impact on the quality of seed heads.**

| Treatment | Formulation | A.I. | Company | Rate/acre |
|---|---|---|---|---|
| Untreated Control | - | - | - | - |
| Endura | 70WG | boscalid | BASF | 4.5 oz. |
| Bravo WeatherStik | 6SC | chlorothalonil | Syngenta | 2 pt |
| Switch | 62.5WG | cyprodinil + fludioxonil | Syngenta | 14 oz. |
| Tanos | 50DF | famoxadone + cymoxanil | DuPont | 8 oz. |
| Fontelis | SC | penthiopyrad | DuPont | 16 fl oz. |
| Omega | 500F | fluazinam | Syngenta | 1.5 pt |
| Cabrio | EG | pyraclostrobin | BASF | 12 oz. |
| Quadris Top | - | difeniconazole + azoxystrobin | Syngenta | 14 fl oz. |
| Scala | SC | pyrimethanil | Bayer | 18 fl oz. |
| BAS 703 01F | SC | fluxapyroxad + pyraclostrobin | BASF | 6 fl oz. |
| Inspire | EC | difeniconazole | Syngenta | 7 fl oz. |
| Regalia | - | extract of giant knotweed | Marrone | 4 qt |
| Roper DF Rainshield | DF | mancozeb | Loveland | 2 lb. |
| Quadris | SC | azoxystobin | Syngenta | 15.5 fl oz. |

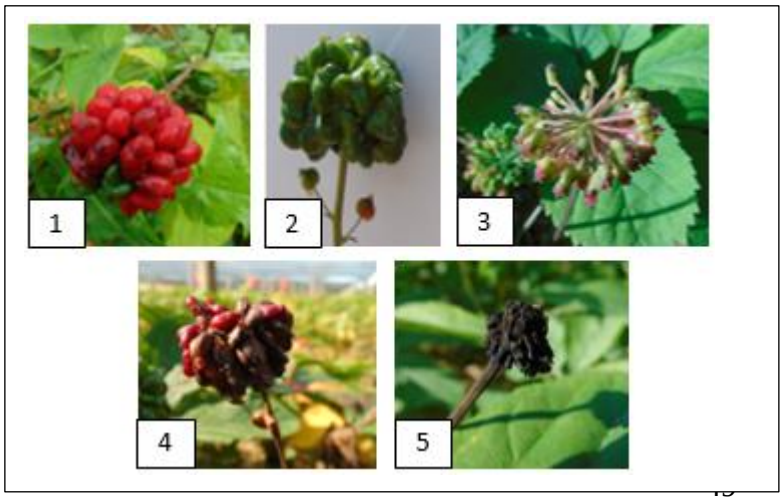


**Figure 3. Category ratings of seed head quality. 1=seed heads intact and ripened, 2=seed heads intact but some still green or small, 3=seed heads appear disease free but crumble when picked, underdeveloped berries, aborted, 4=some visible sign of disease, 5=seed head completely diseased**

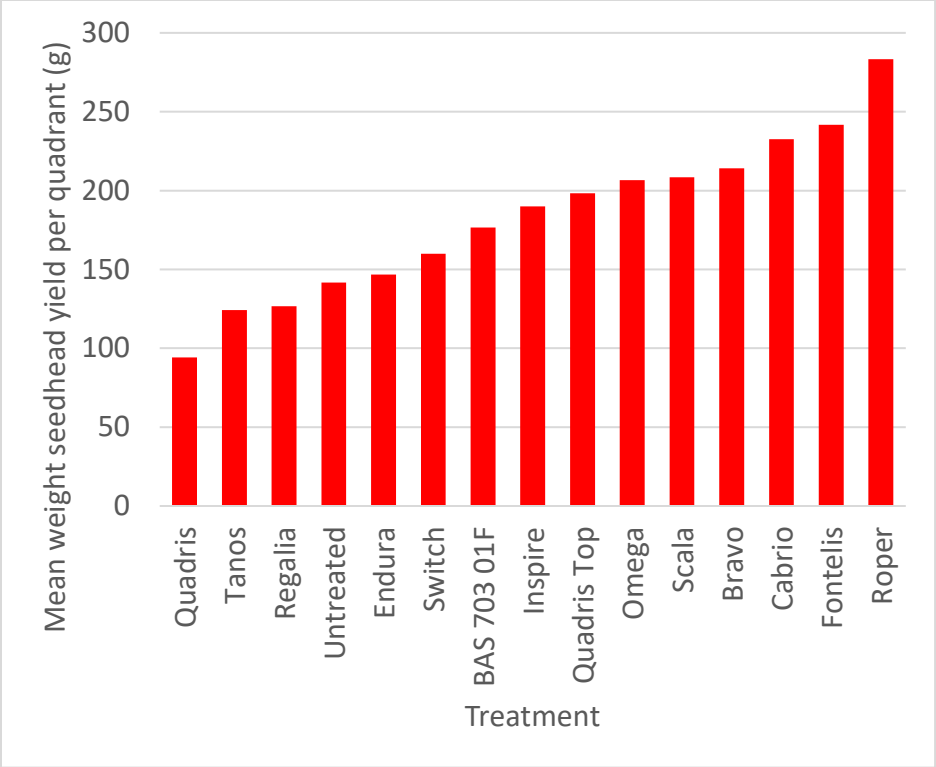


**Figure 4. Mean seedhead yields (g) from quadrants treated with various fungicides.**

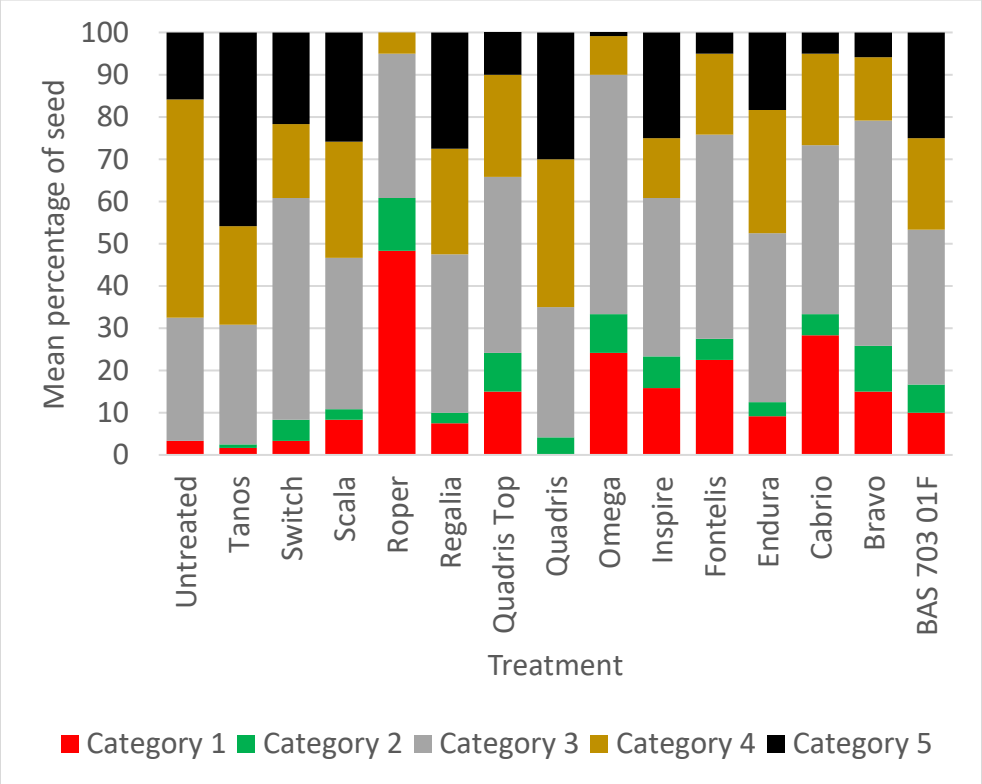


**Figure 5. Percentages of each seed quality category from quadrants treated with various fungicides.**

A trial was initiated in May 2015 in a 2-year-old ginseng garden to determine the effectiveness of various nonregistered fungicides and biocontrol/biopesticides against Alternaria blight. Applications Treatments were applied every 7-days from May-August. Treatment beds consisted of 10 ft. of bed length with a 2 ft. buffer between treatments. Each treatment was replicated four times in a block design. To determine efficacy of the treatments for control of Alternaria leaf blight, number of infected plants per plot (incidence) and disease severity (rating scale 1-10: 1=0-10% foliage in plot covered in lesions, 2=11-20%, 3=21-30%, 4=31-40%, 5=41-50%, 6=51-60%, 7=61-70%, 8=71-80%, 9=81-90%, 10=91-100%) were recorded biweekly throughout growing season.

Endura WG was included as an industry standard, however, results from this trial was surprising as the product was not effective in limiting infection compared to the untreated control. The experimental Luna products were, for the most part, highly efficacious. In recent months, products Luna Sensation and Luna Privilege have been registered for use on ginseng in Wisconsin. Data from this experiment was used when determining to recommend Luna Sensation as it was the most effective product tested in this trial. Data from this experiment was also used when lobbying for Luna Experience to be given an 'A' priority at the 2015 IR-4 Food Use Workshop. As an 'A' priority product, the residue studies have been initiated in Wisconsin with the eventual full registration of the product as the final goal. Experimental product GWN-10411 was not effective and will not be tested in future studies. The biocontrol products Thyme Guard, Serenade ASO, and PreStop were tested alone and in rotational programs. In both cases, application of these products were not effective in limiting Alternaria blight. The addition of the biocontrol products into a rotational programs resulted in severity and the number of infected plants significantly higher when compared to some standard fungicide treatments. This trial was a stop at the 2015 Ginseng Field Day and data and pictures from this trial were presented to growers at the 2016 Ginseng Winter Research Meeting.

**Table 9. Evaluation of nonregistered and biocontrol products against Alternaria blight on 2-year-old ginseng.**

| Treatment[1] and rate/50 gal/acre, applied at 7-day intervals | Disease severity[2] | | Infected plants |
|---|---|---|---|
| | 7/19 | 8/12 | (no.) |
| Untreated control | 6.0 de[3] | 5.3 c-f | 259.8 e |
| Endura WG 4.5 oz. | 6.5 de | 6.5 e-g | 221.8 de |
| Luna Experience 12 fl oz. | 2.8 a | 2.8 ab | 74.8 ab |
| Luna Sensation 7.6 fl oz. | 2.5 a | 2.5 a | 58.8 a |
| Luna Tranquility 11.2 fl oz. | 4.8 b-d | 5.3 c-f | 153.3 b-d |
| Luna Privilege 2.81 fl oz. | 5.3 c-e | 5.0 c-e | 186.3 cd |
| GWN-10411 10 fl oz. | 5.0 b-d | 4.5 b-d | 190.0 cd |
| Aprovia Top 8.5 fl oz. | 3.3 ab | 2.5 a | 117.0 a-c |
| Thyme Guard 0.25% v/v | 5.5 c-e | 5.5 d-g | 238.5 de |
| Serenade ASO 6 qt | 6.3 de | 7.0 fg | 215.5 de |
| PreStop 1000 g | 7.0 e | 7.3 g | 219.0 de |
| Endura 70WG 4.5 oz. + Bravo WeatherStik SC 2 pt<br>*-alt-* Thyme Guard 0.25%<br>*-alt-* Merivon SC 5.5 fl oz. + Dithane DF 2 lb. | 4.0 a-c | 3.5 a-c | 154.0 b-d |
| Endura 70WG 4.5 oz. + Bravo WeatherStik SC 2 pt<br>*-alt-* Serenade ASO 6 qt | 4.8 b-d | 4.0 a-d | 229.3 de |

| | | | | |
|---|---|---|---|---|
| -*alt*- Merivon SC 5.5 fl oz. + Dithane DF 2 lb. | | | | |
| Endura 70WG 4.5 oz. + Bravo WeatherStik SC 2 pt | | | | |
| -*alt*- PreStop 1000 g | | | | |
| -*alt*- Merivon SC 5.5 fl oz. + Dithane DF 2 lb. | 4.0 a-c | 3.5 a-c | 229.8 | de |

[1]-*alt*-=alternate.
[2]Rated on a scale of 1-10, where 1=no disease, 2-9=various degrees of infection, 10=100% defoliation
[3]Column means with a letter in common are not significantly different (Fisher LSD t Test; *P*=0.05).

## III. Goals and Outcomes Achieved

**Goal: Test seed treatments as a means to exclude pests.**

The first ever large-scale replicated ginseng seed treatment study was conducted with a grower cooperator in Wisconsin. Thirteen registered, experimental, and biological treatments were tested against an untreated control to determine their overall effect on germination and plant health. Notably, some treatments such as the grower standard treatment and products such as Wrangler and Actinovate resulted in numbers similar to the untreated seed. Other treatments, however, such as Quadris and experimental product oxathiapiprolin resulted in stand counts statistically higher than the untreated control. The implication that some products resulted in 'hardened seed', or seed that takes one extra year to germinate, was not observed as the 2016 counts resulted in relatively similar counts compared to those done in 2015. These plots will continue to be observed for signs of increased root vigor and yield. The data from this trial has been used to devise a seed treatment plan that was presented to growers at the 2016 Ginseng Winter Research Meeting.

**Goal: Test compost and other biorational materials against root rot organisms.**

Four compost materials were collected from WI and tested in greenhouse studies to determine their effect on root health and size. Results from the 2014 compost greenhouse studies gave some insight on the possible negative effect they might have on ginseng health and to determine their overall safety, the 2015 trial protocols were amended to look more closely at their composition. Results from the 2015 greenhouse experiments confirmed the preliminary results; the addition of compost material can be beneficial or have a negative effect on root health. The testing of composting materials showed that high levels of some nutrients, such as carbon and iron, were associated with the compost products that were harmful. Going forward, we are recommending that compost materials are tested prior to their application. At this point, we have not identified a compost material or biorational product that reduces root by at least 50%, however, possibly more importantly; we have identified compost materials that are likely to increase root rot by more than 50%. Further research on how the materials are associated with disease suppression will be conducted in 2016. All results from the 2015 greenhouse study, including the nutrient evaluation, were presented to growers at the 2016 Ginseng Winter Research Meeting.

**Goal: Develop pesticide recommendations for growers that protect the crop AND allow it to be exported with minimal or no chemical residues at harvest.**

Evaluation of products for efficacy against foliar blights was initiated in 2015. The biocontrol and biopesticide products tested against Alternaria blight were not effective and will not be included in future studies. The use of multiple products in a TOMCAST program was highly efficacious while limiting the overall number of fungicide applications and preventing the detection of residues. Insecticides and fungicides were applied to 2- and 3-year-old ginseng gardens starting in 2014. Fungicides were applied at 7-, 14-, or 21-day intervals resulting in the final application being applied in July or August and a different pre-harvest interval for each treatment. Insect and disease

symptoms were not observed on any of the plants in these studies. Endura and Quadris treatments resulted in residues exceeding the MRL, which was surprising as the products were applied in accordance to the label. This information has been used to assist growers in reducing applications of these products in 2016. The insecticide Lorsban was detected in some samples from this study. Currently, there is no MRL for this product as it was registered in WI under a special local need 24(c) label. All of the trials in this report were visited at the 2015 Ginseng Field Day and data and graphs were presented at the 2016 Ginseng Winter Research Meeting.

**Goal: To disseminate research findings to growers, including Hmong growers, so that they may be incorporated into the grower's production plan in a timely manner.**
**a. Performance Measure: The number of growers present at extension events will be counted. The number of broadcasts on the Hmong community radio program will be recorded.**
On August 7th, despite heavy rains occurring throughout the day, over 100 growers, industry representatives, legislators, and researchers attended the 2015 Ginseng Research Field Day. Approximately 20 Hmong growers were among the attendees. Growers observed various research trials including the plots associated with the FY2014 WI Block Grant. In particular, the seed treatment and the Alternaria blight trials were discussed in length by Dr. Mary Hausbeck (Fig 6).

Research results were presented at the winter ginseng growers' meeting held in Wausau, WI on April 2nd, 2016. Over 110 growers and industry representatives attended the all-day meeting. Topics discussed during the meeting included seed treatments, how the environmental can increase Alternaria blight infection, residues, and which symptoms are associated with the various pathogens of ginseng. Approximately 20 Hmong growers were in attendance. Growers were given handouts with the results from each experiment.

**Figure 6. Ginseng growers listen to research results during lunch at the 2015 Field Research Day.**

The GBW Newsletter was distributed to 175 growers during the reporting time period. Email alerts were sent to 55 growers and text alerts were sent to 63 ginseng growers. Surveys were distributed to growers at the 2016 Ginseng Winter Research Meeting. The tabulated results of this survey are described below (Table 10). A total of 65 surveys were collected. Results of the survey were very encouraging and show a high integration of the research conducted and grower participation. In particular, the results show that pesticide concerns influence pest control strategies with 85% of growers. This shows that growers are aware the some products are likely to cause residues even if labeled for crop use. We are also encouraged to see that people are

highly connected with the information on the website with 91.4% of growers aware of the spray calendar recommendation and >70% of growers getting the emailed 'Disease Alerts'.

**Table 10. Survey results from the 2016 Ginseng Winter Research Meeting (65 respondents).**

| Questions | Yes | No |
|---|---|---|
| Do pesticide residue concerns influence your pest control strategies? | 85.5% | 14.5% |
| Are there products currently labeled for ginseng that you do not apply due to residue concerns? | 27.3% | 72.7% |
| Has the information that pesticide residues are more likely to be detected from certain products resulted in using these products less or differently? | 72.7 | 27.3 |
| Do you treat your seed with fungicides prior to planting or stratification? | 100% | 0.0% |
| Are you aware that on the Ginseng Board of Wisconsin website, a weekly fungicide recommendation calendar for May-September is posted as a tool to help growers with their disease control programs? | 91.4% | 8.6% |
| Have you ever used the weekly disease control program recommendation calendar posted on the GBW website as a tool in your own disease control program? | 78.9% | 21.1% |
| In 2015, did you receive the emailed 'Disease Alerts' that were sent from the Ginseng Board of Wisconsin? | 70.7% | 29.3% |

**B.** See above info

## IV. Beneficiaries

The beneficiaries of this project were the ginseng growers, the associated industries and groups that buy or sell ginseng, and companies that supply the industry. Educating the 150 ginseng growers on the possible risk of some compost products and their association with root diseases may help growers avoid this problem. If a grower was to use a compost product that was detrimental, research results show that plant death is likely to be 50%, or about $65,000 per acre in losses. The ability of some fungicides to increase seed yield might help growers avoid purchasing seeds at ~$50/lb., or $5,000 per acre. Growers are less likely to use products such as Lorsban and Endura in the future, resulting in less products being denied sale due to residue detections of the established MRLs. The residue information is also helpful to buyers, sellers, and exporters of ginseng as they are often the ones who deal with residue problems. Hmong grower participation at the Field Day and Winter Research Meeting has increased and the special research sessions for Hmong growers was helpful in targeting information most helpful to their needs.

## V. Lessons Learned

Due to the late frost event in May of 2015, one of the two seed treatment trials was negatively affected to the point that meaningful data collection would be impossible. Although this was unfortunate, the surviving seed treatment trial was excellent and resulted in data that will be useful to growers and registrants (Table 1).

Results from the 2014 greenhouse compost trials were not as conclusive as expected. In particular, we felt that in the inclusions of biopesticides drenches, pathogens inoculations, and multiple compost products resulted in too many variables within a single experiment. We did,

however, notice from the 2014 trials, that the various compost materials could be more detrimental to ginseng health then helpful in controlling pathogens. To help determine the effect of these compost products, the 2015 trials were amended to include just the single variable. More replications were also included in the 2015 trials so that statistical differences would be more evident. The results from the amended experiment (Tables 2 & 3) clearly show that some compost products can be helpful, while others can be harmful to ginseng.

The results from the residue studies will help shape future experiments. In particular, it appears that certain products are likely to result in residues, independent of the timing and number of applications.

## VI. Additional Information

**Ginseng Board of Wisconsin Newsletter Articles:**

- A PEEK AT THE 2014 FIELD RESEARCH RESULTS- Dec 2014
- The Spring Growers' Meeting Offers the Latest Disease Research and Recommendations- March 2015
- Managing Disease in Gardens Affected by Frost-June 2015
- It's Not Too Early to Think about Next Year's Crop- September 2015
- Let the Silver Bells Ring but Keep the Rusty Root Out….
  and Other End-of-the Year Thoughts on Ginseng-December 2015
- Don't Miss the Spring Growers' Meeting on April 2!-March 2016

**Workshops/Tours:**

2015 Ginseng Research Field Day, research trials tour at grower-cooperators' farms, August 7th, Wausau WI (~100 attendees).

2016 Ginseng Winter Research Meeting, presentation of 2015 trial results. April 2nd, Marathon City, WI (~110 attendees).

**Presentations:**

'Seed Treatment Results and Recommendations' B.R. Harlan and M.K. Hausbeck, Ginseng Winter Growers' Meeting, Marathon City, WI, April 2nd, 2016.

'Know the New Products for 2016' M.K. Hausbeck, Ginseng Winter Growers' Meeting, Marathon City, WI, April 2nd, 2016.

'Get the 'Rust' Out of Your Root' M.K. Hausbeck and B.R. Harlan, Ginseng Winter Growers' Meeting, Marathon City, WI, April 2nd, 2016.

## VII. Contact Info

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# 7) Developing web-based pest and disease forecasting tools for enhanced management of vegetable crops in Wisconsin (FY14-007)

**Report Date:** October 30, 2017

## I. Project Summary

**A.** Potato and vegetable specialty crops grown in WI comprise significant acreage and a combined value of nearly $6.3 billion employing over 35,000 Wisconsin residents. The value of onion and carrot crops alone has increased significantly from 2010 to current due to an increase in acreage, yield per acre, and overall return. In each year, environmental conditions can vary greatly, affecting growing conditions and promoting insect incidence and several aggressive foliar diseases including, Alternaria and Cercospora leaf blight in carrot, Botrytis and Downy Mildew in onion, and early and late blight in potato which can result in yield losses. The anticipation of insect and disease risk through the identification and monitoring of critical environmental factors can enhance management by optimizing the timing of pesticide applications.

Our project aimed to mitigate pest and disease risk statewide by developing and validating pest and disease forecasting tools to trigger the application of protectant pesticides using forecasted weather data. The disease and pest "risk forecasts" were made available to vegetable producers in the UWEX-Vegetable Crop Updates newsletters and at the UW-Vegetable Pathology and Entomology websites. The value of use of the forecasts were discussed at educational conferences and workshops. This project built directly on the efforts of our related Project 13-004 from 2013. We created 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. Our efforts in gaining broad adoption of tools for mitigating pesticide usage in specialty vegetable and potato crops spanned both organic and conventional production systems.

**B.** This project built upon efforts previously supported in specialty crop block grants (FY-2012, FY-2013) and continued effort was placed on building infrastructure needed to develop a graphical user interface (GUI) that is accessible to the vegetable growers of WI.

## II. Project Approach

Specific Objectives:

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

We conducted field experiments that were described in both the FY-2012 and FY-2013 work plans. Field experiments were used to validate results obtained in the field experiments conducted in 2013. Regression analysis was used to determine if action thresholds calculated using forecasted weather data were consistent with those calculated using field-based weather data. Action thresholds calculated using forecasted and field-based data were consistent. A correction factor was developed to best correlate NAM-derived with field level predictions.

***Carrot diseases:*** To evaluate our large scale TOM-CAST model, a carrot cultivar that is susceptible to foliar diseases was planted at the UW Hancock Agricultural Research Station, Hancock, WI. Research plots were scouted each week to determine when 1% disease severity occurred, which dictated the need for first fungicide application. Each week, research plots received fungicide-treatments as prompted by the forecast tool, driven by field-based weather data, and were evaluated for disease. AUDPC and final yield data were collected and analyzed to determine if the TOM-CAST model is effective at limiting disease and maintaining yield. Foliar disease incidence was very low during the 2014-2016 production seasons.
***Onion diseases:*** In 2014-16, we attempted to evaluate 2 disease forecasting models for onion, BLIGHT-ALERT and DOWNCAST, in order to compare for their potential to forecast and manage Botrytis and downy mildew, respectively. These models use different environmental cues to calculate an action threshold. We ran the models with remotely sensed data, and compared the 2 models within-field weather data. During the two years of trialing, we did not observe downy mildew on onion in the study location. Further, our in-field weather station was damaged during commercial field management efforts resulting in some missing data; this event further supported need for a regional NAM-based weather data-driven forecasting tool!

**2. Build a weather database to be used to drive disease and pest forecasting models**

In order to create our internet-based GUI, our computing infrastructure, hardware and software, was upgraded and developed, respectively. General infrastructure enhancements included: 1) Updates to computing hardware (i.e. computers and server) that currently ingest, house, and calculate the weather-based disease forecasts. 2) Updates to the computer software that is currently used for database management. This includes updates to the customized computer programs that were written to ingest weather data and implement the weather based forecasting models. 3) Continued development of applications for the GUI that growers can use to access the weather database directly from their home computers. In 2014, we worked with a computer scientist to write the computer code to speed up weather data downloads, implement the weather-based pest and disease models described in this proposal, and we created a dynamic internet-based GUI that growers can access to view disease and pest forecasts specific to their farm.
***Database creation*.** A server contracted by the Vegetable Pathology laboratory at UW-Madison is 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 PostgresSQL 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. In addition to the NAM forecasted weather data, observed weather data for the integrated surface weather database (ISD) were incorporated into our local weather database.
***Model implementation.*** Computer code that implements the TOM-CAST, BLIGHT-ALERT, and degree-day models based on the NAM 12km weather model and ISD weather data 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 were calculated using field-observed data. Regression

analysis was used to determine if there was a discrepancy between the action thresholds calculated using NWS weather data and those using field-based weather data. Finally, a correction factor was 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 were collected and analyzed to determine if the TOM-CAST model, driven by NWS weather data, is effective at controlling disease.

***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 Caracal, LLC, an internet-based GUI was created to automate the functionality of the database. This GUI was temporarily 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. Since 2015, we have partnered with Adorable IO LLC in Madison WI to take on the GUI development in a contemporary programming code for ease of maintenance and advancement.

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

In 2014, there was an increased effort in the development of extension-based materials with the goal of increasing awareness and adoption of this new management tool among the vegetable growing community. In 2013 and 2014, this project was introduced and discussed at the Annual Wisconsin Potato and Vegetable Growers Association (WPVGA) / UW Extension Annual Muck Meeting and the Central Wisconsin Processing Crops Meeting and has been met with interest from vegetable producers. In 2013, we began sharing web-based forecasts in a static format (Appendix 2) at the UW-Vegetable Pathology website. Results were also offered in the weekly UWEX Vegetable Crops Updates Newsletters with positive response. The introduction, to occur in 2014, and linking of the internet-based GUI disease management tools to the UW Vegetable Pathology and Entomology websites will aid in further dissemination of the research results and increase the adoption of the weather based spray programs.

***Commodity meetings.*** Presentations at commodity meetings reach large audiences. The PIs annually deliver presentations at multiple commodity meetings that reach nearly all target audiences in participating states and beyond. PIs presented information on the mechanics, efficacy, and economics of adopting forecasting models for disease management of muck crops. As stated above, we created a website that provided a GUI that allowed growers to access disease and pest forecasting model outputs. This website was integrated into the current UW Vegetable Pathology and Entomology websites and will provide a tool that vegetable growers in the state of Wisconsin can use to better manage their crops. The functionality of this new tool was discussed and demonstrated at commodity meetings.

***Extension publications.*** Growers, extension field faculty, and crop advisors rely heavily on annually revised, pest management recommendations. As specific tactics are tested and validated in field trials, forecast-driven practices will be highlighted in the weekly Vegetable Crop Updates newsletter and posted online. Results will also be used to create new or update existing extension pest management publications. For example, the *Biointensive IPM Carrot Workbook* was updated to include forecast-driven practices developed during this project.

***Field days and grower contacts.*** Annual field days at stations are an important educational venue that allows growers and clientele to observe first hand, research methods and results from field studies. We recognize the importance of peer-to-peer sharing of information and understand that early adopters will be crucial in effecting change in the industry. Active participation of

growers, county extension faculty, and crop advisors in on-farm research and workshops will enhance their understanding of IPM and facilitate peer learning.
***On-farm tests.*** Our on-farm research collaboration with Miller and Gumz Farms aids in the successful completion of our research objectives and serves as a point-of-entry for implementing new management strategies. For example, they directly engage growers in new technology and demonstrate advantages of adoption. Growers often rely on other growers as a source of information for pest management advice. By conducting on-farm tests with leaders of the industry we took advantage of this dissemination mechanism.

## III. Goals and Outcomes Achieved

**A.** A major undertaking of the project was the development of a weather database to house and manipulate the weather data that is used to forecast disease and pest risk (what we have referred to as building the 'infrastructure' for disease and pest forecasting). However, it is important to reiterate that, once obtained, the weather data can be used to drive multiple disease and pest models which were optimized for WI and can be added to, over time. ***During 2014-2017, we created and launched the internet GUI and we prepared extension-based materials to increase awareness and adoption of the new pest and disease forecasting tools. While we conducted field research to validate the NAM-based disease forecasting tools for onion and carrot, the 2 years in which we ran the trial weren't conducive to the diseases of interest.***

**B.** As per our objectives, we 1) advanced adoption of a modified TOM-CAST disease forecasting model into commercial carrot production & evaluate forecasting models for foliar diseases and pest of carrot and onion, 2) built a weather database to be used to drive disease and pest forecasting models, and 3) developed and disseminated extension material to producers.

## IV. Beneficiaries

This project directly benefited producers of onions, carrots, potatoes, and associated processing industries in the state of WI Currently, there are 140 members in the WPVGA and this project may influence those members that grow carrots, onions, and potatoes and has the potential to impact additional growers and gardeners who are not WPVGA members, but grow vegetables in WI. Refining pest management strategies and improving the quality of vegetables produced will increase crop competitiveness and value in the processing and fresh market sectors. WI carrot, onion, and potato growers will directly benefit from improvements made to pest and disease management practices, decreases in pesticides costs, increases in crop value due to enhanced quality, and expansions of secure market opportunities. Vegetable farms in WI typically employ several people that support crop production and distribution. Statewide, hundreds of people are employed by companies with ties to vegetable production, promoting economic opportunity in rural and suburban areas.

Nearly all WI vegetable-producing farms and their allied industries will benefit from this research. Most onion, carrot, and potato farms raise other vegetable and specialty crops that are essential for diversifying the WI agricultural industries.

Maintaining the muck vegetable crop industry at its current acreage and production value of more than $14 million will impact the farm gate value of WI agriculture. The improved competitiveness of the onion and carrot processing industries due to enhanced end product quality provides stable employment opportunities for several hundred WI residents. The value of sustainably produced vegetables is difficult to estimate, but the WI carrot and onion industries are well positioned to capture added value through the Healthy Grown program and close proximity to 25 million US citizens.

## V. Lessons Learned

Our team learned about the advantages and disadvantages of partnering with free-lance computer coders. Unfortunately, our first contract with Caracal, LLC, was a significant set-back on our early progress. Once we got on track with Adorable IO, LLC, we were able to begin building our efforts in a contemporary coding language that others will more easily be able to modify to retain relevance of our work in to the future.

## VI. Additional Information

***Grower education conference proceedings:***

Frost, K.E., Groves, R.L., Jordan, S.A**., Gevens, A.J.** 2014. The development of a web-based tool for carrot disease forecasting. *In* Proceedings of Wisconsin's Annual Potato Meeting, UW-Madison College of Agriculture and Life Sciences, Research Division and UWEX, Feb. 5-7, Stevens Point, WI, 27:131.

***Vegetable Crop Updates Newsletters:***

**Gevens, A.J.** 2017. Vegetable disease update: early blight and late blight of potato disease forecasting information, national and WI late blight updates, national and WI cucurbit downy mildew updates. *Wisconsin Crop Manager*, Vegetable Crop Updates #23. September 17.

**Gevens, A.J.** 2017. Vegetable disease update: early blight and late blight of potato disease forecasting information, national and WI late blight updates, national and WI cucurbit downy mildew updates, Phytophthora crown and fruit rot of vegetables. *Wisconsin Crop Manager*, Vegetable Crop Updates #22. September 10.

**Gevens, A.J.** 2017. Vegetable disease update: early blight and late blight of potato disease forecasting information, national and WI late blight updates, national and WI cucurbit, basil, and onion downy mildew updates. *Wisconsin Crop Manager*, Vegetable Crop Updates #21. September 4.

**Gevens, A.J.** 2017. Vegetable disease update: early blight and late blight of potato disease forecasting information, national and WI late blight updates, national and WI cucurbit downy mildew updates. *Wisconsin Crop Manager*, Vegetable Crop Updates #20. August 26.

**Gevens, A.J.** 2017. Vegetable disease update: early blight and late blight of potato disease forecasting information, national and WI late blight updates, national and WI cucurbit downy

mildew updates, varied vegetable disease updates. *Wisconsin Crop Manager*, Vegetable Crop Updates #19. August 18.

**Gevens, A.J.** 2017. Vegetable disease update: potato and tomato late blight update. *Wisconsin Crop Manager*, Vegetable Crop Updates #18. August 15.

**Gevens, A.J.** 2017. Vegetable disease update: early blight and late blight of potato disease forecasting information, national and WI late blight updates, national and WI cucurbit downy mildew updates, first report of onion downy mildew in WI. *Wisconsin Crop Manager*, Vegetable Crop Updates #17. August 11.

**Gevens, A.J.** 2017. Vegetable disease update: potato early and late blight disease forecasting, updates on late blight in WI and nationally, updates on cucurbit downy mildew. *Wisconsin Crop Manager*, Vegetable Crop Updates #16. August 4.

**Gevens, A.J.** 2017. Vegetable disease update: potato early and late blight disease forecasting, updates on late blight in WI and nationally, updates on cucurbit downy mildew, blackrot of cabbage, bacterial diseases of tomato. *Wisconsin Crop Manager*, Vegetable Crop Updates #15. July 29.

**Gevens, A.J.** 2017. Vegetable disease update: potato early and late blight disease forecasting, updates on late blight in WI and nationally, updates on cucurbit downy mildew, managing powdery mildew in cucurbit crops. *Wisconsin Crop Manager*, Vegetable Crop Updates #14. July 22.

**Gevens, A.J.** 2017. Vegetable disease update: potato early and late blight disease forecasting, updates on late blight in WI and nationally, updates on cucurbit downy mildew, Phytophthora crown and fruit rot in vegetables, first detection of hop powdery mildew for WI. *Wisconsin Crop Manager*, Vegetable Crop Updates #13. July 14.

**Gevens, A.J.** 2017. Vegetable disease update: copper applications in response to hail damage in potato and vegetable crops, potato early and late blight disease forecasting, updates on late blight in WI and nationally, updates on cucurbit downy mildew. *Wisconsin Crop Manager*, Vegetable Crop Updates #12. July 8.

**Gevens, A.J.** 2017. Vegetable disease update: potato early and late blight disease forecasting, updates on late blight in WI and nationally, updates on cucurbit downy mildew. *Wisconsin Crop Manager*, Vegetable Crop Updates #11. June 29.

**Gevens, A.J.** 2017. Vegetable disease update: potato early and late blight disease forecasting, updates on late blight in WI and nationally, updates on cucurbit downy mildew. *Wisconsin Crop Manager*, Vegetable Crop Updates #10. June 23.

**Gevens, A.J.** 2017. Vegetable disease update: potato early and late blight disease forecasting, updates on late blight in WI and nationally, updates on cucurbit downy mildew. *Wisconsin Crop Manager*, Vegetable Crop Updates #9. June 16.

**Gevens, A.J.** 2017. Vegetable disease update: potato early and late blight disease forecasting, updates on late blight in WI and nationally, updates on cucurbit downy mildew, blackleg updates, considering Phostrol for potato disease control, hop disease update. *Wisconsin Crop Manager*, Vegetable Crop Updates #8. June 10.

**Gevens, A.J.** 2017. Vegetable disease update: Updates for cucurbit downy mildew and late blight, disease forecast information for late blight and early blight of potato, fungicide considerations for cucurbit downy mildew. *Wisconsin Crop Manager*, Vegetable Crop Updates #7. June 3.

**Gevens, A.J.** 2017. Vegetable disease update: late blight and cucurbit downy mildew updates, early blight forecasting information, request for potato soil samples for Dr. Richard Lankau. *Wisconsin Crop Manager*, Vegetable Crop Updates #6. May 31.

**Gevens, A.J.** 2017. Vegetable disease update: updates on cucurbit downy mildew and potato/tomato late blight, updated fungicide list for potato late blight in Wisconsin. *Wisconsin Crop Manager*, Vegetable Crop Updates #5. May 22.

**Gevens, A.J.** 2017. Vegetable disease update: potato cull pile destruction law reminder, national updates on status of late blight and cucurbit downy mildew, updated fungicide list for downy and powdery mildew of hop. *Wisconsin Crop Manager*, Vegetable Crop Updates #4. May 13.

**Gevens, A.J.** 2017. Vegetable disease update: special pesticide registration updates, national late blight updates, review of blackleg pathogens on potato. *Wisconsin Crop Manager*, Vegetable Crop Updates #3. May 7.

**Gevens, A.J.** 2017. Vegetable disease update: welcome and review of disease forecasting concepts, hop crop status updates, introducing Dr. Yi Wang of UW-Horticulture. *Wisconsin Crop Manager*, Vegetable Crop Updates #2. April 30.

**Gevens, A.J.** 2015. Early season vegetable diseases. Introducing disease forecasting tools useful to Wisconsin. *Wisconsin Crop Manager,* Vegetable Crop Update #3. April 10.

**Gevens, A.J.** 2014. *Wisconsin Crop Manager,* Vegetable Crop Updates Disease Supplement #1. Updates on Late Blight Disease Forecasting. June 24.

**Gevens, A.J.** 2014. Vegetable disease update: Early Season Disease Management Considerations in Vegetable Crops, Disease Forecasting Introduction. *Wisconsin Crop Manager,* Vegetable Crop Update #2. April 16, 2014. Spanish Version Available Online.

***Oral Presentations:***

| | 2015 | |
|---|---|---|
| 1. | Jan 26 | ***Late blight and downy mildew updates in vegetable crops.*** Wisconsin Fresh Fruit and Vegetable Growers Conference, Wisconsin Dells, WI. Kalahari Conference Center. |
| 2. | Jan 15 | ***Web-based pest and disease forecasting tool for enhanced processing vegetable*** |

| | | |
|---|---|---|
| | | ***crop management.*** Wisconsin Crop Management Conference, Madison, WI. Alliant Energy Center. |
| 3. | Jan 15 | ***Late blight and downy mildew updates in processing vegetable crops.*** Wisconsin Crop Management Conference, Madison, WI. Alliant Energy Center. |
| 4. | Jan 26 | ***Late blight and downy mildew updates in vegetable crops.*** Wisconsin Fresh Fruit and Vegetable Growers Conference, Wisconsin Dells, WI. Kalahari Conference Center. |
| 5. | Dec 2 | ***Updates in management of processing vegetable crops.*** Midwest Food Processors Association. Processing Crops Conference. Wisconsin Dells, WI. |
| 6. | May 11 | ***Integrated disease management in sustainable potato production.*** Healthy Grown. Hancock Agricultural Research Station. Hancock, WI. |
| 7. | Mar 5 | ***Vegetable disease updates.*** 2015 Commercial Vegetable Update. Clark County University of Wisconsin Extension. Thorp Fire House. Thorp, WI. |
| 8. | Mar 4 | ***Late blight updates and a new web-based disease forecasting tool for Wisconsin.*** Central Wisconsin Processing Crops Conference. Hancock Agricultural Research Station. Hancock, WI. |
| | 2014 | |
| 1. | Dec 3 | ***Late Blight Updates for Wisconsin.*** Midwest Food Processors Association. Processing Crops Conference, Wisconsin Dells, WI. |
| 2. | Aug 25 | ***Late Blight Updates for Wisconsin.*** Special grower/industry meeting to address increased incidence of late blight in Central Sands, WI. UW-Hancock Agricultural Research Station. Hancock, WI. |
| 3. | Aug 21 | ***Potato Disease Research & Extension Updates.*** Antigo Potato Field Day. UWEX Langlade County Research Station. Antigo, WI. |
| 4. | Aug 5 | ***Potato & Vegetable Research and Extension Program Updates.*** Twilight Garden Tour at Hancock Agricultural Research Station. Hancock, WI. |
| 5. | Jul 25 | ***Late Blight and Vegetable Disease Updates.*** Wisconsin Horticulture Updates Conference Call. Madison, WI. |
| 6. | Jul 22 | ***Potato and Vegetable Disease Updates.*** Hancock Agricultural Research Station Field Day. Hancock, WI. |
| 7. | Jul 21 | ***Vegetable Disease Updates.*** UWEX-Green Lake County Field Walk. Dalton, WI. |
| 8. | Jun 19 | ***Vegetable Disease Updates.*** UWEX-St. Croix County Field Walk. SunBow Farms. Eau Claire, WI. |
| 9. | Apr 1 | ***Late Blight of Tomato and Potato: Introduction & Impact.*** University of Wisconsin-Agronomy. First Detector Training Program. Madison, WI. |
| 10. | Mar 5 | ***Updates on potato and tomato late blight***. Central Wisconsin Processing Crops Meeting, Plover, WI. |
| 11. | Mar 5 | ***Timing and selection of effective fungicides for disease control in carrots***. Central Wisconsin Processing Crops Meeting. Plover, WI. |
| 12. | Feb 5 | ***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. Stevens Point, WI. |
| 13. | Feb 5 | ***Distribution, Character, and Management of Late Blight in Recent Years.*** University of Wisconsin Extension & Wisconsin Potato and Vegetable Growers Association Grower Education Conference. Stevens Point, WI. |

## VII. Contact Info

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# 8) Farm to glass: university outreach to improve the quality of Wisconsin's fermented beverages (FY14-008)

**Report Date:** December 30, 2016

## I. Project Summary

The Wisconsin fermented beverage industry has witnessed steady growth over the last decade. The number of wineries has grown from 13 in 1999 to more than 100 in 2016. Also, demand for locally produced products and ingredients has increased. Such ingredients include hops for the state's microbreweries and apples for the state's developing fermented cider industry.

The Wisconsin Grape Growers Association (WGGA) recognized this growth trend. This rapid growth spurred concern that the quality of the state's fermented beverages was not competitive with products produced outside of Wisconsin. The WGGA further was concerned that poor quality products could harm the reputation of the developing industry and limit its potential. The industry is competing in a competitive and increasingly crowded marketplace. Poor perceptions of quality will limit acceptance from consumers and commercial customers.

This project was the first step in the development of a comprehensive Fermented Sciences Program of research, outreach, and education at UW-Madison. The development of this program is underway, and the first step was the hiring of an outreach specialist that addressed quality issues in the state's craft fermented beverages.

## II. Project Approach

The first objective of the project was to hire an outreach specialist. Nicholas Smith was selected and hired for the position. He began work in April 2015. After hiring of the outreach specialist, input was sought from the grape and wine community to determine the top quality issues. A survey was sent to the email lists for both the Wisconsin Grape Growers (WGGA) and Wisconsin Winery Association (WWA). The survey received 42 responses. Appendix A shows the survey along with a summary of the responses. Further input was obtained by the outreach specialist visiting wine makers and meeting with directors on the boards for the WWA and WGGA. Roundtables were attempted, but not completed due to limited interest, weak response, and scheduling challenges from the industry. The outreach specialist was invited to become an ex-officio board member of the WWA in September of 2016. This allows the outreach specialist and the Fermented Sciences Program to be in direct and regular contact with the board of directors of the WWA.

With the input obtained from winery visits, the quality survey, and meetings with organization directors, the outreach specialist hosted 10 workshops between July of 2015 and May of 2016. Summaries of the workshops and statistics are presented in the next section. The workshops attracted a total of 148 attendees. Electronic surveys were sent to all the participants following the workshops. An example of the post workshop survey can be seen in Appendix B. All surveys asked the participants if they had learned ways to improve the quality of their wine. Of

those that responded, all said they had learned ways to improve the quality of their wine. Response to these surveys was low however, with only 36 respondents, or 24% of the total attendees. While the electronic surveys are convenient, it may be more useful to have written assessments available at the end of the workshop. This way the organizer can hand out the evaluations and encourage completion. Online surveys can be more easily ignored and be overlooked in email browsers.

Outside of workshops hosted by UW-Madison and the outreach specialist, the outreach specialist participated in events and workshops hosted by the WWA, Wisconsin Vintners Association (WVA) and WGGA. The outreach specialist worked with the executive director of the Wisconsin Fresh Fruit and Vegetable Growers Conference to identify topics and speakers. The outreach specialist has participated in these tasks for the 2016 and 2017 conferences. Beyond assisting with identifying speakers and selecting topics, the outreach specialist is also a presenter at the conference.

*Fresh* magazine is a shared publication shared by several fruit and vegetable organizations in Wisconsin. The outreach specialist has been a regular contributor with four article submissions. Topics have focused on quality issues encountered in the vineyard and winery.

Analytical services for the industry became available in 2015. The survey shown in Appendix A identified the analysis of interest by wineries and grape growers in Wisconsin. YAN analysis had the highest interest in the survey and has been the most requested service since analytical services began. The project is working on completion of a new website to help promote the services and provide further information. Analytical services for hops were also offered, but focused on research projects being performed by the Wisconsin Hop Exchange.

Working with the Wisconsin Department of Revenue, the outreach specialist obtained information regarding the state's production of wine. Using this information the outreach specialist was able to determine the total amount of wine produced in Wisconsin during a twelve month period, and rank wineries by production volume. Further work is needed to determine the amount of grapes and apples used by the wine and cider industry. Not all of the growers participate in the WGGA and may be difficult to reach. Some wineries are also not interested in sharing information regarding their fruit sourcing.

The WWA, WVA, and WGGA have worked with the outreach specialist and Fermentation Sciences Program on addressing quality issues in the state. The organizations have provided input and guidance. They have further provided opportunities for the outreach specialist to speak at organization meeting and conferences.

## III. Goals and Outcomes Achieved

Table 1 summarizes the outreach activities statistics completed by the outreach specialist.

**Table 1:** Overview of Enology Outreach Statistics for April 2015 through June 2016.

| Activity | Events | Notes |
|---|---|---|
| Site Visits | 53 | |
| Presentations | 14 | |
| Workshops | 10 | 148 Attendees |
| Articles Written | 4 | *Fresh* Magazine |
| Interviews | 5 | Cap Times, Isthmus, UW-CALS, Milwaukee Journal Sentinel, Wisconsin Public Radio |
| Pilot Brewery Projects | 15 | 4 different customers |
| Analytical Requests | 9 | 6 different customers |

Table 2 provides statistics regarding the attendance, date, location, and evaluation responses for the ten workshops hosted by the outreach specialist.

**Table 2:** Summary statistics for outreach events conducted by UW-Madison Fermentation Sciences Project

| Workshop | Date | Location | Attendees | Completed Evaluations |
|---|---|---|---|---|
| Sparkling Wine 1 | July 21, 2015 | Lowell Center, UW-Madison | 25 | 5 |
| Pre-Harvest Workshop | August 11, 2015 | Babcock Hall, UW-Madison | 20 | 4 |
| Winemakers Roundtable | October 27, 2015 | Elmaro Vineyards, Trempealeau WI | 6 | 0 |
| Sparkling Wine 2 | January 9, 2016 | Babcock Hall, UW-Madison | 20 | 6 |
| Mead Production | March 31, 2016 | Babcock Hall, UW-Madison | 9 | 2 |
| Laboratory Skills | April 1, 2016 | Babcock Hall, UW-Madison | 9 | 2 |
| Cider Production | April 20, 2016 | Babcock Hall, UW-Madison | 9 | 3 |
| Laboratory Skills | April 21, 2016 | Babcock Hall, UW-Madison | 8 | 2 |
| New Winery Workshop | April 29, 2016 | West Madison Agricultural Research Station | 27 | 4 |
| Sparkling Wine 3 | May 12, 2016 | Dancing Dragonfly Winery, St. Croix Falls WI | 15 | 8 |

The next table provides information regarding presentations and participation at events not hosted by the outreach specialist.

**Table 3**: Presentations by the outreach specialist at events hosted by organizations other than the Fermentation Sciences Program

| Event | Date | Host/Location | Presentation or involvement | Estimated Attendance |
|---|---|---|---|---|
| Spring Workshop | April 14, 2015 | WWA-Elmaro Vineyards | Assisted with Workshop | 25 |
| Spring Workshop | April 15, 2015 | WWA – Vines and Rushes Winery | Assisted with workshop, gave a brief presentation | 30 |
| WVA Monthly Meeting | April 8, 2015 | WVA, Milwaukee | Introduction of outreach specialist | 30 |
| Cold Climate Winemaking | April 25, 2015 | Colorado State University, Grand Junction CO | Producing Wine from Cold Climate Grapes | 10 |
| WWA Spring Membership Meeting | May 4, 2015 | WWA – River Bend Winery, Chippewa Falls WI | Sulfide Production in Wine | 30 |
| WVA Workshop | June 27, 2015 | WVA - Milwaukee | Assisted with workshop on fermentation | 15 |
| Plant Pathology Seminar | September 8, 2015 | UW-Madison | Fermentation Science Program and Current Research on Cold Climate Grapes | 40 |
| Beloit College: Chemistry Class | September 17, 2015 | Beloit College | Wine Chemistry and Analysis | 10 |
| Wednesday Night at the Lab | October 21, 2015 | UW-Madison | Cold Climate Wine Production in Wisconsin | 30 at the event, event also broadcasted on public television |
| WVA Monthly Meeting | December 9, 2015 | WVA - Milwaukee | Topics in Cold Climate Wine Production | 30 |
| Grape Quality Workshop | December 15, 2015 | Elmaro Vineyards, Trempealeau WI | Grape Quality and Cold Climate Grapes | 30 |
| WI Fresh Fruit and Vegetable Conference | January 25, 2016 | Wisconsin Dells, WI | Review of Wine Research at UW-Madison | 45 |
| WI Fresh Fruit and Vegetable Conference | January 26, 2016 | Wisconsin Dells, WI | Rosé | 45 |

| | | | | |
|---|---|---|---|---|
| Malolactic Fermentation | April 5, 2016 | Elmaro Vineyards, Trempealeau WI | Malolactic Fermentation and Cold Climate Wine Production | 25 |
| DIY Science | April 15, 2016 | UW-Madison, DIY Science at Discovery | Interactive Presentation on Wine Science | 30 |
| WWA Spring Meeting | May 25, 2016 | WWA – Blind Horse Winery, Kohler WI | Research and Outreach Update for Fermentation Sciences Program | 25 |

The following is a month by month recap of outreach activities that provides more detailed information regarding the outreach activity of the Fermentation Sciences Program.

**Timeline of outreach activities**

**February 2015 - March 2015.** Outreach Specialist candidates were interviewed for the position. Nicholas Smith is chosen as a finalist and accepted the position. He began work on March 28th.

**April 2015**

The Wisconsin Winery Association (WWA) hosted winery workshops at Elmaro Vineyards (Trempealeau) and Vines and Rushes Vineyard (Ripon) on April 14 and April 15. The outreach specialist attended and assisted with these workshops. He spoke on bench trial techniques and discussed the use of fining agents in wine. He further introduced himself to the industry members present. He also engaged individual members of the industry on activities the outreach program at the University of Wisconsin may offer to the industry. Also in April, the outreach specialist attended the monthly meeting for the Wisconsin Vintners Association (WVA). There he was introduced to the group. While the WVA is not a professional group, they are directly supporting the outreach program at UW. Several WVA members have established commercial operations in Wisconsin including Two Brothers Winery. Coordinating outreach programs with the WVA allows the outreach specialist to identify potential new winery owners.

During April the outreach specialist made nine site visits to wineries and cideries in the state. These visits allow commercial practitioners to discuss areas of interest regarding their facility and to discuss the needs of the industry.

Aside from seeking information on top quality issues from wineries at site visits and association workshops, the outreach specialist sent out an email survey to the entire WWA and WGGA addressing top quality concerns in the industry. The survey revealed that the largest quality concerns are oxidation and managing fermentation.

In April, the outreach specialist attended an event hosted by the Wisconsin Apple Growers Association (WAGA) on growing cider apple varieties. The event was held at Maiden Rock Winery (Stockholm).

**May 2015**
At the WWA spring membership meeting, the outreach specialist gave a technical presentation on the sources, prevention, and correction of sulfides in wine. The outreach specialist made four site visits in May, including two operations that were under development.

**June 2015**
The WVA held its annual education meeting in late June. The outreach specialist assisted with the meeting. Also during June, the outreach specialist worked with the Steele Laboratory to begin establishing research protocols that address quality issues in Wisconsin wine. Sulfide production is often the result of insufficient nitrogen content necessary to support healthy yeast activity. Protocols were developed to measure nitrogen content in fruit juice. Coordinated research efforts with the Department of Horticulture also began in June. The Department of Horticulture is performing a series of experiments at the West Madison Agriculture Research Station (WMARS). Those projects include the impact leaf shading has on fruit quality. Winemakers and growers in Wisconsin are interested in best practices for growing different cultivars of grapes. Researchers in Horticulture, including Dr. Atucha, and the Steele Lab, worked with the outreach specialist to determine research possibilities for the 2015 harvest.

The outreach specialist made thirteen site visits in June.

**July 2015**
The outreach specialist attended the American Society of Enology and Viticulture, Eastern Section, Conference in Dunkirk New York. This meeting gathers enology and viticulture researchers east of the Rockies to present and discuss their research. The outreach specialist met with researchers focused on cold climate varietals to discuss their research. He further identified potential speakers for outreach workshops and for the Wisconsin Fruit and Vegetable Growers Conference.

The outreach program offered the first installment of a three part series on sparkling wine production on July 21. The chemistry of cold climate grapes are naturally suited for sparkling wine. 25 attendees from around the state and Minnesota attended the workshop. Of those that responded to the post workshop survey, 100% indicated they increased their awareness of how to enhance the quality of their wine.

Eight site visits were conducted in July.

**August 2015**
A Pre-Harvest Workshop was offered by the outreach specialist on August 11. There were 20 attendees. The workshop focused on the science and application of sulfur dioxide in wine, as well as the implementation of healthy alcoholic and malolactic fermentations. Of those that responded to the post workshop survey, 100% indicated they had increased their awareness of how to enhance the quality of their wine. This workshop demonstrated the use of analytical procedures for wine analysis. It would further be beneficial to conduct a workshop that focuses on analytical techniques where participants can perform the methods. This workshop was held in mid-August with the intention that the information presented would be timely for harvest.

Eight site visits were conducted in August.

**September 2015**
The outreach project began offering analytical services to the wine and cider industry in September. Hops analysis has been available for multiple seasons. Wine assays includes nitrogen analysis. Insufficient nitrogen levels in fruit juice can lead to problematic fermentations. The project offers an array of analysis that are often cost prohibitive for individual wineries to perform themselves. Undergraduate students have been trained on wine analysis techniques and are performing the analysis for the industry.

Wine research trials began in September. These trials extend research conducted at WMARS. The wine research lab will evaluate the aroma differences between shaded and unshaded fruit from four different cultivars. The wines were made available for tasting at the Wisconsin Fruit and Vegetable Conference in January 2016. Under the supervision of the outreach specialist, further research was conducted by a group of undergraduates for their senior class project. The impact of temperature and skin contact on the production of Marquette and Frontenac wine was evaluated.

The outreach specialist was invited to speak at Beloit College to a class of senior chemistry students. The students were studying wine analysis techniques. The instructor invited the outreach specialist to speak on wine analysis and career options for chemistry students in the fermented beverage industry. The outreach specialist further spoke at a UW Plant Pathology graduate student weekly seminar.

**October 2015**
The outreach specialist submitted an article for *Fresh* magazine on wine issues to be addressed after primary fermentation of wine. Several wine quality issues were addressed in detail. Along with the *Fresh* article, the outreach specialist continued work on identifying and contacting speakers for the 2016 Fruit and Vegetable Growers Conference.

In October, the outreach specialist attempted a series of winemaker roundtables. These roundtable serve as an opportunity for winemakers to receive feedback on their wines and to discuss the activities of the Fermentation Sciences Program. The first roundtable was October 27$^{th}$ at Elmaro Vineyards. Five wineries from west central Wisconsin, and one winery from southeast Minnesota attended. Of those that completed the post roundtable survey, 100% indicated they had increased their awareness of how to improve the quality of their wine.

Another roundtable was scheduled for November 4$^{th}$ at Wollersheim Winery. It was cancelled however. These roundtables not only provide an opportunity to obtain advice regarding wine quality issues, but also serve as an opportunity for wineries in a region to meet and collaborate on other topics. One of the challenges of the Wisconsin wine industry is a lack of interaction and collaboration among the wineries. Roundtables and gatherings of wineries will continue to be a challenge for the project.

Six winery visits were conducted in October.

The outreach specialist also spoke on Wisconsin Wine and the Wisconsin Wine Industry for a weekly broadcasted science series held at the UW Biotechnology center, Wednesday Nite @ the Lab.

**November 2015**
Two site visits were conducted in November, both to individuals planning to start a winery. The fermentations lab worked with the Food and Drug Administration on a project involving beer and gluten. Work continued on the development of a project with Wollersheim Winery to help fund the Fermentation Sciences program. A wine is created under the Red Fusion Label. Proceeds will benefit the Fermentation Sciences Program. Students from the Food Science Department and the Department of Horticultural Sciences assisted with the Red Fusion project.

**December 2015**
Two presentations were given in December, one at the monthly meeting of the Wisconsin Vintners Association, the other at an educational event organized by Elmaro Vineyards. The Elmaro presentation was a part of a workshop on improving grape quality in Wisconsin. The outreach specialist further worked with the executive director of the Fruit and Vegetable Growers Conference to plan sessions and contact potential speakers. Work began with BevSource, a private company based in Minnesota. The company utilized the brewing research capacity of the Fermentations Lab and began contracting services.

**January 2016**
The outreach specialist hosted the second session of the Sparkling Wine Workshop Series at UW- Madison. Twenty people attended the workshop. He further helped with the winery track at the Fruit and Vegetable Growers Conference and gave two presentations at the conference. The first presentation was on the research being conducted by Horticultural Sciences regarding the impact of fruit shading on wine quality. The research project conducted by the undergraduate students examining maceration time and temperature was further presented. The second presentation was on the production of rosé wine from cold climate grapes.

**February 2016**
One site visit and one presentation at an undergraduate class. Time was spent developing content for the spring workshops.

**March 2016**
The spring workshop season began in March. The first workshop focused on mead production and featured Jon Hamilton of White Winter Winery, (Iron River, WI). This workshop had nine attendees.

**April 2016**
Four workshops were hosted at UW-Madison in April. Those workshops covered laboratory analysis, cider production, and starting a winery. There were two separate but identical laboratory workshops which had seventeen total attendees. The cider workshop had nine attendees. The cider workshop had speakers from Scott Laboratories and The Great Lakes International Cider and Perry Competition. Twenty-seven people attended the New Winery Workshop. The New Winery Workshop had multiple speakers including representatives from: DATCP, TTB, SCORE, and the UW-Madison Small Business Development Center. The outreach specialist spoke at this workshop on selecting winery equipment. Also in April the outreach specialist spoke at a workshop hosted by Elmaro vineyards on malolactic fermentation. The outreach specialist presented a workshop on Wisconsin wine for the Morgridge Institute and UW Wisconsin Alumni Research Foundation. This program has monthly DIY Science classes for the general public.

**May 2016**
The final installment of the sparkling wine workshop series occurred in May. This time it was held offsite, at Dancing Dragonfly Winery in St. Croix Falls WI. Fifteen people attended. Michael Jones of Scott Labs and Larry Mawby of L. Mawby Wines presented.
The outreach specialist presented at the monthly meeting for the Wisconsin Vintners Association and made two site visits.

**June 2016**
Four site visits were conducted.

**B. Goal:** The goal of this project is to increase the quality of Wisconsin's wines, ciders, hops/hop pellets, as well as the quality of specialty crops supplying the industry.

**Benchmark:** The outreach specialist elicits from wine makers, cider makers, and hop producers each sector's top two quality concerns.

The outreach specialist through visiting with winemakers, meeting with organization leaders, and the use of an electronic survey identified the top issues for the wine and cider industry. These issues were not identified for the hop industry.

**Performance Measure Output:** The Outreach Specialist develops educational programming in concert with industry needs that address key quality issues.

The outreach specialist developed and hosted ten workshops. The top quality issues were addressed at the workshops, even if it was not the main topic. The outreach specialist also presented at workshops hosted by the WWA and WGGA.

**Performance Measure Outcome:** The educational programming will result in the industry having increased awareness of how to enhance the quality of their projects. We will utilize web-based surveys with attendees to determine that we are achieving an, at minimum, 50% increase in awareness of attendees of how to enhance the quality of their products.

Web bases surveys were administered for attendees of workshops hosted by the outreach specialist. Of those that completed the survey, 100% indicated they had increased awareness of how to enhance the quality of their products.

**Target:** Educational programming and microbial and chemical analytical methods are developed, implemented, and evaluated that address the underlying causes of top quality concerns. Growers and fermenters have concrete steps to implement to address causes of quality issues.

Educational programming was developed and administered. Analytical methods for hops, cider, and wine were developed. Analytical services are available for the wine, grape, and cider industry. Currently hop analysis has been limited to a limited number of hop growing organizations. All services, including hops analysis, will continue to expand over the remainder of the project.

**Benchmarks:** The outreach specialist through meeting with wine makers and cider makers, and an email survey, identified top quality concerns for these industries. Wineries top issues include clean fermentations and avoiding post fermentation oxidation. While the cideries have similar concerns, their top issues are selecting, growing, and obtaining enough local cider specific apples to make cider.

## IV. Beneficiaries

Key beneficiaries of the project include the Wisconsin Winery Association, the Wisconsin Grape Growers Association, and the Wisconsin Vintners Association. Activities associated with the project are summarized in Section II. The outreach specialist has hosted ten workshops and presented at ten other industry sponsored events. Based on feedback from post workshop surveys, attendees have indicated that they have learned ways to improve the quality of their wine.

## V. Lessons Learned

Many things were learned by the outreach specialist and members of the project. Quality is a challenging goal to measure. The project attempted to establish objective methods to measure quality improvements, but a different baseline would be useful. The industry is diverse with practitioners having a wide range of knowledge and experience. Developing educational programs that serve everyone in the industry is a challenge. The industry does not have a background of collaboration or involvement and is difficult to assemble for the discussion of outreach activities. The industry is primarily made up of small facilities that are often not the primary business or source of income for the owner. These practitioners are often unable to attend industry events and workshops due to limited availability. Webinars and digital resources would better suit this section of the industry. The project needs to continue visiting wineries and continue building a relationship between the university and members of the industry. There is an interest from the industry and the project to offer analytical services. The success of the analytical lab requires continued evaluation and refinement to both meet the needs of the industry while being efficient and self-sufficient.

The primary goal of the project is to improve the quality of fermented beverages produced in Wisconsin. One of the difficulties in such an endeavor is establishing a baseline. While the project identifies, addresses, and assesses through the use of surveys the impact of outreach efforts, it does not directly measure improvements in quality. There is no definition of quality, or an objective way to measure quality. These concerns may be too difficult for a short project such as this, but these issues need attention. In Missouri for example, researchers randomly select a sampling of wines from the state's producers, and subject these wines to chemical analysis. This provides a general, but useful set of measurements to evaluate the industry over time. There is discussion between the Fermentation Sciences program and the WWA to introduce a similar process, using wines entered into the Wisconsin State Fair Wine Competition. Regardless of method, a subjective baseline to track the industry would be beneficial.

The outreach program has to continue to discover ways to address an industry with a significant gap in knowledge and experience. Winemakers in Wisconsin vary greatly in their education and experience. This proves challenging when designing workshops. Comments collected from the workshop surveys show a divide between those that feel the topics are too basic, to those that think the topics are too advanced. Workshops and educational programs need to be tailored and advertised to the appropriate audience.

Webinars and digital archives of workshops or educational programming allows for greater access to a larger audience. Not all workshops lend themselves to digital content, and some attendees prefer the in person scenario. Several lessons have been learned from the workshops offered during this program. First, there is strong price sensitivity. As workshop fees approach $50, attendance will decline. Second, avoid workshops on campus. The West Madison Agricultural Research Station has proven to be popular with attendees, as well as workshops at wineries around the state. Traffic and parking issues related to campus may discourage attendance.

Industry roundtables are referenced in the project. There was limited interest in these from the industry. In general, assembling members of the industry is a challenge. In lieu of this, I spent a lot of time visiting wineries and meeting with winemakers and owners in person. The results have been mixed. Some wineries have shown a lot of interest in the project. They attend workshops and send emails or phone calls seeking information and help. There are wineries that are interested in participation, but lack the time to attend a workshop. These are usually winemakers/owners that have full time employment and operate a winery as a side business. On the other hand, there are wineries that have reluctantly met with me and stated they have no interest in the program. Many are unaware of any issues with their wine making they need to address, or have no interest in addressing quality issues. Others still have ignored requests to meet, or flatly declined to meet.

Using data from the Wisconsin Department of Revenue, we can evaluate the size and scale of the Wisconsin wine industry. The top five largest wineries account for 60% of the state's total production. The top twenty-five wineries account for 86% of the state's total production. Which means that total production of the remaining 75 to 100 wineries accounts for less than 15% of the

wine produced. Over half of the licensed wineries in the state produce less than 1,000 cases of product each year.

I have visited many of these small facilities since beginning work as the outreach specialist. While the owners are well-intentioned individuals, they often lack some combination of education, experience, and capital. Often, these proprietors also have full time employment outside of the winery. This makes educational efforts challenging. Future workshops and educational efforts should include a webcast or recorded option. Expanding access to the educational opportunities through digital means will allow for greater access to industry practitioners. Workshops and webcasts that teach basic cellar and analytical skills would further be useful. That still leaves issues regarding insufficient capital or equipment, and experience. At the new winery workshop, I brought in experts on business planning and finance.

The project relies on responses from electronic surveys issued after the completion of a workshop. As mentioned earlier, survey response was not particularly high. Greater completion rates should be achieved. Possible methods to accomplish this may include more reminders to fill out surveys or administering the surveys in person at the end of the workshop.

Awareness of the Fermentation Program continues to grow, but many wineries are not fully aware of the services available. A new website is nearing completion that will provide more information about the program. A greater emphasis on social media may also establish a connection to the industry. Visiting the wineries remains the most impactful activity in regards to developing the relationship between the university and individual wineries. Continued visits and communication with the wineries is necessary. The establishment of the program and the outreach activities requires the outreach specialist to be in the visiting wineries and calling on them regularly. Winery owners with history of agriculture tend to be aware of university outreach and extension programs. Many of the smaller wineries, particularly winery owners that do not have previous experience in agriculture, appear to have less understanding and interest in outreach. Building relationships with the industry is a long term endeavor that will require direct interaction. The program should also be prepared for the reality that some winery owners will have no interest in the program or participating with the rest of the industry.

Another goal of the project was the establishment of analytical services. Progress was made in developing and offering these services. Many analysis have been made available to the wine industry. Response has been low, but the services have not been well advertised. As the Fermentation Sciences program finishes the development of a website, it will be easier for interested individuals to find information regarding analytical services. The slower start has been beneficial in helping identify logistical concerns. Analytical laboratories require a lot of time and resources. It remains to be seen if the fermentation lab can offer these services in a sustainable manner. A limited menu of services may need to be considered moving forward.

## VI. Additional Information

None

## VII. Contact Info

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# 9) Developing a clean propagative plant process for Wisconsin hops (FY14-009)

**Report Date:** October 30, 2017

## I. Project Summary

**A.** Hops are a labor intensive, perennial flavor crop that is typically harvested in late summer to fall of each year after yard establishment. Hops production has grown significantly in WI over the last 6 years with over 50 producers raising one half acre or more. Over a century ago, hops production in Sauk County, WI comprised 20% of world production. In the late 1800's production declined in the state due, in part, to disease limitations. Currently, WI hops growers have, by economic necessity, relied upon out-of-state sources of hops rhizomes that are not verified for pathogen-free status. As the seat of the U.S. hops industry is in the Pacific Northwest, predominant available cultivars are not necessarily best suited for the unique environmental conditions of WI or its unique craft brewing industry. The availability and establishment of pathogen-free propagative plant material promotes field production with optimum yield, quality, and environmental and economic sustainability. Further, the development of a sustainable method of rhizome production in WI for WI will limit introduction of hops pathogens and create a mechanism for further advances in identifying cultivars with regionally specific traits of interest. Demand for high quality WI-grown hops has increased with the expansion of craft beer/beverage production. With collaboration from UW Extension, UW-Plant Pathology, growers, allied processing industries, and guidance from the WI Seed Potato Certification Program, building off of our previously funded hops Block grant project, 13-003, we 1) evaluated hop varieties to identify high yielding, superior quality varieties adapted to WI; 2) standardized and gained adoption of an economically sustainable system for production of pathogen-free planting stock for WI growers, and 3) evaluated the disease status of existing hop yard plantings. Our research and development were complemented by 4) a focus on grower education. This project directly supported the growth of the WI hop industry.

**B.** With collaboration from UW Extension, UW-Plant Pathology, growers, allied processing industries, and guidance from the WI Seed Potato Certification Program, we built this project off of our previously funded hops Block grant project, 13-003, which initiated a grower-grower collaborative effort and started the clean hop rhizome process.

## II. Project Approach

We increased the number of pathogen-free hop rhizomes through the establishment of a clean production system and developed a production system conducive to identifying hop varieties adaptable to produce plants that would sustain vigor and health in a first year of field exposure and would persist into the subsequent growing season in Wisconsin. We increased awareness of new knowledge pertaining to the benefits of clean hop propagation in plant health and long term productivity of yards. We assembled a core group of producers and brewers interested in participating in the development of and earliest phases of clean rhizome production adoption. To sustain the effort, we established a process for a UW clean hop rhizome service which could be

extended into the commercial sector and become a private enterprise with market sustainability in subsequent years. We assessed success of this project through specific questions on a semi-annual hop production survey applied to growers in cooperation with UWEX county agent Carl Duley. We were able to track how many hop yards were establishing with rhizomes from our (or other) clean-tissue program. Our goal was to reach a 60% industry adoption rate of clean rhizomes (from our or other clean plant networks) in new yards in order to promote grower expectation of a 5-fold acreage increase over the next 5 years with improved yield and quality.

## III. Goals and Outcomes Achieved

**A.** Objective 1: We standardized a pathogen-free tissue culture collection of hop varieties which served as the starting point for generating planting material for variety evaluation, and for providing pathogen-free planting stock for WI hop growers. Pathogen-free hop varieties are available as tissue culture plantlets or cuttings from the Clean Plant Center of the Northwest (CPCNW) at Washington State Univ., and from the National Clonal Germplasm Repository (NCGR) in Corvallis, OR. Protocols specific to hop tissue culture maintenance have been obtained from the CPCNW and NCGR. NCGR lists 185 hop cultivars and selections in its collection, including 14 of the 21 hop varieties recently planted by WI growers. Since only small amounts of plant material are available from these two sources, we established a clonal collection at UW-Madison in order to produce sufficient quantities of pathogen-free planting material for participatory hop variety trialing by WI hop growers. Twenty-four hop varieties for on-farm evaluation were chosen in collaboration with participating hop growers and the grower advisory board.

Objective 2: We produced pathogen-free planting material for continued on-farm variety evaluations, and advanced hop rhizome production methods to optimize productivity and economic sustainability.

Our research into hop propagation methods has revealed a lack of reliable published protocols and an active and innovative grower community with keen interest in economically viable propagation methods. We frequently consulted with WI growers to define the most commonly used propagation techniques and we collaboratively design trials to compare and optimize these methods. Two major transitions occur in production of nuclear and propagation stock. Nuclear stock plants are derived from tissue culture plantlets, maintained in greenhouse conditions and used for further propagation. The standard method of transfer from tissue culture to sterilized potting medium in greenhouse conditions can result in plant losses due to the drop in humidity and increase in light levels. We trialed 2-3 transfer methods, including the use of semi-opaque covers, misting chambers, and a nutrient film technology (NFT) system. The second major transition is from nuclear stock to propagation stock (plants derived as cuttings from nuclear stock which will be made available to hop growers for variety evaluation and further propagation). The standard method is to take softwood cuttings and root them in a misting chamber before transferring to sterilized potting medium. Since NFT systems allow access to parts of the plant normally covered by soil, we hypothesized that it would be possible to take both softwood cuttings and rhizome cuttings from these plants. We compared methods for plant growth and cutting production, and inputs of time and materials were tracked to determine the most efficient production methods.

Objective 3: We coordinated participatory variety trials in WI hop yards, and evaluated disease incidence in existing plantings. Grower cooperators (Albers, Buss, Urness, Gorst Valley) included plants of each cultivar in standard production in their hop yards. Cooperator farms represent key hop production areas in the state of WI to best evaluate cultivars under a range of state soils and climates. Gevens, Genger, Duley, and Rehbein will periodically surveil test cultivars for health status, as well as additional characters. Data were subjected to appropriate statistical analysis and a summary report will be provided to cooperating producers and industry at large.

Objective 4: We provided educational opportunities for current and future WI hop growers which focused on variety selection for the WI growing environment and craft brewing industry, the importance of disease-free planting stocks for healthy hop yards, and the process by which hop plants can be cleanly propagated.

UWEX, through lead efforts of Carl Duley and Tim Rehbein, has established positive rapport with hops growers. A March 2014 UWEX Hops Production Meeting, held in Wausau, WI drew a crowd of over 100 comprised of both established and new growers, craft and hobby brewers, and several representatives of hops cooperatives and exchanges. Respondents to the program survey indicated that all components of the education program were successful in raising the level of awareness of production practices from a low-moderate status pre-meeting to moderate-high post-meeting. The meeting further stimulated much discussion and interest in a WI-specific clean hops rhizome program, with multiple respondents citing the development of this program as a priority for industry advancement. Annual meetings of similar character have taken place in each year from 2014-present. Typically, we coordinated a winter educational session with formal presentations by researchers and the industry, and summer sessions with field walks and workshops. Further distribution of project updates or grower inquiries were achieved through use of email list serves, newsletters (ie: UWEX Vegetable Crop Updates), facebook, and static web postings (ie: Buffalo and Vernon Co. UWEX websites, UW-Vegetable Pathology website). A list serve has been developed to aid in communication of the WI Hops Grower Association which is currently, still in establishment.

**B.** We accomplished all of our proposed project goals including 1) we selected varieties for on-farm evaluation and established a tissue culture collection of these varieties, 2) we produced hop plants for variety trials in conjunction with grower collaborators, 3) we conducted greenhouse hop propagation and refinement of methods to generate a standard approach, 4) we established variety trial plots in commercial hop yards across the state, and 5) engaged in extension efforts to provide results of the project to producers and foster 2-way information sharing between growers/processors and researchers.

## IV. Beneficiaries

Our project has benefited current and future producers of hops in WI and the Midwestern region by making available planting stock free of disease for optimum growth, yield, and quality with potentially reduced reliance upon chemical control options for enhanced human and environmental safety. Successful and increased production of hops for WI means enhanced

market placement, additional revenue in the beverage and locally grown sectors for additional benefit to brewers and consumers. Results of our efforts should provide increased access and cost-effectiveness of clean stock making entry into hops production more economically sound and attractive to new hobbyists and/or commercial producers. While an economic value cannot be placed on the intrinsic significance of re-establishing WI as a key hops producing location in the world, this mission drives many hops producers who take pride in the tradition of locally grown quality craft beer in WI.

Currently there are approximately 80 hops producers across the state of WI. Most producers have membership in one or more regional or statewide hops cooperatives or exchanges which aid in connecting market demand with production. Key organizations, such as Gorst Valley, WI Hops Exchange, and Midwest Hop and Barley Cooperative are participants in this cooperative project and are prime beneficiaries. There are 8 large and regional breweries (15,000->6 million barrels beer/year) in WI, such as Miller, Leinenkugel, New Glarus; greater than 30 microbreweries (15,000 or less barrels beer/year), such as Ale Asylum, Grumpy Troll, Hudson; and countless hobbyist brewers that would benefit from enhanced quality and quantity of WI-grown hops.

Beneficiaries would reap reward of high quality, locally-sourced, and sustainably produced hops for brewing established and potentially new flavors unique to WI.

In a 2013 grower survey in WI, IA, and MN, hops growers indicated an expected increase in acreage and farm gate value of crop by 5-fold. This increase is based on current production practices and expectations. With advancement in rhizome quality, expectations for yield and quality may be increased promoting further acreage expansion and expected return of greater than $2.85 million in the next 5 years. WI acreage has expanded from ~50 to 320 within a 5-year period.

## V. Lessons Learned

We learned that hop varieties respond very differently to varying tissue culture and plant maintenance practices. Protocols can be generalized for all varieties, or specialized/optimized if a grower is to focus on just one or fewer varieties in their production. Accessing clean plant tissue from the national clean plant network or other private laboratory can be challenging and costly, respectively.

## VI. Additional Information

***Extension Publications:***

**Gevens, A.J**., Marks, M.E. 2014. *Hop Downy Mildew: Identification and Management*. UW-Extension Publication.

**Gevens, A.J**., Marks, M.E. 2014. *Hop Powdery Mildew: Identification and Management*. UW Extension Publication.

**Gevens, A.J**., Marks, M.E. 2014. *Hop Viruses: Identification and Management*. UW-Extension Publication.

***Trade Magazine Publications:***
Marks, M.E., **Gevens, A.J.** 2015. What's hoppin' in Wisconsin hops?! Fresh. A magazine of the Wisconsin Fresh Market Fruit and Vegetable Growers Association (April Edition).

***Vegetable Crop Update Newsletters:***
**Gevens, A.J.** 2017. Vegetable disease update: potato early and late blight disease forecasting, updates on late blight in WI and nationally, updates on cucurbit downy mildew, Phytophthora crown and fruit rot in vegetables, first detection of hop powdery mildew for WI. *Wisconsin Crop Manager*, Vegetable Crop Updates #13. July 14.

**Gevens, A.J.** 2017. Vegetable disease update: potato early and late blight disease forecasting, updates on late blight in WI and nationally, updates on cucurbit downy mildew, blackleg updates, considering Phostrol for potato disease control, hop disease update. *Wisconsin Crop Manager*, Vegetable Crop Updates #8. June 10.

**Gevens, A.J.** 2017. Vegetable disease update: potato cull pile destruction law reminder, national updates on status of late blight and cucurbit downy mildew, updated fungicide list for downy and powdery mildew of hop. *Wisconsin Crop Manager*, Vegetable Crop Updates #4. May 13.

**Gevens, A.J.** 2017. Vegetable disease update: welcome and review of disease forecasting concepts, hop crop status updates, introducing Dr. Yi Wang of UW-Horticulture. *Wisconsin Crop Manager*, Vegetable Crop Updates #2. April 30.

**Gevens, A.J.** 2016. Vegetable disease update: DSV (Blitecast, Late Blight) and P-Day (Early Blight) updates, late blight and cucurbit downy mildew national updates, powdery mildew on hops, diagnostic updates. *Wisconsin Crop Manager*, Vegetable Crop Updates #23. August 12.

**Gevens, A.J.** 2016. Vegetable disease updates: DSV (Blitecast, Late Blight) and P-Day (Early Blight) updates, early season late blight symptoms and inoculum sources; management link to potato blackleg seminar from Focus on Potato, WI hop updates. *Wisconsin Crop Manager*, Vegetable Crop Updates #9. May 27.

**Gevens, A.J.** 2016. Vegetable disease updates: national late blight updates, hop downy mildew updates for Wisconsin. *Wisconsin Crop Manager*, Vegetable Crop Updates #5. April 29.

**Gevens, A.J.** 2016. Vegetable disease updates: hop downy mildew updates for Wisconsin. *Wisconsin Crop Manager*, Vegetable Crop Updates #4. April 22.

**Gevens, A.J.** 2015. Potato fungicide updates for 2015: new registrations and label updates. Hop disease identification and management. *Wisconsin Crop Manager*, Vegetable Crop Update #2. April 3.

**Gevens, A.J.** 2014. Vegetable disease update: Potato production updates, Late Blight Updates, Blitecast and P-Days for late blight and early blight management, Cucurbit downy mildew update, Hops update. *Wisconsin Crop Manager,* Vegetable Crop Update #13. July 11.

**Gevens, A.J.** 2014. Vegetable disease update: Late blight reminders, updates, and a look at Blitecast, Hop downy mildew detected in Portage and Dane Counties, Cucurbit downy mildew -- info resources. *Wisconsin Crop Manager,* Vegetable Crop Update #6. May 23, 2014. (Spanish Version Available)

**Gevens, A.J.** 2014. Vegetable disease update: Early Season Hop Update, Considerations for organic late blight control. *Wisconsin Crop Manager,* Vegetable Crop Update #3. April 28, 2014. Spanish Version Available Online.

***Academic/Professional Meeting Abstracts:***

Marks, M.E., **Gevens, A.J.** 2017. Detection of mefenoxam-insensitive populations of *Pseudoperonospora humili* in Wisconsin hop yards. 221-P. Fungicide Resistance. American Phytopathological Society Annual Meeting. San Antonio, TX.

Marks, M.E., **Gevens, A.J.** 2016. Screening for phenylamide fungicide insensitivity in Wisconsin hop downy mildew (*Pseudoperonospora humili*) populations. 296-P. Chemical Control. American Phytopathological Society Annual Meeting. Tampa, FL.

Marks, M.E., Geske, A.P., **Gevens, A.J.** 2015. Disease detection in hop rhizomes and plantlets to ensure clean yards in Wisconsin. 466-P. Diseases of Plants – Disease Detection and Diagnosis. American Phytopathological Society Annual Meeting. Pasadena, CA.

Marks, M.E., Frost, K.E., **Gevens, A.J**. 2014. Evaluating Hop Downy Mildew (*Pseudoperonospora humuli*) Forecasting Tools to Manage Disease in Wisconsin. North Central Division American Phytopathological Society Meeting, Madison, WI, Jun. 13-15. *Phytopathology* In-Press.

***Oral Presentations:***

| | | |
|---|---|---|
| | 2017 | |
| | Aug 10 | ***Hop Production Workshop.*** UWEX Hop Education Program, Tomah, WI. |
| | Mar 4 | ***Integrated Management of Powdery and Downy Mildew of Hops in the Upper Midwest.*** Minnesota Hop Growers Association Annual Meeting. Shakopee, MN. |
| | Feb 25 | ***Managing Disease in Wisconsin Hops & Fungicide Updates*****.** University of Wisconsin Extension Hop Production Workshop. Amherst, WI. |
| | Feb 25 | ***Hop Downy Mildew Research Updates*****.** University of Wisconsin Extension Hop Production Workshop. Amherst, WI. |
| | 2016 | |
| 1. | Jul 8 | ***Hop Disease Management Updates.*** Hop Production Meeting. University of Wisconsin Extension. Roscholt, WI. |
| 2. | Apr 19 | ***Hop diseases of Wisconsin and their diagnostics and management.*** North Central Plant Disease Diagnostic Network Meeting. Madison, WI. |

| | | |
|---|---|---|
| 3. | Mar 12 | ***Updates in hop disease management.*** Hop production meeting. University of Wisconsin Extension Buffalo County. LaCrosse, WI. |
| | 2015 | |
| 4. | Aug 15 | ***Managing downy mildew in Wisconsin hops.*** University of Wisconsin Extension & Wisconsin Department of Agriculture, Trade, and Consumer Protection Hop Management Meeting. Albers Hop Farm. Arkensaw, WI. |
| 5. | Aug 14 | ***Managing downy mildew in Wisconsin hops.*** University of Wisconsin Extension & Wisconsin Department of Agriculture, Trade, and Consumer Protection Hop Management Meeting. Davali Ridge Farm. Waterloo, WI. |
| 6. | Mar 14 | ***Hop disease research and extension updates***. Gorst Valley Grower Education Meeting. Mazomanie Public Library. Mazomanie, WI. |
| | 2014 | |
| 7. | Mar 1 | ***Managing diseases in Wisconsin hops: fungicide and project updates.*** University of Wisconsin Extension Hop Production Seminar. Wausau, WI. |

## VII. Contact Info

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# 10) Cranberry flea beetle biology and management (FY14-010)

**Report Date:** September 30, 2016

## I. Project Summary

**A.** There are more cranberries grown in Wisconsin than in all other US states combined, and the most significant pests attaching the crop are insects; so it has long been a top priority of the cranberry industry to keep certain insect populations in check. Growers in Wisconsin, however, have had to contend with a pest problem that other cranberry-growing regions have largely been spared: the cranberry flea beetle. The curiously rapid rise of the cranberry flea beetle in central Wisconsin (Wood, Monroe, Jackson, Juneau, and Portage counties) has been sustained over seven growing seasons now, suggesting the rise is not just an itinerant problem.

The single pest species has caused a spike in insecticide spraying on many Wisconsin marshes, which has increased insecticide residue levels in fruit and put Wisconsin growers at a competitive disadvantage. While the residue levels are within legal limits for the U.S. market, they exceed the levels designated for European and Asian markets. As a result, Wisconsin growers are in need of a way to control flea beetle populations without increasing insecticide residues in fruit, and they need this solution as soon as possible.

To provide a more effective pest control approach for flea beetle control, the objectives of this study were set up to: 1) discover native entomopathogenic nematodes (insect-killing nematodes) in wild and cultivated cranberry systems; and 2) screen them for pathogenicity against flea beetles, the cranberry fruitworm, and sparganothis fruitworm.

The proposed work focuses largely on the creation of a bio-insecticide (nematode-based biological control) program. We will be comparing these nematodes to standard insecticides in order to test whether these native nematodes may be substitutable or complementary with insecticides.

**B.** The proposed project builds on the FY13 flea beetle project by 1) increasing grower understanding of flea beetle biology, 2) demonstrating that Belay is a highly effective post-bloom soil-soak treatment, and 3) most importantly, discovering and developing a new pest control technology (native nematodes as bio-control agents). The nematodes not only are lethal for flea beetles, but also for sparganothis and cranberry fruitworms. This technology adds to the existing arsenal of insecticides that can be used for flea beetles, but the nematodes provide insect control without adding chemical residues to the fruit.

Ultimately, a field-ready nematode formulation (bio-insecticide) will be formulated that can be applied and irrigated into pest "hot-spots." The earlier project (FY13) was originally set up only for flea beetle control via soil-soak insecticides, but in our FY14 work we have succeeded in isolating three candidate nematodes that consistently kill flea beetles, sparganothis, and cranberry fruitworm larvae. Nematode prospecting and culturing continues, as does virulence testing.

## II. Project Approach

*Soil-soak trial:* In 2014, we initiated a large-scale soil-soak trial involving just one insecticide: Altacor® (chlorantraniliprole), a new and very effective insecticide for cranberry growers. The insecticide Belay® was not tested due to substantial concerns over the use of neo-nicotinoids on a fruit crop (Ocean Spray Cranberries, Inc., clearly indicated that no fruit treated with Belay® would be allowed into its processing centers). At five large commercial marshes in Wisconsin, insecticide and control treatments were applied to beds (3-4 acres each) immediately post-bloom. Two replicates (beds) of the treatment and controls were established at each marsh, and each bed was pre-irrigated to thoroughly saturate the canopy and duff layers, preventing adsorption of the insecticide active ingredient onto leaf surfaces. After pollinators had been removed from the marshes, the insecticide, Altacor®, was applied at a rate of 4.5 oz./acre in 50 gallons $H_2O$/acre along with 2.5% FS Aqualite (Growmark; Bloomington, IL) by volume, a nonionic surfactant. The nonionic surfactant was used to help move the insecticide into and through the soil profile. Immediately after Altacor® application, treated beds were irrigated for an additional four hours. Control beds received only the irrigation set, and were treated as per the specific grower's management regime. Flea beetle counts commenced soon thereafter and ended in early September. Adult flea beetles were sampled with a sweep net on two dates post-treatment. Ten sets of 20 sweeps were conducted in each study bed for a total of 200 sweeps bed. In terms of adult flea beetles, there were no differences between the Altacor® and control treatments.

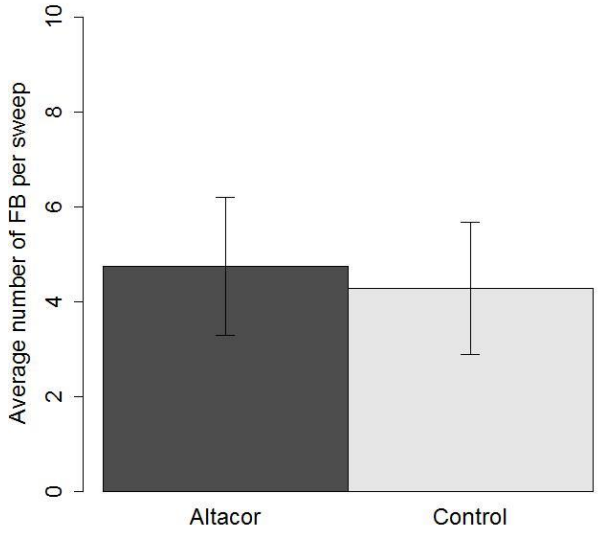



**Fig. 1.** Number of adult flea beetles found in beds treated with Altacor® vs. untreated control.

Our 2014 replicated trials (Altacor® vs. controls) were examined across three marshes. Based on this work, Altacor® did not appear to be an effective material for flea beetle control (Fig. 1). To verify that residues of Altacor® had actually penetrated the soil profile, reaching the depths needed to treat flea beetle larvae, we took soil cores during the experiment. Based on the residue data (Fig. 2), the active ingredient of Altacor® clearly percolated deep enough to reach most, if not all, the flea beetle larvae. Despite having delivered the insecticide to the larvae, mortality was insignificant. The failure of Altacor® to control flea beetle populations emphasizes the important role that Belay® had represented within the cranberry IPM programs of Wisconsin.

*Soil percolation of insecticide:* Soil samples were taken within 24 hours of the Altacor® application in order to measure Altacor® presence throughout the soil horizon and determine the efficacy of the application methods. The 24 hour sample was not possible at two of the marshes due to restricted entry intervals of other pesticides that were applied on the same day. Soil samples were taken to 10" with a probe 1" in diameter. Ten samples were taken per bed. Altacor® was successfully delivered to the soil profiles where flea beetle larvae feed.

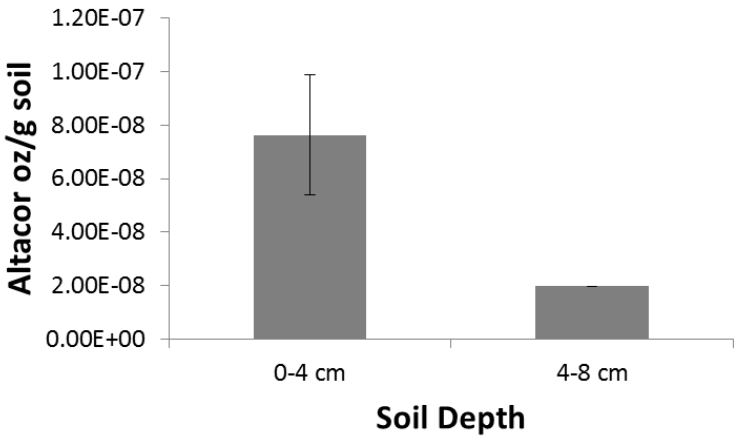



Fig. 2. Altacor® residues at two soil depths within treated beds.

*Prospecting for native nematodes as bio-control agents:* Given that cranberries and their pests are native to North America, we have initiated a program to discover and isolate native nematodes as biological control agents. In the summer of 2014, we successfully recruited a PhD student to begin statewide surveys of entomophagous (insect-eating) nematodes in the native marshlands of Wisconsin. To-date, three different entomophagous nematode species have been isolated, all of which appear to be new to science, and all of which are pathogenic to the cranberry fruitworm and sparganothis fruitworm, the two major moth pests of Wisconsin cranberries. Screening for flea beetle larvae will commence in the spring of 2016, when the eggs have overwintered and adequate larvae are available within our lab cultures.

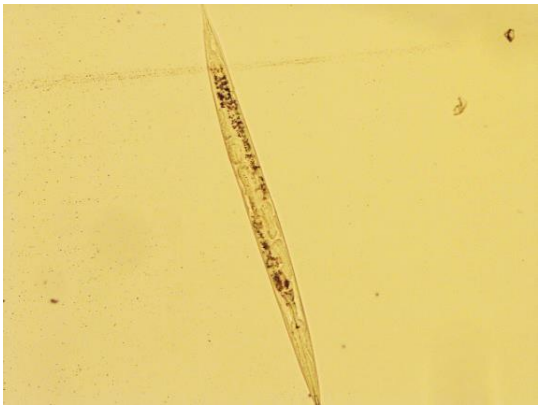


**Figure 3.** A new insect-eating nematode species, native to Wisconsin marshlands (collected in Jackson Co., summer 2015).

Three (3) strains of entomopathogenic nematodes have been recovered from Jackson County, Wisconsin (one is pictured in Figure 3). The nematodes were collected by a standard bioassay technique from moss-covered soils and peat, in close proximity to wild cranberry plants. All three nematode strains have been shown to attack Sparganothis Fruitworm (Fig. 4), and all seem similar in their virulence (ability to kill the host). Based on preliminary trials, these nematodes are quite virulent, killing over half the SFW within just three days of treatment, at doses less concentrated than typical nematode applications. At higher doses and longer host exposure-periods, mortality rises dramatically, but our early trials are aimed at simply showing that the nematode can kill SFW. It remains to be seen whether or not these 3 nematode strains will be an

**Figure 4.** Nematodes emerging from CFW cadaver. Nematodes (pale, threadlike worms) can be seen swimming away from the dead caterpillar.

effective bio-control agent for SFW, but given that the nematodes in our trial had to search out their prey before killing them, there is reason to be optimistic.

In the case of the Cranberry Fruitworm (CFW), one of the three nematode strains was able to kill larvae and/or pre-pupae that had finished feeding, tunneled into cotton, and spun a pupal case (Fig. 5). What's interesting about this particular nematode strain is that in order for it to get access to the CFW larva, it had to crawl through the thick pupal case first. After penetrating the defenses of CFW, the nematode infects the caterpillar, consumes it, and spills out in the thousands. So far, this particular nematode strain is the only one that kills both SFW and CFW.

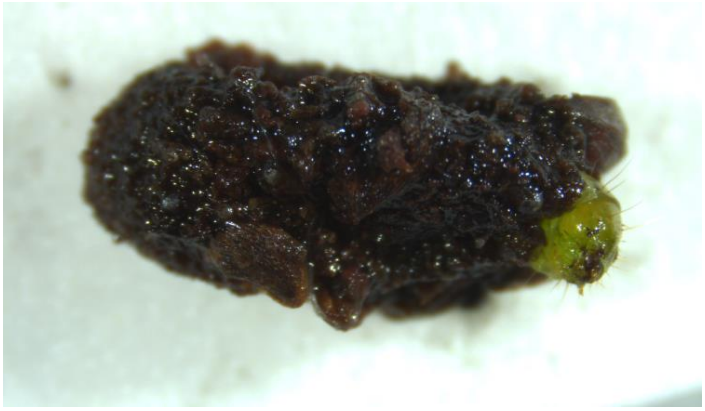


**Figure 5.** Cranberry fruitworm caterpillar within its pupal case (greenish head is protruding). Nematodes crawl through the silk mesh of the pupal case, then attack the CFW larva within. This individual was in a morbid state and soon died.

Although flea beetles, sparganothis fruitworm, and cranberry fruitworm are most notorious for the damage they do to cranberry tissue above the surface of the soil, all of these pests spend at least part of their life cycles on/in the soil. It is possible that a well-timed application of the soil-dwelling nematodes could bring all these pests and the pathogen into contact. After the nematodes infect the insect, they release symbiotic bacteria into the host that kills the insect, and the nematodes then use the cadaver as a space to feed and breed. Thousands of nematodes have been recorded coming from a single infected SFW cadaver, so it may be possible for one application to increase nematode populations in the soil, providing pest protection season-long.

*Surveying impacts on grower practices:* In the winter of 2014-2015 (at the Winter Cranberry School meeting, Wisconsin Rapids, WI), we again used a remote "clicker" system to survey a crowd of 90-100 self-selected audience members from a pool of 400-500 cranberry growers. This information allowed us to assay changes to grower

knowledge of flea beetle biology and control tactics. Again, in the 20015-16 Winter Cranberry School meeting, growers were surveyed (~100 self-selected).

## III. Goals and Outcomes Achieved

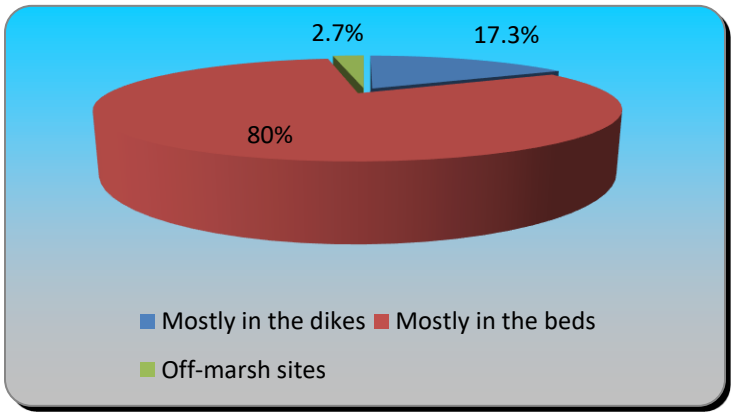
**A.** *Performance goals, metrics, benchmarks, and outcomes*

**1) Increase grower understanding of cranberry flea beetle biology and control within the Wisconsin.**

*New evidence on flea beetle biology and control:*

The subterranean feeding habits of the cranberry flea beetle larvae were successfully documented over the course of 2013-2014. We have shown that the larvae feed at relatively shallow depths, making them amenable to soil-soak treatments. Using the isotopic signatures ($^{15}N$ and $^{13}C$) of flea beetles, as well as the cranberry roots on which they feed, we demonstrated that the larvae primarily feed on roots within the top 1-4 cm of soil, while relatively few feed 4-8 cm deep. These findings reveal the depth to which a soil-soak insecticide will need to percolate (i.e., only the top 8 cm of soil need be treated, avoiding the water table of the marsh). Our work also shows that the cranberry/red-headed flea beetle (RHFB) develops almost exclusively in cranberry beds, not the dikes that surround the beds. Very few adults emerged within our dike cages, while many emerged within the cages set up in the beds (see Fig 2 at right). This finding allowed us to "put to rest" questions relating to flea beetle immigration from dikes or other off-site locations. This also suggests that soil treatments should be applied to beds only. The adult beetle emergence was prolonged, lasting approximately 1 month, highlighting the need to treat the entire flea beetle generation when they are feeding underground as larvae, rather than waiting for adults to slowly emerge from the soil. Altogether, these findings established the basis for our trials of soil-applied insecticides.

*Impacts on grower practices, measured based on year-to-year changes:*




At the WSCGA Winter Meeting of 2014, we measured grower knowledge of flea beetle biology and pest management practices. This served as the baseline to assess changes in grower knowledge and behavior, which was measured again one year later during the winter of 2014-2015. From the initial assessment (86 respondents), we found that insect pests commanded a disproportionate amount of pest management effort (47% of pesticide sprays were insecticides, versus those of fungicides and herbicides), and 96% of all growers applied 2 or more insecticides per year. On average, 40% of these were directed *strictly* for flea beetle. 88% of Wisconsin cranberry growers believe that spraying for flea beetles is worth the expense. 15% of growers believed that flea beetles overwinter in the dikes, while 13% believed they overwinter exclusively in the beds (some growers were unsure, and 63% believed that flea beetles may overwinter in both the beds and dikes). Of the flea beetle sprays, 72% were applied only to beds, while 28% were directed at beds and dikes. This means that much insecticide was applied to (and thus wasted on) the dikes.

One year later (winter, 2015), insects were again the top pest management concern for growers (89 respondents), with 94% of growers applying 2 or more insecticide sprays during the previous growing season. Most growers now understood that flea beetles overwintered largely in the beds, not the dikes (see pie chart at right). 80.0% of respondents indicated flea beetles overwinter in beds, a major increase from the 13% of the previous year.

**2) Demonstrate efficacy of single early-season soil-soaks, and impacts on grower practice;**
*Soil-soak efficacy trials*: Soil-soak treatments were conducted over the course of two summers. Treatments were applied either pre-bloom (early June) or post-bloom (late July), timed for the larval stage of the flea beetle. The single post-bloom application of Belay® was significantly better than the control, while all of the pre-bloom treatments (Belay®, Altacor®, Delegate®, NematacC®, untreated control) were no better than the control,. In terms of crop protection potential, Belay® applied post-bloom was the superior insecticide/timing for a soil-application. However, due to non-scientific, non-agricultural issues associated with Belay, this material was deemed inappropriate for cranberries, despite being use as a soil-soak, post-bloom.

Following this trial, it remained to be discerned whether Altacor® or Delegate might also work well if applied post-bloom. So, in 2015, we tested Altacor® as a post-bloom soil-soak. Despite ample evidence that Altacor® had penetrated 5-10 cm deep within the soil horizon (Fig. 2), there was no evidence whatsoever that this insecticide could control flea beetles (Fig. 1). Thus, Belay® remains the top insecticide for flea beetle control, and when applied immediately post-bloom as a soil-soak, there was no residue detectible in the fruit.

Following discussions with growers, 80% indicated they understood that the place to target flea beetles was in the beds, not the dikes. This represented a major improvement in grower understanding of flea beetle biology. 36% of all sprays were *strictly* for flea beetles, and of these, 97% were applied to the beds (compared with 72% in the previous year), suggesting that grower pest management practices had changed in response to their new understanding of pest biology. Growers encouraged our research group to continue to investigate Belay and Diazinon as post-bloom soil-soaks, and we have taken this into advisement.

**3) Discover a readily culturable nematode species that can control flea beetles.**
*Virulence screening in the lab and in the field:* As described above, we have discovered native nematode species and have successfully kept them in culture (Figs. 3-5). We have tested them against flea beetles, cranberry fruitworm, and sparganothis fruitworm, and have reached our benchmark of 90+% mortality of targeted pests. There is variability among nematode species, and among trials, but we have evidence that a pre-bloom soil soak of the nematode, *Oscheius wisconsini*, achieved flea beetle control that was similar to the very best insecticides: Belay and Diazinon.

**4) Industry-wide changes in spraying, reducing insecticide residues within fruit**
*Ongoing research and education:* Changing grower practice has always been difficult, thus this goal and target outcome must be characterized as an ongoing challenge. While we know we have educated growers on the proven track record of Belay for flea beetle control, and have made it clear there is no residue detectible in fruit when Belay is applied immediately post-bloom, growers have been very slow to adopt this practice. That said, a small number of growers,

particularly in northern Wisconsin, are indeed using Belay as suggested, and are finding great results. Other growers are waiting for a nematode formulation to be ready for large-scale applications, mainly to keep their flea beetle hot-spots in check. Many growers, however, continue to apply late season insecticides as they have always done

**B.** Our work was successful in demonstrating that the cranberry flea beetle overwinters almost exclusively within the cranberry beds, at shallow depths. Following our outreach/education efforts within the Wisconsin cranberry industry, we documented a significant increase in grower understanding of flea beetle biology. Prior to our efforts, 13% of growers believed that flea beetles overwintered entirely in the beds, while after our outreach efforts, 80% understood where flea beetles overwintered. Importantly, this changed grower practices. Now, 97% of flea beetle sprays are directed entirely at the beds. Altogether, this represented a genuine, positive impact on grower practices.

We clearly demonstrated the high efficacy of post-bloom soil-soaks of Belay®. These soil-soaks target the beetle larvae where they are feeding, and when irrigated adequately after spray applications, there are substantial reductions in flea beetle populations. Despite meeting our goals and continuing to provide this information to growers, an unanticipated problem did emerge relating to a particular decision by the largest cranberry processor/retailer in the world, Ocean Spray Cranberries, Inc. This company effectively banned the neonicotinoid, Belay®, from use on any marsh because of the negative associations with honey bee declines. This was unfortunate, particularly given that our application timing was *post-bloom*, and that no insecticide residues were detectible in the fruit harvested from our research plots (residue data were determined by Ocean Spray and Valent, the company that manufactures Belay®). Thus, despite the fact that we had successfully side-stepped the bee issue by applying this insecticide after the bloom period, and had evidence that there were no Belay® residues in the berries, this insecticide was still deemed too risky by Ocean Spray, Inc. As such, this compound was no longer available for flea beetle control, and we were forced to investigate another insecticide, Altacor®. This insecticide clearly did not perform as well as Belay®.

While our Wisconsin growers were able to improve their IPM practices (97% now exclusively treat beds, not dikes), their sprays were all *foliar* applications, not soil-soaks, and were often applied late-season (Aug, Sept), increasing the likelihood that excessive insecticide residues were present in the harvested crop. Additionally, the foliar application approach generally required multiple applications. It is critical, therefore, to continue the search for a viable, effective early-season soil-soak.

Because late-season foliar spraying remains the dominant form of flea beetle control, there is an even greater demand for alternative tactics. Growers are enthusiastic over the successes of the nematode work, and are willing to apply it to their worst flea beetle hotspots. Eventually, a benchmark for the Steffan Lab will be to have mass-produced enough *O. wisconsini* nematodes to inoculate marshes with these native nematodes (as a free-service to growers). This will demonstrate on-site that these nematodes can provide effective pest control for flea beetles, as well as sparganothis and cranberry fruitworm.

## IV. Beneficiaries

Wisconsin cranberry growers and their attendant industries (e.g., material suppliers, pest management consultant services) are the major beneficiaries of this project. There are over 250 growers in the State, employing thousands of workers. By improving grower understanding of flea beetle biology and optimal IPM approaches, pest management in Wisconsin's cranberry systems has been made more efficient.

## V. Lessons Learned

Our field work revealed that it is extraordinarily difficult to locate flea beetle larvae using soil cores. After taking ~400 cores and devoting over 300 person-hours to screening the soil, only a single larva was found. This was a learning experience for the lab, and highlighted the importance of simply finding a flea beetle hotspot, and digging up soil cores from these beds.

## VI. Additional Information

Presentations and publications were made at the winter cranberry meetings (2013, 2014, and 2015) and spring workshops (2013, 2014). Proceedings of the Winter Cranberry School can be found at the Wisconsin State Cranberry Growers Association website. Newsletters online at the Wisconsin Fruit News and Cranberry Crop Management Journal are available.

## VII. Contact Info

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# 11) Promoting Wisconsin cranberries and other specialty crops to India, Mexico, and other markets (FY14-011)

**Report Date:** October 23, 2017

## I. Project Summary

**A.** Cranberries are an important part of Wisconsin's economy, and have long been Wisconsin's number one fruit crop. The Cranberry Marketing Committee (CMC) estimates Wisconsin yielded 4.9 million barrels of cranberries during the 2013 fall harvest, representing nearly 60 percent of the nation's crop and securing Wisconsin as the number one cranberry producer in the nation for the 19th consecutive year. Wisconsin cranberries account for almost 85 percent of the total value of fruit production in the state, and contribute nearly $300 million annually to the state's economy and support approximately 3,400 jobs. However, market demand has not kept up with the supply. With domestic consumption relatively stable, a viable option for Wisconsin cranberry producers is to look to international markets, specifically emerging markets as a way to increase sales. Emerging markets have the potential to create demand with continued population growth and also the purchasing power as disposable incomes continue to rise. One such market, as evidenced by research conducted by the CMC, was India.

However, due to difficulty finding companies in India to participate in trade activities (buyers mission and trade mission), WDATCP requested a change in scope and budget to better utilize funds and make a bigger impact for Wisconsin cranberry growers and processors. The revised project focused on promoting activities in Mexico. Reduced barriers of trade, low cost of shipping were some factors that were considered when choosing Mexico as one of the countries to focus on. Activities that were initially decided were a buyers mission in fall of 2015 as that would provide buyers with in-depth knowledge of the processing facilities, an opportunity to see the cranberry harvest and engage with the producers. Participation in a Mexican food show in Spring 2016 was also considered as a follow up activity to the buyers mission. However, the trade mission to Mexico fell through as we received feedback from the producers that a 2016 spring trade mission might be too early and redundant. Also, it was determined that Mexico is a mature market for cranberries and that many of the buyers were already familiar with the products.

Hence, the scope was further broadened to **promote all specialty crops domestically and internationally**. After much deliberation and evaluation of domestic food shows, it was decided that exhibiting at the 2017 National Restaurant Association Show would be a great opportunity for Wisconsin specialty crop producers to be recognized domestically and internationally.

**B.** Not applicable

## II. Project Approach

For the promotion of cranberries in Mexico, once we identified an in-market contractor in Mexico, we worked with them to recruit four buyers from across Mexico to participate in a reverse buyers mission. A reporter from El Universal was also identified. These buyers traveled to Wisconsin Oct

19-22, 2015. They visited two different types of marshes – fresh fruit and processed fruit, met with three Wisconsin cranberry suppliers, visited three processing facilities and a receiving station. During their visit, the entire delegation learned about the history and nutritional benefits of cranberries, sampled cranberries with other products, and saw first-hand harvesting methods as well as processing methods. Evaluations from the suppliers indicate projected sales of approximately $500,000.

Further feedback about possible activities was solicited in 2016. Based on their feedback, we decided not to pursue a Mexico based trade show, but instead focused on a domestic show that attracts a large number of international buyers from across the world. The other feedback received was to expand the scope of the project to include other specialty crops as well. Based on this feedback, we decided to promote Wisconsin wines and other specialty crops including cranberries at the 2017 National Restaurant Association (NRA).

We identified five Wisconsin wine companies to exhibit at the specially organized Beverage Alcohol Restaurant (BAR) section within NRA and identified an additional two companies to exhibit within the Wisconsin Pavilion at NRA. The Wisconsin Pavilion at BAR was designed with the help of SCBG funds to enable us to stand out from amongst the other exhibitors. Funds were also used to offset the cost of exhibiting at BAR/NRA to initially allow new companies an opportunity to promote their products at an international show at little risk to themselves. Five of the seven Wisconsin specialty crop companies exhibiting at BAR/NRA were new to the show.

## III. Goals and Outcomes Achieved

**A.** The overall objective of these activities was to first create awareness, develop the customer base, and work toward building strong customer loyalty with the ultimate goal of increasing sales for Wisconsin specialty crop companies such as cranberries, wines, sauerkraut, etc. Wisconsin companies interested in participating in the mission/food show were identified. Assistance was provided in terms of advice and guidance to companies new to exhibiting at the show. Those companies interested in meeting with international byers were provided additional recommendations about interacting with foreign buyers, transforming a lead into a sale, and shipping, etc.

The Wisconsin Pavilion at BAR was designed with the help of SCBG funds to enable us to stand out from amongst the other exhibitors. Funds were also used to offset the cost of exhibiting at BAR/NRA to initially allow new companies an opportunity to promote their products at an international show at little risk to themselves.

**B.**

| No | Goal | Performance Measure | Outputs | Benchmark | Target |
|---|---|---|---|---|---|
| 1 | Increase availability of WI specialty crops | • Recruit 3-5 Mexican buyers and at least one media person to meet Wisconsin companies selling juice/dried berries/value-added products<br><br>**Actual:** Recruited four Mexican buyers and one media person. | Meetings between suppliers and Mexican buyers will be scheduled. Participants in the reverse buyer's mission will be surveyed about their experience participating in the events.<br><br>**Actual:** Meetings were scheduled between the buyers and Wisconsin suppliers. | DATCP is not currently promoting WI cranberries in Mexico<br><br>**Actual:** DATCP helped to create awareness, and develop a potential customer base for existing WI suppliers by introducing them to Mexican buyers and a media journalist. The publication 'El Universal' has a daily circulation of over 140,000 prints and over 22 million digital visitors per month. | 20 new connections<br><br>**Actual:** $500,000 in projected sales. Nine new contacts were made and three new supplier relationships established. |
| 1 | **Increase availability of WI** specialty crops | • Recruit 4-6 companies to exhibit at the National Restaurant Association Show<br><br>**Actual:** Recruited Seven companies to exhibit at BAR/NRA | Distributors will be able to sample products, meet with company representatives<br><br>**Actual:** Distributors were able to sample products, and meet with company representatives. NRA attracted more than 43,000 foodservice buyers from more than 40 different segments. There were attendees from all 50 states and over 100 countries. | DATCP is not currently promoting specialty crops at this show<br><br>**Actual:** DATCP helped to create awareness, and develop a potential customer base. Distributors were able to sample products, and meet with company representatives. NRA attracted more than 43,000 foodservice buyers from more than 40 different segments. There were attendees from all 50 states and over 100 countries. | 20 new connections<br><br>**Actual:** Feedback shows seven new connections and approximately $10,000 in projected sales. |
| 2 | **Generating awareness of Wisconsin specialty crops products and building** | • Product tasting at shows<br>• Generate 2-3 media articles on cranberries in leading trade publications | Reach out to a minimum of 350 consumers/ distributors/retailers<br><br>**Actual:** NRA attracted more than 43,000 foodservice buyers from more than 40 | DATCP is not currently promoting specialty crops at this show or WI cranberries in Mexico<br><br>**Actual:** DATCP helped to create awareness, and develop a potential customer base. | 75 new connections<br><br>**Actual:** NRA attracted more than 43,000 foodservice buyers from more than 40 |

| | | | | | |
|---|---|---|---|---|---|
| | **top-of-mind recall** | **Actual:** Product tasting took place at both BAR and NRA. A media article on WI cranberries was written by the journalist who had accompanied the Mexican buyers. A copy is attached. The publication 'El Universal' has a daily circulation of over 140,000 prints and over 22 million digital visitors per month. | different segments. There were attendees from all 50 states and over 100 countries. | Distributors were able to sample products, and meet with company representatives. NRA attracted more than 43,000 foodservice buyers from more than 40 different segments. There were attendees from all 50 states and over 100 countries. | different segments. There were attendees from all 50 states and over 100 countries. |

## IV. Beneficiaries

The three Wisconsin suppliers that attended the one-on-one meetings with the four Mexican buyers were direct beneficiaries of this activity. $500,000 in projected sales. Nine new contacts were made and three new supplier relationships established. These suppliers distribute cranberry products from the more than 250 Wisconsin growers.

The five Wisconsin wine companies that participated in BAR and the two specialty crop companies that participated in NRA were direct beneficiaries. NRA attracted more than 43,000 foodservice buyers from more than 40 different segments. There were attendees from all 50 states and over 100 countries. Feedback shows seven new connections and approximately $10,000 in projected sales. The five wine companies purchase grapes from many Wisconsin growers. Their exposure at the show helped increase awareness of Wisconsin's more than 100 bonded wineries and more than 400 grape growers.

## V. Lessons Learned

Spreading out activities and expanding the scope of countries would have provided more opportunities for Wisconsin cranberries suppliers. As mentioned before, participation in the Mexican international trade show was cancelled only because the WI suppliers felt that it was redundant and unnecessary as it was scheduled four months after a successful buyers mission.

Strengthening relationships with the associations would have helped with more robust promotion among wine companies. This has been a good project to help understand even better ways to make inroads in national and international markets for many Wisconsin specialty crops.

## VI. Additional Information

None

## VII. Contact Info

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# 13) Chop, chop! Wisconsin-grown produce culinary videos for schools (FY14-013)

**Report Date:** September 26, 2016

## I. Project Summary

**A.** Wisconsin schools are working to purchase and serve more Wisconsin grow fresh fruits and vegetables to both meet demand for farm to school programs, and to meet stricter regulations for fruit and vegetable servings offered in the National School Lunch Program. Simultaneously, Wisconsin specialty crop producers are looking for new, stable markets that offer volume and growth. The goal of the Chop! Chop! Culinary Skills Training project was to increase the culinary skills and knowledge of school food service staff through free training videos, an area identified as a main barrier to purchase and use of local foods through survey within the state and by USDA. The ultimate goal of the project was to increase purchase of Wisconsin-grown produce for use in schools by reducing the culinary skills barrier.

The new USDA School Meal Pattern, established in July of 2012, mandated a significant increase in fruit and vegetable servings provided to students, with a focus on specific subsets including "dark leafy" and "red orange" vegetables. Food service staff reported significant challenges in meeting these new requirements, including a lack of appropriate recipes to prepare meals and limited student acceptance. Farm to school, the use of locally-grown fruits and vegetables and other items in school meal programs, combined with experimental food-system education, rose to the top as a primary solution to the challenges set by the new meal pattern guidelines.

This contributed toward the increased procurement and demand of Wisconsin grown fresh produce. However, significant barriers still existed for schools to start or expand purchasing of Wisconsin fruits and vegetables. Wisconsin-based and national surveys conducted by WDATCP, UW-Madison Center for Integrated Agricultural Systems and USDA repeatedly showed a lack of: culinary skills by food service staff, basic understanding of produce use and seasonality, familiarity of handling fresh products, and appropriated recipes and skills for menu incorporation.

The Chop! Chop! Project addressed these barriers to purchasing, preparing and serving Wisconsin-grown produce through a series of 5 short, free, practical training videos aimed at school food service leaders and staff. Each video features a template of valuable information with content from the following categories: 1) basic culinary skills, 2) group or family of related produce, 3) ideas for produce incorporation within the school meal landscape, 4) school meal nutrition requirements, 5) utilization of quality acceptable "cosmetically imperfect seconds" when appropriate, and 6) peer mentoring through an interview between a farmer and school food service director. *See table 1.A Chop! Chop! Video content*

The high quality videos were filmed by the Wisconsin Public Television video crew, produced by a UW-Madison multimedia professional with a background in public health, nutrition and farm to school. The script and materials for the videos were developed by experts in farm to school, school meals, food safety and Wisconsin produce. To relate to school nutrition

audiences, each video starred highly respected, retired food service director Susan Peterman, with an introduction featuring local food educator and Wisconsin chef, Terese Allen.

After five years of conducting small-scale, in-person culinary skills training events, it became clear that these events were very effective, but with very limited reach and very high associated costs. A new solution was needed in order to meet the demand for culinary trainings throughout the state. Free, detail-oriented training videos disseminated through the state's many school nutrition channels was the perfect solution to reach a wide audience at a fixed cost.

**B.** This project did not build off any specific previous Specialty Crop Block Grant

## II. Project Approach

The approach to the project was a collaborative one. CESA Purchasing served as the lead for the project, however, the partner organizations carried equal importance throughout. The true strength of the project was the core team assembled to carry out the work plan, and the ancillary support provided by the members of the Advisory Panel formed early in the project. The core project partners, in addition to CESA Purchasing, included UW Madison Center for Integrated Agricultural Systems (CIAS) as project coordinator, Wisconsin Department of Public Instruction (DPI) as school nutrition experts, UW-Madison School of Human Ecology (SOHE) as videographer and editor, Susan Peterman, retired food service director, expert contributor and on-screen personality, and Terese Allen, local food historian, as expert contributor and on-screen personality. CESA Purchasing, CIAS, and DPI worked closely through the entire project, gaining the success of collaboration. Through the period of script review, filming and editing, SOHE, Susan, and Terese formed a core part of the team. A major success of this project was forming a core work group, advisory panel, and very focused work plan and outcome before starting the project.

The primary goal of the funded project was to create and disseminate a series of free educational culinary skills training videos. This was accomplished as of January 2016 as all five Chop! Chop! Videos were published to the Chop! Chop! Channel on YouTube and shared through a concise Chop! Chop! Webpage on the CIAS website which also includes print versions of recipes used in the videos, evaluation materials, a screening guide and a *Chop! Chop! Resource Guide* developed and published by DPI partners. (WWW.cias.wisc.edu/chopchop) The full list of videos and content are shown in Table 1.A Chop! Chop! Video Content. As of July, 2016, evaluation metrics collected at the point entering the videos indicate at least 1373 viewers watched the videos. YouTube metrics indicated the videos were accessed at least 1200 times through July 2016. The project team is very satisfied with the quality and content of the videos, and evaluation feedback conveys that same message. The paragraphs below outline the activities performed through the grant, as indicated in the work plan.

*Establish Advisory Panel
The Advisory Panel convened for the first time, in person, to discuss the project moving forward and to hone in on th emost appropriate produce items, culinary skills, and recipes to include as video content. Advisory Panel members were drawn from the following organizations: Wisconsin Department of Agriculture, Trade and Consumer Protection (DATCP); CIAS; National Farm to School Network; Wisconsin School Nutrition Association; Janesville and Fort Atkinson Child Nutrition Directors; Fifth Season Cooperative; Town and Country R,C&D; Farm Logix; Mutch Better Foods, LLC; DPI; SOHE; CESA 3; and the Wisconsin Food Hub. This was a successful gathering to gain a wider understanding of the project importance ans use within the community, hone in on messagin for the target audience, cultivation of dissemination partners and solidifying video content. The Advisory Panel was engaged by email throughout the project, and met again in March 2015 to review the video scripts and video process.

*Develop Evaluation Plan and Tools
Evaluation was an important part of this project to both gague effectiveness of video content, reach and impacts on viewers. Development of the evaluation plan began with research on best practices for evaluaton of free, online tools to determine an effective strategy to collect viewer metrics without creating barriers to viewing content. The evaluation plan consisted of the following:

- A short pre-viewing screening survey requesting county, state, number of people who were watching the video and role. The project group decided not ot collect email addresses in this step to avoid discouraging people from moving forward. This short survey was a required step when clicking through to the videos.
- A post-video survey linked to the video was also created which addressed all metrics important to project evaluation. The challenge here was finding the right incentive for people to follow through and take the post-viewing survey. Anyone who wanted to collect the available Continuing Education Credits through WI-SNA was required to complete the surveys before receiving CEUs.
- A post-post survey was created to assess long-term impacts of the videos, 1-3 months after the initial viewing.

The project team also knew it was important to collect other quantitative metrics of video and resource usage, incluing use of the Chop!Chop! website and views of the videos on the Chop! Chop! Channel. Additional qualitative evaluaton points were established as well. Evaluation began with launch of the videos and continues. All evaluation in this reporting is through July 2016.

*Contract Videographer and Presenter
CESA Purchasing and Wisconsin Farm to School partners are lucky to have long-standing relationships with the videographer at SOHE. This videographer has a long history in production of farm to school, public health, and food-related projects, which allowed for all partners to start with a stronger understanding of the project and goals. During this time, the contract was signed with the videographer, and a firm timeline for scripts, pre-production, filming, post-production and release was put into place. The videographer also served an advising role throughout the project as to best practices for filming and multimedia inclusion. During this time two additional contracts were confirmed with the hosts of the videos. Originally, local food author Terese Allen

was slated to serve as on-screen personality in each of the videos. However, the Advisory Panel decided the best option was to include a well-respected food service peer as the lead in the videos. This emphasis on peer to peer learning was much appreciated. Retired Child Nutrition Manager Susan Peterman was hired as video presence with Terese remaining on board to do the video intros and wrap ups and to lend the voice of a cultural Wisconsin food expert. Both were integral to script development and feedback toward final edits of the videos.

*Identify Featured Produce Items
The project team knew setting concise video content, including fruits and vegetables to feature, was important to project success. One of the first details finalized was the produce items featured in each video. The final list includes dark leafy greens, brassicas for slaw, root vegetables, winter squash, tomatoes and peppers. Establishing the list of products was an important step for finding the appropriate farmers to feature in each video.

*Develop Draft Video Script
Drafting the video outlines and scripts was a truly collaborative process including all project partners. The content areas identified by the Advisory Panel were translated into script format. The project videographer provided a script template to guide development, as writing for video production was new to the group. CIAS took the lead for developing a standard introduction and closing to be used in each video, as well as topic-specific content for each of the five videos. Created using collaborative Google Docs, once the video scripts were complete, each underwent a review by all core project partners for general effectiveness, and details regarding child nutrition, food safety, ease of filming, and effective culinary skills. Once the scripts were refined by the core team, they were then reviewed by the Advisory Panel at an in-person meeting during March 2016. After these edits were incorporated, the scripts were considered final, and filming details were planned based on the scripts. This was the largest step in translating a project idea into action.

*Recruit Farmer and Food Service Directors for Videos
An important component of the Chop! Chop! Series is to convey the easy purchase and incorporation of Wisconsin-grown foods communicated by food service directors to peers. To this end, an original goal of the project was to feature a short interview between a farmer and a school food service director in each video. The farmer was to be someone who produced a crop featured in the video, who had a strong working relationship with an existing food service director. This aspect of the project was to be carried out by Town and Country RC&D. Unfortunately, the staff person at this organization left in early 2015. The farmer/FSD matching was carried out by staff at CIAS. This aspect of project development proved challenging, as there were limited options to select from for these interview pairs. However, the work to find the right pairs paid off, as many qualitative reports indicate these interviews are the most impactful components of the videos. The interviews featured a diverse set of Wisconsin specialty crop farms including CSAs, a hydroponic farm, an apple orchard, a market farm and a farm growing large volumes for institutions. In retrospect, finding a significantly larger farm, and a farmers of diverse ethnic backgrounds would have made a nice contribution to this project. The list of farms and districts participating in the videos is listed below. Ultimately, these interviews strengthened our ability to highlight the positive economic impact of school districts purchasing specialty crops from local sources.

Dark Leafy Greens: Ledgeview Garden/DePere School District
Brassicas: Amazing Grace Family Farm/Janesville School District
Root Vegetables: High Meadow Farm/Fort Atkinson School District
Winter Squash: Apple Blossom Farm/Oshkosh School District
Tomatoes & Peppers: Vermont Valley Community Farm/Mt. Horeb School District

*Contracts for Film Locations, Film Crew and Needed Equipment
Middleton-Cross Plains School District (a CESA Purchasing Nutrition Cooperative District) offered the use of their beautiful new kitchen space as the film location for the project. Although the initial plan was to film In a WPT studio, filming in a familiar school food setting won out as the most effective strategy for conveying the school food environment. This contract was set in place for filming in June 2015. This district was kind enough to offer use of all needed equipment and facilities for free, which aided in creating effective videos without incurring additional cost or hassle of transporting large food processing equipment long distances. The videographer contracted with a professional Wisconsin Public Television crew for one day of filming with the aim of gaining very high quality professional footage by a three-camera team.

*Develop Marketing and Dissemination Plan (Mar-June 2015)
Early on it was clear that good videos would not be effective if not shared widely within the Wisconsin community, and beyond. Between March and June, CESA Purchasing with support from key advisory members developed a thorough marketing and dissemination plan, focusing on a primary and secondary target audience. Primarily, the goal is for the videos to be shared as widely as possible with Wisconsin schools and other food service institutions. The second audience is the national farm to school audience. This audience is in need of both 1) culinary skills training videos and school food service appropriate recipes and 2) training materials to meet the new USDA and SNA professional development standards for school food professionals. The dissemination plan took both audiences into account, with a primary focus on reaching Wisconsin audiences through the newsletters and social media of the following organizations listed in the attached document. The secondary strategy is through in-person trainings and conference presentations. The dissemination plan is fully completed, and outlined in more detail in the "Goals and Outcomes Achieved" section below. The Chop! Chop! videos and website have been shared widely, and online analytics prove a correlation between information dissemination and resource usage. Finally, plan also incorporated general community outlets and partners. Chop! Chop! resources disseminated to the general community helped educate community leaders and tax payers about the positive economic effect Farm to School has on Wisconsin specialty crop farmers.

*Focus Group: Evaluation and Dissemination (Mar 2015)
The initial Work Plan in the grant proposal indicated the use of focus groups to provide feedback on the video scripts, evaluation plan and dissemination plan. The project Advisory Panel was used as the focus group to provide feedback on these three project components. The group reviewed the documents and provided significant feedback at an in-person meeting in March 2015. This meeting was held at Middleton-Cross Plains School District, and Advisory Panel members were able to provide feedback on the film location and layout of the district kitchen facilities as well.

*Rehearse Script (Apr 2015)
The initial project work plan indicated a meeting for video presenters, videographer and project staff to rehearse the script in April. This specific step was not needed as all parties worked collaboratively in project development. Presenters received the final scripts ahead of filming and were asked to review as needed. The day before filming presenters were in the kitchen space with the videographer to run through filming set-up and address any questions that came up. Rehearsal and planning time was built in to filming days to save time and travel for all involved.

*Recipe Development* (Mar-Sept 2015)
An important goal of the Chop! Chop! project was to not only demonstrate culinary skills, but also to provide the other skills necessary to use Wisconsin-grown produce in school meals. A major component to this is properly vetted recipes appropriate for school meals and scaled to institutional proportions. Going in to the project, we suspected we would be able to highlight existing recipes, but that wasn't always the case. Of the following recipes, almost all had to be adapted in some form or another, and then put through appropriate analysis to determine their fit within the school meal program. Most notably, the coleslaw recipe was developed almost from scratch to accommodate all three vegetables, and the two dressings were heavily adapted from existing USDA recipes. Although unexpected time and resources, including additional time rented in the UW-Madison Food Science Lab, went in to developing these recipe resources, we know it's important to continue to add to the small database of local food recipes for schools, and that this makes an important contribution.

Leafy Greens: Fall Kale Salad
Winter Squash: Sweet Butternut Mash
Tomatoes & Peppers: Peak Season Ratatouille
Cabbage, Broccoli and Cauliflower: Creamy Chipotle Cole Slaw
Cabbage, Broccoli and Cauliflower: Zippy Wisconsin Slaw
Root Vegetables: Chef T's Roasted Root Vegetables and School House Seasoning

*Filming and Food Preparation* (June 2015)
The initial project work plan set a very strong outline for each of the details needed to develop and create the Chop! Chop! videos. However, one component not fully understood and accounted for ahead of time was the direct preparation needed for filming, especially in the case of food items.

Almost all of the preparation for filming, including script, video crew, presenters, farmers etc., was planned well in advance. However, as no one in the group had filmed a full-scale cooking show before, we were not expecting the significant amount of food preparation included in video production. Food production included purchasing and staging all ingredients to be used on the set, all ingredients prepared ahead of time to be used in food production on-set, food in various stages of preparation (pre-baked pizza, already-roasted vegetables, pre-baked squash, etc.) to be used in demonstration throughout the video, and "final versions" of foods produced in the videos. To meet the needs of this portion of the project, an undergraduate Food Science student was hired to assist CIAS staff in the UW-Madison Food Lab to prepare food the day before moving to the film set. All food and ingredients were then transported to the film set. The kitchen for filming was reserved for three days. Additional food items were purchased by CESA Purchasing in order to accommodate for all stages of the recipes.

*Video Production (June 2015)
Video production was streamlined to be as efficient as possible to save on travel and time. Filming took place in three separate 'segments'. The first chunk of filming was a half-day at High Meadow Farm where the introduction and wrap-up were filmed, along with the 'mini intros' to segments which repeated throughout each film (like the FSD/farmer interviews). This allowed the crew to become a bit familiar with each other, and allowed for additional on-farm footage to be included in the final videos to bring the sense of WI-agriculture to viewers.

The second segment of filming was the core culinary skills footage filmed over three days at Middleton-Cross Plains School District. The first day was used to set up the filming area and make sure it was ready for the crew. This day was also used for additional food preparation. Day two was primarily used for filming with the professional WPT crew as well as behind-the-scenes food preparation throughout the day. Day three was used for additional clean up and gathering b-roll and footage of food prep as needed. Some farmer/FSD interviews were filmed in the school kitchen. The remaining FSD/farmer interviews were filmed on farms as the third 'segment' of filming. The filming took place two months later than expected, but allowed for use of an empty school kitchen and farms with more robust produce growing.

*Video Post-Production (Jun 2015-Feb 2016)
Video post-production was one of the longest phases of video development, both for inclusion of revisions and because of food safety-related delays. The videographer immediately began editing video content after filming, with the goal of presenting one video to the group for immediate review, which could then be used as a template for editing the other videos. Overall, it was a challenge to edit the videos down to a watchable length (less than 15 minutes) while maintaining vibrant and engaging content. There were at least three rounds of feedback and feedback incorporation between videographer and core team for each of the videos. There were two unexpected pieces of post-production that stalled the final release of the videos: video design and food safety (the latter will be discussed below). Although we budgeted time to review video content, we did not include time for deciding upon the 'design' of the video including visual backgrounds, images and music. This was an extra step for the videographer to find stock images, templates and 'skins' that could be purchased and used as appropriate graphic visuals at the professional caliber we were envisioning for the project. Ideally, we would have liked to include significantly more images and infographics throughout the videos, but time and cost were a limiting factor. Once the team was on the same page, and the videographer found appropriate images to use, the project was back in swing. The additional time also allowed for two requests to be accommodated: a) an integrated 5 series video with one intro and ending that would help stream-line in-person group training and b) an integrated Farmer/Food Service Director interview segment that captured a singular snapshot of the relationship challenges and opportunities between these two professions as they worked to support Farm to School strategies.

*Website and Logo Design (June-Oct 2015)
Although discussed in the project proposal, sufficient time was not included in the work plan for development of a Chop! Chop! website and logo. The core project team understood the importance of branding, and wanted the Chop! Chop! series to be unified and well-branded as a series and as stand-alone videos. The team worked with an independent designer to create a project logo that conveyed both Wisconsin-grown produce and culinary skills appropriate for a

school and institutional audience. CESA Purchasing was able to support the hiring of the graphic designer for this additional aspect of the project. See Table 2. A.: Chop! Chop! Logo

The team was also aware that a clear, concise, and well-branded website was needed to contain all Chop! Chop! resources in one place. CIAS staff was able to develop the online presence as a page on the existing CIAS website. The goal was to create a home base for all of the videos, resources, recipes and viewing tools associated with the Chop! Chop! videos. Although the page looks simple, much time went into a simple concept that would clearly convey all aspects of the project and include easy entry points for project evaluation.

Video Publication (& Food Safety Hindrances) (Oct - Nov 2015)
Although most aspects of the project were completed on time and above expectation, there were issues created around food safety practices included (or not included) in the video. Although the first videos and their supporting resources and evaluations were published on-time in early October, the team received an almost-immediate request from DPI Food Safety and WI Department of Health Services (OHS) Food Safety Specialists to remove all videos because of food safety inconsistencies. Of all the project challenges, this was the only one that was a hard-stop in delaying the public release of the videos. When this request was made, all published videos were temporarily pulled from the Chop! Chop! Website. All Chop! Chop! Videos then went through an additional review and series of edits from the food safety teams at DPI and then OHS. This review took an additional three weeks, and then required another round of edits to be made to all of the videos, as some of the requested changes were in stock intro/wrap-up footage used in all videos. Final versions of all videos were released by December 2015, with outreach and dissemination taking place in early 2016. (The food safety issues will be addressed further in the "Lessons Learned" section below.) The delay relating to food safety discrepancies is much of the reason the project team filed for an extension of the grant deadline.

*Video Outreach and Dissemination (Oct 2015-Jun 2016)
Although the final videos were not published until December 2015, outreach strategies commenced in October 2015 to align with National Farm to School Month. Dissemination began through conversations and emails with farm to school, school food service, local/regional food partners, state agencies, nonprofit organization partners and media partners who agreed early on in the project to be dissemination partners or who were listed as outreach targets. These partners were notified of the Chop! Chop! Project overview and upcoming launch, including the 'sizzle reel' trailer. With over 50 attendees, the videos officially 'launched' with a kick-off event hosted by CESA Purchasing and CIAS on the UW Madison campus in October 2015. The event screened portions of the videos, included presentations from core partners, farmers and food service directors, and garnered local media attention. Throughout the video development phase, video snippets and the Chop! Chop! concept were used at training events throughout the state. Once the videos were live, the full dissemination strategy (as outlined below in Section Ill) was carried out with the videos promoted through both media and electronic channels, as well as through trainings and other in person events. The team plans to continue to push the Chop! Chop! training resources through dissemination channels at least two per year moving forward, and through in-person and reoccurring training activities throughout the state on an ongoing basis.

*Evaluation and Reporting (Oct 2015-Aug 2016)
The final stage of project work is evaluation and reporting. Evaluation tools were set in place in conjunction with the final launch of the videos. The past months have consisted of summarizing evaluation data and conducting follow up evaluations (post-post video surveys) with video viewers who completed preliminary evaluations forms.

## III. Goals and Outcomes Achieved

**A.** The initial goal of producing culinary skills videos emphasizing Wisconsin-grown produce items was achieved, with a total of 5 videos ranging from 12-15 minutes in duration produced and publicly shared. These videos are supported by a comprehensive website including recipes and other resources. In addition, the Chop Chop Resource Guide was developed and published by partners at WI DPI Team Nutrition towards the end of this project as an unanticipated resource to be used as an additional tool with the video training.

After the videos were finalized, outreach became the focus of project work in order to provide maximum reach for the videos within the school food service and farm to school communities. As outlined in the project proposal, there were three main avenues for dissemination. Dissemination regarding the Chop! Chop! videos is ongoing, and will continue after the end of the funded grant period. Outreach activities are shared below in alignment with grant objectives.

- CESA Purchasing Nutrition member districts (64} were engaged via email, social media posts, e-newsletter, and at monthly/quarterly meetings in multiple ways during the course of the project including but not limited to:
    - Participation in the Advisory Committee
    - Initial screening of the videos shared with CESA Nutrition directors for feedback regarding content and usability.
    - Videos utilized for SNA CEU Training facilitated by Susan Peterman for 63 school districts.
    - Resources regarding the video series were shared at four CESA Nutrition Purchasing regional training meetings with school food service directors and their line staff
    - Used in a presentation by Susan Peterman with 70+ nutrition directors on how to use the video tools towards obtaining federally required professional development credits for directors and staff.
- News of the project was disseminated publicly through a developed press release and/or other publicity materials and language developed by project staff. The goal was outreach through 15 partner organizations. Chop! Chop! information was shared through e-mail, newsletter, e- newsletter, social media or other avenues through the following 14 partners, some promoting the videos more than one time, for a total of at least 19 notable outreach activities. Most successfully, the Wisconsin Farm to School Newsletter directly reaches over 1000 farm to school practitioners within the state. Wisconsin School Nutrition Association shared news of the video multiple times, and through various channels. The USDA Farm to School team found these Culinary Skills videos to be of interest too, and included the resource in their farm to school e-newsletter with national reach.
    - Wisconsin Farm to School (3)

    - Great Lakes Region Farm to School Network (3)
    - WI Department of Public Instruction - Team Nutrition
    - WI Department of Public Instruction - School Nutrition Team
    - Wisconsin Department of Ag, Trade and Consumer Protection
    - Wisconsin Department of Health Services
    - School Nutrition Association of Wisconsin
    - University of Wisconsin, Madison - Center for Integrated Agricultural Systems
    - University of Wisconsin, Madison - College of Ag and Life Sciences
    - National Farm to School Network (2)
    - Wisconsin Local Food Network
    - UW-Extension
    - Edible Madison
    - USDA Farm to School Newsletter
- The secondary form of dissemination was through in-person conference presentations, meetings, trainings and workshops. The project proposal outlined four venues for in-person dissemination, which was exceeded with 18 events held. (Please note, all CESA-related activities are listed separately above). A summary of activities include:
    - Chop Chop Kick Off & Special Screening event held on the UW-Madison campus. September 2015. (All Partners hosted, So+ attendees including core project partners, Advisory Panel Members, farmers and food service directors featured in the videos and general farm to school partners from around the state and media.)
    - National Farm to Cafeteria Conference, Lightning Talk. June 2016. (CIAS, 100+ Participants)
    - National Farm to Cafeteria Conference, Full Workshop. June 2016 (CIAS, 55 Participants)
    - Four School Nutrition Skills Development Courses. 2015 (DPI, Team Nutrition, 56 Participants)
    - What's New Webinar. (DPI Team Nutrition, Unknown Participants)
    - USDA Team Nutrition Grantee Meeting.2016 - (DPI Team Nutrition, 50 participants)
    - Team Up Training. (DPI Team Nutrition, 90 Participants)
    - Two Farm to School, School Nutrition Skills Development Courses. Summer 2016 (DPI, School Nutrition Team, 45 Participants)
    - Wisconsin Farm to School AmeriCorps Training. August 2016. (CIAS, 21 Participants)
    - Wisconsin Farm to School Summit workshop. Jan 2015. (CIAS, CESA, 36 Participants)
    - Two Wisconsin Local Food Network Summit Presentations. 2015 & 2016. (CIAS, 47 Participants)
    - WI-School Nutrition Association Spring Director Meeting.2016 (CIAS, 55 Participants)
    - WI-School Nutrition Association Annual Conference, Workshop .2016. (CIAS, CESA, 42 Participants)
    - United Fresh Produce Alliance National Convention - "Produce Forum for School Success". June 2016 {CESA Purchasing, SO school nutrition directors from across the U.S. and USDA representatives).

The reach of the videos was extensive, and exceeded project goals. The videos were viewed online by individuals or used for in-person group trainings. Video views were measured in two ways. A total of 1,373 views were recorded through the short pre-survey administered before access was given to the videos, which asked for the state, county and number of viewers. A total of 1,201views were recorded by YouTube, the second measurement. Because it is possible view the videos without completing the pre-survey, and because YouTube views do not indicate how many people are watching each video at a time, there is no alignment between these two numbers, and they are not comprehensive. Instead, they represent the minimum number of views. Of this, at least 931viewers were from Wisconsin, far exceeding the goal of 250 views by WI food service staff.

Post-video evaluations also indicate the training videos and resources boost both knowledge and purchase of Wisconsin-grown produce items. Of survey respondents, an average of 95% and 98% agreed or strongly agreed that the videos increased both knowledge of the culinary skills and menu incorporation ideas demonstrated in each video. This is impactful as lack of culinary skills and menu information are high-ranked barriers preventing schools from purchasing WI-grown produce. Further, 95% of survey respondents agreed or strongly agreed they planned to begin or increase purchases of WI-grown product after viewing the training videos. The project primarily aimed to increase purchase of WI-fruits and vegetables through increasing school food service staff skills in handling and incorporating local produce, which data shows was accomplished. The secondary goal of the videos was to highlight the economic and community benefits of supporting Wisconsin's growers through the purchase of Wisconsin product, accomplished through sharing short interviews highlighting WI farmers in each video. The evaluation results indicate this strategy was a success, with an average of 95% of survey respondents strongly agreeing or agreeing that they increased knowledge of the importance of purchasing from WI growers. Lastly, the project aimed to introduce and educate food service staff about 'cosmetically imperfect seconds' (CIS), and lay the foundation to grow the market for these products that may not have value in the wholesale market for aesthetic reasons. Survey results report that an average of 96% of respondents agreed or strongly agreed that they learned important information about CIS products.

Effectiveness of video content was also important to the project team, as messaging, imagery and school-food details are very specific to this target audience. At least 90% of all survey respondents rated content areas of the videos as effective or very effective including: culinary skills demonstrations {93%), recipe demonstrations (92%}, nutrition and menu planning (92%), and the interview conversations between farmers and food service directors (93%). Further, an estimated 46% of survey respondents were in leadership and/or decision making positions (Child Nutrition Directors or farm to school program staff), and an average 93% of these people in leadership positions indicated they would use these videos to train other food service staff within their organizations.

The project did follow up with those who watched the videos and complete the initial evaluation study to gauge video impacts months after the videos were initially viewed. The number of responses to this follow up survey was extremely low, only 11, representing a very small portion of the total number of video viewers. This follow up survey indicated that almost half of

respondents (S) did in fact start or increase purchase of Wisconsin-grown products within 2-7 months of viewing the videos. The surveys also indicated that the culinary skills learned through the videos, and the accompanying resources like recipes, were still being actively used by viewers after the initial training. Because the response rate to this follow up survey was so low, these numbers show a soft indication of the medium term impacts of the training video project, but do not provide definitive answers. It is heartening to see that video skills and resource materials are still being used after the initial exposure.

The long term goal of the project was to alleviate barriers food service staff and directors report when attempting to procure, process and menu Wisconsin-grown produce items. The evaluation evidence suggests these training videos are a key resource in helping school food service staff overcome a lack of culinary skills and recipe resources needed in order to integrate more Wisconsin grown foods into school meal service.

**B.** The major goals and outcomes for the project center on video reach and exposure within Wisconsin, video effectiveness, and the increased purchase of WI-grown specialty crops by schools food services.

As indicated above, measured through either the pre-video survey or YouTube video views, video reach exceeded the goal of 250 views by Wisconsin school food service staff, with exposure to over 1,200 individuals. Although the target audience was Wisconsin school food professionals, it's heartening to see the Chop! Chop! Video series gain national exposure, with over 350 views outside of Wisconsin.

The initial project evaluation goals outlined in the proposal called for 160 completed evaluations (60% response rate) indicating the following video outcomes immediately after watching the training videos:

- 2 point knowledge gain (on a 5 point scale) in demonstrated culinary skills and menu incorporation
- 3.5 effectiveness rating for video content (on a 5-point scale)
- 45% of viewers indicating an increase in purchase of Wisconsin-grown products
- 40% of viewers indicating an increase in knowledge about the importance and impacts of purchasing Wisconsin-grown products
- 20% of viewers reporting an increase in understanding and interest in using cosmetically imperfect second products.

Video evaluations indicated these target outcomes were met by the project. However, it is important to note that the evaluation strategy was shifted slightly upon project implementation. In order to minimize potential barriers for participants to engage with the free online videos, a pre- survey was not administered to viewers before watching the video, as indicated in the proposal. Instead, a short survey only collecting number of viewers, county, state and title was used. Therefore, only a post-video evaluation was used. This also limited the project team's ability to conduct follow up surveys (2-7 months after watching videos), as email data was only available for individuals who completed the post-video survey and provided contact information, or through the CESA Purchasing email list. A four-point scale (strongly agree, agree, disagree, strongly disagree) was used to measure knowledge gains for culinary skills, recipe

implementation, economic benefits of purchasing from Wisconsin farmers, and CIS products. The same scale was also used to gauge impacts on purchasing WI-grown products after watching the videos.

The overall desired outcome of this project was for "at least 45% of training participants to indicate increased use of Wisconsin specialty crops in school food service due to the training content," representing at least 146 school food service professionals increasing their purchases of Wisconsin grown specialty crops when accessing these training materials during the time of the grant project. This goal was largely met, though not entirely as intended. There were 248 video evaluations completed by school food service staff and farm to school professionals, and over 90% of these responses indicated they would begin or increase purchase of WI-grown product as an outcome of watching a training video. That said, this response rate represented only 15% of all video viewers. Further, as the project team analyzed evaluation data, it became clear that only about 45% of video viewers were School Food Directors or farm to school staff, and therefore in a position to make purchasing decisions impacting school meal operations. However, this does indicate that the videos were used as Intended, shown to school food line staff as a training tool to improve culinary skills and allow the school food system to accept and use more locally-grown products. However, the project team did not initially recognize the two distinct audience groups: those with the power to make changes to school food procurement (Food Service Directors) and those directly in-need of additional culinary skills in order to actually incorporate additional WI-grown product into school meals.

## IV. Beneficiaries

There are two most significant beneficiaries of the Chop! Chop! project. The first is Wisconsin's School Food Service directors who now have a very specific set of tools that provide support to overcome some of the most often named barriers to purchasing more local foods for service in Wisconsin schools: culinary skills and institutionally-appropriate recipes. The culinary skills training videos are housed online and available for free to any of the 800+ Wisconsin school food authorities who would like to use them. Almost 1,400 school food service leaders and staff in Wisconsin and across the country have benefited from these trainings through July 2016. These videos fill a need that cannot be met through in-person trainings alone. Between the positive tone of the video and the peer-to-peer networking of the farmer/FSD conversations, the videos serve to both encourage and support those who are new to farm to school and local food purchasing to entering this new area of school meal procurement.

The second key beneficiary is Wisconsin's specialty crop producer of all sizes, who will benefit from additional market access and exposure thanks to these videos. Although the evaluation component of the project does not assess how much new and additional purchase of Wisconsin-grown produce items occurred because of this project, evaluations do indicate that 95% of viewers agreed or strongly agreed that they will begin or increase purchase of Wisconsin-grown products, and in follow-up surveys (although results are small) about half of respondents report this increase to be true.

Although the original intent of the videos was focused on culinary skills, the strength and genuine nature of the farmer/FSD conversations, along with the overall tone of the videos, served

to promote the farm to school concept in general and increase overall awareness of these programs and the beneficial impacts they provide for farmers, schools and students. In fact, a separate segment incorporating all farmer/FSD conversations into a single reel was created and distributed based on interest and requests from community partners.

Lastly, Wisconsin students will benefit from the increased use of fresh, local and minimally processed fruits and vegetables in school meals. These increases have been shown to improve the quantity and variety of future fruit and vegetable consumption. The 500,000 students that participate daily in school lunch programs will be presented with new and empowering options for obtaining their produce servings, while also learning about the roots of their Wisconsin-grown food. Studies show students that participate in school salad bars and farm to school programs are more likely to try new fruits and vegetables and are also able to learn first-hand about appropriate serving sizes. Through increased procurement of Wisconsin specialty crops, students will eat healthier diets and achieve improved health behavior in the future.

## V. Lessons Learned

There are many lessons learned from completing the Chop! Chop! video series. The most significant is the overwhelming enthusiasm for the videos and the breadth of their spread across the country which indicate the demand for this type of culinary skills training resource. In fact, at the June 2016 United Fresh Produce Alliance convention in Chicago, numerous school nutrition directors from across the U.S. were eager to learn and gain access to these videos for immediate use as a F2S professional development tool.

The training team was happily surprised to see the online reach of the project as well, and how it has already been listed as a culinary skills training resource for many farm to school TA providers, including on the website for USDA Farm to School program. This emphasizes the need for the project, and the usefulness of the resources created. Not only are the training videos well received, the series of six institutional recipes developed for the project have been used by schools and are beautifully shared through the Chop! Chop! Resource Guide developed by WI DPI Team Nutrition, with two copies sent free to each school food service authority in the state.

Also, the short video conversations between food service directors and farmers with strong farm to school relationships highlighted in each video turned out to be a huge success. The five conversations are both moving and eloquently share anecdotes about the positive impacts farm to school has for growers like increased marketing and awareness of F2S farms, increased student appreciation of meals featuring fresh products, and the importance of high volume sales to schools to the bottom line of farm incomes. These videos were so impactful, they became the foundation for a funded grant project from National Farm to School Network to highlight farmer/food service director relationships through short video interviews from each of the six states in the Great Lakes region.

There were some learning moments through the timeline of the grant project as well. The primary challenge faced by the project team was an unforeseen delay based on food safety issues. Although the video scripts were edited by WI DPI Team Nutrition Members and school food service staff and consultants with significant experience, some of the final videos were

flagged by Food Safety team members at DPI and WI Department of Health Services for showing unapproved practices for handling fresh produce such as how lettuce and squash are washed, some work surfaces used throughout the video and when gloves were worn. These flagged items delayed the official release of the videos, because they required re-filming of some scenes and visual notifications added to the videos to note best food safety practices. It was ultimately important to the project team to release videos demonstrating proper food safety practices. However, the process illuminated differences between state mandated best practices and practices most commonly used in schools. Also, certain decisions were made for the filming of the video (i.e., an uncovered stainless steel work surfaces added too much glare to the camera frame, and ungloved hands provided a much clearer image of how to handle some produce items) that compromised food safety best practices - which were then always noted in the video in some manner. This delay, in reformulating videos to meet food safety needs, was not expected, and a good reminder for future projects to engage food safety professionals and all state entities involved with food safety early in the script development and review process to make the review process most efficient. It is valuable to note that the issues experienced in developing these training videos were leveraged into a workshop at the National Farm to Cafeteria Conference highlighting best practices for creating farm to school training materials.

Also, there were some lessons learned on the evaluation front as well. When developing the project, staff were lumping all video viewers into one category: food service directors who are also in a decision making position to purchase more WI-grown fruits and vegetables. However, it became clear that because the video was to be used as a training tool with food service line staff who would actually be handling and using products, that not all video viewers were in a decision making position to purchase additional WI-grown items. Although evaluation materials were appropriate to both audiences, the team did not take steps to differentiate between nutrition directors and line staff in evaluations.

Lastly, there was one remaining evaluation lesson learned surrounding post-video evaluations from viewers. Because online video viewers were not required to complete a post-video evaluation, and because the team did not explicitly collect emails addresses from viewers, the post-video evaluation response rate was low. Also contributing to this was low engagement from outside project partners in using paper versions of the evaluation forms when showing the videos at in-person trainings. For future projects, the team would be more explicit in requiring in-person facilitators to use the evaluation form, and think through creative solutions to encourage online viewers to complete the evaluation form. The most successful strategy to receive completed evaluations from viewers was to require them in order for viewers to receive professional development CEUs. The project team does feel the evaluations received are meaningful, and meet the grant objectives.

## VI. Additional Information

- Chop! Chop! Website and links to videos: www.cias.wisc.edu/chopchop
- Chop! Chop! Resource Guide, Developed by WI DP/ Team Nutrition: https://dpi.wi.gov/sites/default/files/imce/team-nutrition/pdf/Chop%20Chop%20Resource%20 Guide%202016%20-%20FINAL.pdf

- Please note, project partners WI DPI Team Nutrition received USDA Team Nutrition grant funds to develop culinary skills training videos. We worked collaboratively to produce and promote the five videos highlighting Wisconsin specialty crops. However, the Chop! Chop! video featuring whole grains was developed through Team Nutrition, and no SCBG funds were used for the development of the whole grains video.

## VII. Contact Info

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# 14) Risk Management tools for Hmong growers (FY14-014)

**Report Date:** June 27, 2017

## I. Project Summary

**A.** Risk Management Tools for Hmong Growers seeks to provide culturally appropriate training to improve the knowledge and use of risk management tools to 80 Hmong fresh market produce growers and 40 Hmong ginseng growers. A total of four workshops, offered in various geographical areas, will be held to help fresh market produce growers increase their knowledge of safe food handling and pest management techniques. Two Good Agriculture Practices (GAPs) pre-audit field days will be conducted to demonstrate GAP audit processes. The "Doctor Is In" Series: Building the Foundation for Growing Quality Ginseng" will feature six small group grower discussions designed to increase Hmong ginseng growers' knowledge of crop protection techniques.

As results, four workshops were offered to 50 Hmong fresh produce growers in Green Bay, La Crosse, Stevens Point and Wausau. The one in Green Bay was canceled due to lack of participation. Two field-day trainings were held in East Troy and Athens for 8 Hmong fresh market growers. The total number of Hmong fresh market growers served under this grant was 58 participants. Moreover, we offered six "Doctor Is in Series: Building the Foundation for Growing Quality Ginseng" group discussions to 48 Hmong ginseng growers. From the workshops/trainings evaluations, all participants felt they had learned enough to feel confident about using the information they had learned. Most of them also stated that they learned something new that they have never known before.

Many Hmong fresh market produce and ginseng growers lack access to culturally appropriate risk management training that can enhance their sustainability, improve the quality and safety of their produce, and provide them with tools to improve their bottom line. Language and other cultural barriers create obstacles to obtaining and implementing information that other, mainstream farmers have access to. Many Hmong ginseng growers in Wisconsin feel they lack a solid foundation of knowledge in growing ginseng. While this crop is difficult to grow, in part because of its susceptibility to destructive plant pathogens, new crop protection tools are available. However, these new products and practices have complicated crop management/ protection strategies for all involved in growing this specialized crop. Workshop evaluations, collected from Hmong growers at the spring Ginseng Growers Conference in 2014, identified what information they would like to know more about. The evaluation was completed by 31 of the 42 Hmong growers in attendance. Topics identified include: effective pesticide and fungicide use, soil health, how to handle fluctuations in weather, ginseng seed production, and record keeping.

**B.** The project was used and built from the safe food handling materials and basic pest management developed in the FY 9, 10, 11 & 13 Specialty Crop Block Grants. We introduced different topics such as cover crops & crop rotation, and brought Hmong fresh market growers to on-farm field trainings. We also targeted different audience groups like the Hmong ginseng growers and helped them to improve their pest management knowledge and skills.

## II. Project Approach

On February 7, 2014, we hosted the first cover crops for pest management and soil health workshop in La Crosse, WI to 21 Hmong fresh market produce growers. The evaluations from the workshop showed that all participants felt they had learned enough to feel confident about using the information they had learned. Most of them also stated that they learned something that they have never known before.

On April 25, 2015, we hosted a workshop on the USDA Noninsured Crop Disaster Assistance Program (NAP) which was requested by the Hmong growers in Marathon County. We had a total of 12 Hmong growers (9 ginseng growers and 3 fresh produce growers) attendance at this workshop. Evaluations from this workshop showed that all participants felt they had learned enough to feel confident about using the information they had learned. Some of them contacted the local Farm Service Agency and enrolled into the NAP program. They also stated that they wanted to learn about farm loan programs next time.

For the field day trainings, we brought 3 Hmong growers to attend the 2015 Wisconsin Cover Crops Conference in East Troy on August 14, 2015. They learned so much on the benefits of cover crops. This conference was held on Friday so it was very hard to bring Hmong growers to attend the conference because most Hmong fresh market growers in WI sell at Saturday farmers markets so on Fridays they harvest fresh produce and get them ready for Saturday markets.

For the Doctor Is In Series: *Building the Foundation for Growing Quality Ginseng*, we offered and hosted 6 workshops for Hmong ginseng growers in Marathon County. All the workshops were held at the Hmong American Center, Inc. in Wausau, Wisconsin. The first workshop was hosted on March 28, 2015. We had a total of 6 Hmong ginseng growers attended this workshop. The second workshop was hosted on April 11, 2015. We had a total of 5 Hmong ginseng growers attended this one. The third workshop was scheduled on May 23, 2015, but it was canceled due to the loss of the first Hmong ginseng grower, a good leader in the Hmong community. May 23, 2015 was the day of his funeral service. The fourth workshop was hosted on June 27, 2015. We had a total of 6 Hmong ginseng growers attended. On July 18, 2015, we hosted the fifth workshop and 16 Hmong ginseng growers came. On August 7, 2015, we hosted the sixth workshop. We brought the Hmong ginseng growers to attend the Ginseng Field Day Training. We had a total of 20 Hmong ginseng growers attending this field day training.

On August 8, 2015, we made up for the workshop canceled on May 23, 2015 and recapped everything in the series. We had a total of 21 Hmong ginseng growers in attendance at this workshop. They learned so much for the workshop series to improve their farming practices and to build their foundation. At the end of the series, 3 Hmong ginseng growers stepped forward and volunteered to be the mentors for other ginseng growers who need help. We recognized those Hmong ginseng growers who showed commitments and attended at least 50% (3 out of 6 workshops) of the workshop series with a certificate of completion signed by Kathy Schmitt, Wisconsin Farm Center Director at the Wisconsin Department of Agriculture, Trade and Consumer Protection and Dr. Mary Hausbeck, Professor/Researcher at Michigan State University.

On November 7, 2015, we hosted a mentor training on the topics of cover crops for pest management and soil health in Stevens Point, Wisconsin. We invited a staff member from Dane County UW Extension to speak on the topic of cover crops for pest management. We also invited a staff member from Natural Resource Conservation Service to cover the soil health topic. Furthermore, we introduced other coaching skills at the training as well. We had a total of 17 Hmong participants at the event.

On September 18, 2016, we hosted a Good Agricultural Practices (GAPs) field day training at Stoney Acres Farm in Athens, Wisconsin. We had 5 Hmong growers attend this field day training. Some Hmong growers could not find the place and then they decided to drive back home. For this field day training, we walked through the field, high tunnels and packing shed to discuss about planning & planting schedule, cover crop & crop rotation, machinery, post harvesting and marketing. This training covered pretty much the major parts of farming in small to mid-size scale. The participants enjoyed the tour and asked a lot of good questions.

## III. Goals and Outcomes Achieved

**A.** Project Goals:

- Reach out to 80 Hmong fresh market produce growers
- Conduct 4 workshops
- Conduct 2 field-day trainings
- Reach out to 40 Hmong ginseng growers
- Conduct 6 “Doctor Is in Series: Building the Foundation for Growing Quality Ginseng” small group grower discussions

Project Accomplishments:

- Reached out to 58 Hmong fresh market produce growers
- Conducted 3 workshops and 1 workshop was offered, but no participation
- Conducted 2 field-day trainings
- Reached out to 48 Hmong ginseng growers
- Conducted six “Doctor Is in Series: Building the Foundation for Growing Quality Ginseng” group growers discussions

For the post survey, we were able to 41 out of 58 Hmong fresh market produce growers to complete the survey. Below is the summary of the post survey for the SCBG FY14: Risk Management Tools for Hmong Growers Project.

Goal: Hmong fresh market produce growers will increase their knowledge and implementation of risk management techniques. Performance Measure and Benchmark: Evaluations gathered the day of the workshop ask participants to rate, on a scale of one to five, how much they have learned as a result of their participation in the workshop for several key informational areas covered in the workshop. A follow up phone survey conducted near the end of the project will ask participants which of those key informational areas they have put to use in their operation. Target: Rating scale average of 3.5 or greater on a five point scale on workshop evaluations.

Follow up phone survey: 70% of the growers surveyed implement at least one of the key informational areas from the workshop.

**Outcome:** Achieved goal with 85% of growers surveyed implementing at least one of the key informational areas from the workshop.

Information gathered from the workshops and phone surveys will be tracked on an Excel spreadsheet and will be used to track results and deficiencies. If workshop rating scores do not meet an average of 3.5, content and/or teaching method(s) will to be changed. If farmers fail to meet the implementation goal of 70%, staff needs to explore why. Possible explanations might be: relevancy of information, cultural appropriateness, degree of difficulty, a need for more hands on follow up to transfer knowledge to skill, etc. These results will be used to modify curriculum, teaching methods, and other practices in future workshops during the grant period and in future projects.

Outcome: All workshops achieved an average rating of 3.5

**B.**

## SCBG FY14: Risk Management tools for Hmong growers

## Post-Survey

This evaluation just take a moment of your time. To deliver quality services, your inputs are important to us. Please complete this short evaluation!

1. What types of farming do you do? _36___ Vegetables __3__ Ginseng __4__ Fruit Trees

2. Which of the following skills/information have you been using for your farming practices?

__41___ The knowledge of cover crops
__41___ The knowledge of crop families
__41___ The knowledge of crop rotation
__41___ The knowledge of understanding good agricultural practices (GAPs)
__41___ The knowledge of worker hygiene (washing hands, wearing proper clothes, etc...)
__36___ The knowledge of cleaning work places, containers, farm equipment, etc...
__38___ The knowledge of using postharvest water
__11___ The knowledge of NAP insurance (eligibility, coverage & payment, etc...)
_____ Others:_____

1) I have a better knowledge of using a washer for vegetable, like carrots.
2) Equipment for Farming
3) More knowledge of the loan programs through FSA

3. Do you wash your hand before handling your fresh produce after attending the workshop?
__41_ Yes
_____ No

4. Have you been using/planning to use cover crops on your fields/farm after attending the workshop?
__29__ Yes
__12__ No

5. Have you owned any NAP or other crop insurance policy after attending the NAP program workshop?
__7___ Yes
__34__ No

6. What else would you like to share that has not been covered on this survey?

- I learned about changing the way I do my packaging and how I can improve my marketing materials. I also really like how open the presenters were. The handout she gave us about her planting schedule was very helpful. I have try it and it gives me more ideas as to how I can plant and sell.

- Farm-equipment, different kinds of cover crops, touring the hoop houses, learning about the ways they were growing their tomatoes. I took that idea and using it.

- I only rent my land so I cannot plant cover crops. I wish there were more people to attend this workshop as I have learned a lot. I learned about the cooler, that I can build myself one. I like the tomatoes in the hoop houses. I learned to take care of them better after this workshop. I also learned about the different types of farm equipment. The watering hose and the planter. I am saving money now to get one.

- I would like you to hold another field day for us as we did not go through all the field. I want to see how each equipment works on the field. I learn that cilantro is very good for bugs and also help the roots on other vegetables. I planted a lot of cilantro around my beets, carrots and other root vegetable, which helps a lot. Thank you so much for offering this important workshop to us.

- The information we have learned from our field training was very valuable. We learned how different kinds of farming equipment could help us increase our production and decrease our labor work. We purchase a tractor after attending this workshop.

- I have learned so much from this training. Thank you very much for the speakers and for you. Sharing and talking about cover crops, has help me understand more about the benefits, the how to and when it would be a good time to plant.

- It was not what I intended to learned about ginseng in this workshop, but it was helpful.

- It's been a while I can't remember everything, but I did learned a lot.

- I have been using cover crops for many years and notice that it tremendously help improve the soil health. It slows down the growth of weeds and gives my vegetables more life. I think it's better if everyone shares what kind of cover crops they have used in the past and talked about their experiences. I like to see more brainstorming ideas from other farmers as how they grow their vegetables and sell their products.

- After attending this workshop, I have planted a few rolls of cover crops. I am waiting to see what the change will be for next year.

- I have learned more and more each time I attend these workshop. The values and education provided has made a significant improvement in myself and as well as my farming life. I appreciate all you do and everything you and Jack has done to help us. We cannot imagine where we would be without both of you.

- It would be more beneficial if you can provide us a list of all cover crops and where we can purchase them in our own town. Also if you could talk about fertilizer for our vegetable.

- I really like the soil health. I would like to see more class offer about soil health, fertilizer, spraying the right stuff to our vegetables that will produce more. I also would like to see more workshop being offer about flowers and fruit trees.

- I learned a lot! I change my crop rotation this year. I want to see a change, because from this workshop I learned that cover crops have an important role in a successful farming system.

- I really like cover crops but have not plant any because I do not have enough land to rotate. The information that was provided at the workshop was very useful. Please continue to teach us. Thank you so much.

- I learned a lot from the workshop. I have shared the information that I have learned to my friends and family. I like the demonstration shown.

- More topics and speakers to cover about caring for ginseng.

- I know that couple presenters were there to teach and share their expertise to us, but since my mother passed away, I don't remember much. What I do remember is that it was a very good workshop and that I have learned a lot.

- I learned so much, especially understanding more about cover crops, that it benefit the soil and future crops. Stops weed.

- I learned cover crops reduce wind and water erosion on all types of soil. It also suppress the growth of the plants and weeds. So much that has been taught in the workshop helps me to become a better farmer.

- I want all my friends and family to attend this workshop as it has improve my skills in farming. A lot of people just think it's easy to plant cause its dirt and it will grow like it is in Laos, but it's not. It will cost you less in the long run and save you more as you continue to learn about cover crops. Thank you so much to all of you.

- I learned a lot. Thank you.

- There were so much that I have learned. One thing I remember is crop rotation and the crop family. I never knew there was such thing. I just plant everything how I like it and where I wanted to plant. Never knew and think that plants would have family and that I need to group them.

- Can't remember, but thank you.

- Very good workshop. Thank you very much. Without you and Jack no one would care to offer such an important workshop. Thank you.

- I would really like it if you can do or show us what cover crops look like out in the field. We see pictures, but it's different when you actually see it with your eyes. It would be better to touch, smell and know which cover crops are the best to choose for planting.

- For so many years since I started farming no one told us about cover crops and crop families. Through this training, I gained so much that has made a change in my farm. I change my crop around. I change the way I plan my schedule for planting and I understand more about other loan programs to help me if I need it.

- Showing us seeds of cover crops. Picture presentation were useful. Financial loans through FSA. Good food and thank you very much.

- I learned that FSA offered different kinds of loan programs for farmers with low interest rate. After this workshop, I was able to get a loan to help me purchase a small tractor. The resources provided was great, the people was knowledgeable.

- This was the first time I learned about cover crops and crop rotation. I really like how the lady show us how to spread cover crops. There was so much that was shared and I don't remember everything except for cover crops.

- Good information was provided through the FSA

- It was a good workshop.

- It would be good if you could show us the different kinds of equipment that plants cover crops. Thank you, it was very good. I learned a lot.

- I went through the loan program at FSA and couldn't get a loan because of my incomplete application and credit. I don't understand why there are so much paperwork and no one couldn't help me complete them. It would be nice if you or Jack could help us with that. I did went elsewhere and got a loan for my tractor.

- Will attend again. Very good!

- I would like to learn more about soil management, application of fertilizer, and the different cover crops for varying soil types, climate, and terrain. I like to understand more about not just seeing what it's like above ground, but rather understanding what is unseen below the soil surface. This will help me maintain better control of my garden.

- Can you cover more about fruit trees, the diseases that can kill your fruits, types of spray for prevention, and fertilizer that increase fruit blossom? All that fruit tree are require to have.

- No comment, good workshop.

Surveyed by: Sophiaya N. Xiong Date of Completion: June 9, 2017

Thank you for you cooperation by completing this short survey!

## IV. Beneficiaries

These are some beneficial statements from the Hmong growers who actually learned and gained knowledge by attending our workshops/trainings.

> "I learned about changing the way I do my packaging and how I can improve my marketing materials. I also really like how open the presenters were. The handout she gave us about her planting schedule was very helpful. I have try it and it gives me more ideas as to how I can plant and sell."
>
> Hmong grower

"I would like you to hold another field day for us as we did not go through all the field. I want to see how each equipment works on the field. I learn that cilantro is very good for bugs and also help the roots on other vegetables. I planted a lot of cilantro around my beets, carrots and other root vegetable, which helps a lot. Thank you so much for offering this important workshop to us."

Hmong grower

"The information we have learned from our field training was very valuable. We learned how different kinds of farming equipment could help us increase our production and decrease our labor work. We purchase a tractor after attending this workshop."

Hmong grower

"I have learned so much from this training. Thank you very much for the speakers and for you. Sharing and talking about cover crops, has help me understand more about the benefits, the how to and when it would be a good time to plant."

Hmong grower

"There were so much that I have learned. One thing I remember is crop rotation and the crop family. I never knew there was such thing. I just plant everything how I like it and where I wanted to plant. Never knew and think that plants would have family and that I need to group them."

Hmong grower

"For so many years since I started farming no one told us about cover crops and crop families. Through this training, I gained so much that has made a change in my farm. I change my crop around. I change the way I plan my schedule for planting and I understand more about other loan programs to help me if I need it."

Hmong grower

"I have learned more and more each time I attend these workshop. The values and education provided has made a significant improvement in myself and as well as my farming life. I appreciate all you do and everything you and Jack has done to help us. We cannot imagine where we would be without both of you."

Hmong grower

## V. Lessons Learned

Field-day training--It was quite challenging to bring growers to an on-farm field-day training, especially during the busy season in the summer, but it is the best time to host field-day trainings. Based on the field-day training evaluation feedback, we will try to host more field-day trainings in the future.

Post Survey—It was time consuming to call each participant to complete the survey. We sometimes played phone tag a couple times to complete one survey. However, it is the most effective way to conduct a survey with Hmong growers. For future improvement, we will take a

sample and work with that sample instead of calling every participants who attended the workshops/trainings.

## VI. Additional Information

Field-day Training in Athens, WI

Hmong Ginseng Growers Trainings in Wausau

## VII. Contact Info

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# 15) Virus Diseases, an Emerging Threat to Wisconsin's Cranberry Industry (FY14-015)

**Report Date:** October 11, 2017

## I. Project Summary

**A.** In 2012, disfigured, scarred cranberries were noticed on three cranberry marshes near Warrens, Wisconsin. The injury was severe enough to make the fruit unmarketable, even for processing. We identified tobacco streak virus (TSV) as the probable cause of scarring. During a survey in 2013, we detected TSV at additional sites in central Wisconsin and discovered a second virus, blueberry shock virus (BlShV), in scarred berries from marshes in both central and northern Wisconsin. This was the first time that viruses had been linked to disease symptoms in cranberries. Because viruses are known to cause significant yield loss in other crops and because they are not curable, growers wanted to know what to expect from TSV and BlShV. How would these viruses impact yield and plant health? What could we do to prevent the introduction and spread of viruses? Answering these questions was the motivation for this project.

**B.** This was our only SCBG project on cranberry viruses

## II. Project Approach

Our main objectives were to conduct research on the biology and impact of two viruses diseases new to cranberries in Wisconsin, tobacco streak virus (TSV) and blueberry shock virus (BlShV), and to deliver the results to growers and other researchers. We established a strong link between scarring symptoms on cranberry fruit and the presence of either TSV or BlShV on several important cranberry varieties throughout the major cranberry growing regions in Wisconsin, Massachusetts, and New Jersey. We determined that both viruses are carried on pollen, and are likely spread by insects that feed on pollen (e.g., thrips) or pollinators themselves. Interestingly, with both TSV and BlShV, infected plants go on to produce normal, healthy fruit the year after symptoms occur even though the viruses can still be detected. Yield components (e.g., number of flowers per shoot, percent fruit set, berry weight) are not negatively affected by either virus after the year of symptom appearance. Detection of TSV and BlShV in various plant parts (e.g., leaves, buds, roots, fruit) varies depending on the time of year, a finding that will be used to advise growers who want to sample their plants to determine if viruses are present. Unfortunately, TSV and BlShV are detected in terminal buds in early spring, suggesting that growers will not be able to "escape" the viruses when they use cuttings for propagation.

We have two main audiences for our project: commercial cranberry growers and the research community. We have delivered our results to cranberry growers in a variety of formats: orally to more than 400 people at the 2015 and 2016 Wisconsin Cranberry School and in writing in the proceedings for that conference; to approximately 550 subscribers of the Cranberry Crop Management Journal; and to smaller groups of about 20 growers in special meetings/discussions focused on cranberry virus research updates. We have delivered results to other researchers at the 2015 American Phytopathological Society Annual Meeting and the 2015 North American

Cranberry Research and Extension Workers Conference. Two research papers on TSV were published in the peer-reviewed scientific journal *Plant Disease* in 2016, and one paper on BlShV is in press with *Plant Disease*. Those papers contain tables and figures that illustrate the data and will be provided upon request. We also published two bulletins with practical recommendation for growers (UW Extension publications, Blueberry Shock Virus in Cranberry, No. A4147 and Tobacco Streak Virus in Cranberry, No. A4110, available free of charge from the UW Extension Learning Store, learningstore.uwex.edu).

## III. Goals and Outcomes Achieved

**A.** The short-term objectives of this project were to conduct research on the biology and impact of viruses in cranberries and to develop and disseminate research-based management recommendations for TSV and BlShV. The main performance measure was validation of our research by our scientific peers who reviewed the three articles published in *Plant Disease*. Our two UW Extension bulletins were also reviewed by experts and are being shared widely among growers at field days, conferences, and through the Cranberry Crop Management Journal.

**B.** We accomplished the goals and outcomes (research and extension publications; dissemination of knowledge to growers) that we described in the original proposal.

## IV. Beneficiaries

Oral presentations to cranberry growers and consultants:

- 2015 Wisconsin Cranberry School, January 21-22, Stevens Point, WI, 450 participants.
- 2015 Early Season Cranberry Workshops, April 22, Warrens, WI, 50 participants.
- 2015 Early Season Cranberry Workshops, April 22, Wisconsin Rapids, WI 65 participants.
- 2015 Cranberry Research Roundtable, November 6, Madison, WI 20 participants.
- 2016 Wisconsin Cranberry School, January 20-21, Stevens Point, WI, 450 participants.
- 2016 Early Season Cranberry Workshops, April 28, Valley Junction, WI, 52 participants.
- 2016 Early Season Cranberry Workshops, April 28, Cranmoor, WI, 64 participants.
- 2016 Cranberry Research Roundtable, November 11, Madison, WI, 32 participants.

Research papers aimed at the scientific community:

- Thomas-Sharma, S., Wells-Hansen, L., Page, R., Kartanos, V., Saalua-Rojas, E. Lockhart, B.E.L., and McManus, P.S. 20__. Characterization of Blueberry shock virus, an emerging Ilarvirus in cranberry. Plant Disease, accepted pending revision.
- Wells-Hansen, L.D. and McManus, P.S. 2016. Recovery of cranberry plants infected with *Tobacco streak virus* and incidence and distribution of TSV in the field. Plant Disease 100:2257-2265.
- Wells-Hansen, L.D., Polashock, J.J., Vorsa, N. Lockhart, B.E.L., and McManus, P.S. 2016. Identification of *Tobacco streak virus* in cranberry and association of TSV with berry scarring. Plant Disease 100:696-703.

UW Extension bulletins aimed at grower audiences:

- Thomas-Sharma, S. and McManus, P. 2017. Blueberry Shock Virus in Cranberry, No. A4147

Wells-Hansen, L. and McManus, P. 2016. Tobacco Streak Virus in Cranberry, No. A4110.

## V. Lessons Learned

Our research showed that although TSV and BlShV render fruit unmarketable, plants recover and produce normal fruit in subsequent years. This has helped assuage panic about viruses in the industry. Nurseries and propagators are now more aware of viruses, and some have stepped up their screening protocols to ensure that they sell virus-free planting stock. It would be even better if the industry had standards for virus testing that all nurseries and propagators agreed to. However, I have not been able to gain traction on this topic.

## VI. Additional Information

N.A.

## VII. Contact Info

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# 16) Assessing spotted wing drosophila phenology and overwintering in Wisconsin (FY14-016)

**Report Date:** October 31, 2016

## I. Project Summary

**A.** Spotted wing drosophila (SWD) is an invasive pest of soft-skinned fruit that has caused significant losses statewide in Wisconsin berry crops in both 2012 and 2013. In 2014, berry growers named SWD as their top pest concern and as a consequence, some growers have discontinued growing fall-bearing raspberry. No economic threshold has yet been established for SWD, thus once SWD is detected in a crop, fruit growers are advised nationwide to apply insecticides every 4-7 day until harvest. These intense control measures can be very costly for growers while not completely preventing crop loss as insecticides only target adult flies and not larvae inside the fruit. In addition, it is important to properly address phenology and first detection in Wisconsin to provide fruit growers with a more complete understanding of when to protect their crops to improve IPM practices for this challenging invasive pest. While our understanding of the seasonal phenology of SWD in Wisconsin is increasing, the timing of first occurrence in the season, and adult population density and distribution in berry, cherry, and grape crops remain unclear. Recently, scientists in Oregon have discovered the presence of a SWD winter form, which could have important implications for cold tolerance and winter survival of SWD. In this project, our specific objectives were to: 1) assess the seasonal phenology of occurrence of SWD adult populations in Wisconsin; 2) identify the possible presence of SWD seasonal morphs in Wisconsin and determine the reproductive output potential of females; and 3) provide reports, field days, and timely updates to the susceptible fruit industries.

The current recommendations for managing SWD in soft fruit rely on frequent applications of broad spectrum insecticides, affecting the current practices of IPM for many growers. Understanding how to identify SWD, when the flies are present, and the likelihood for SWD to successfully attack a fruit will help fruit growers make sound pest management decisions. The deliverable information from this project are 1) increasing our knowledge of the seasonal phenology of SWD as it fluctuates with establishment and climate variations; 2) determining the presence of winter morphs and the reproductive output of females to warn growers on the overwintering capability of SWD.

**B.** This study did not build from work previously funded by the Wisconsin Specialty Crop Block Grant Program.

## II. Project Approach

**Objective 1: Assess the seasonal phenology of occurrence of spotted wing drosophila adult populations in Wisconsin.**

Monitoring of SWD was conducted at six farms in South Central Wisconsin with two traps per farm from May 13, 2015 until January 13, 2016, following two consecutive weeks of no SWD flies caught in traps. Clear 32-oz. plastic deli monitoring traps baited with yeast and sugar were checked weekly, the bait changed, the trap content returned to the laboratory where the number of male and female flies was recorded.

In 2015, the first SWD flies were caught on June 22, a week earlier than in 2014 (Fig 1). Population peak occurred between early August until early October, coinciding with harvest of fall-bearing raspberries and some later blueberry varieties, such as 'Bluecrop' and 'Nortland'. The last flies of the season were captured on December 30, approximately 50 days later than in 2014. Overall population trends suggest that more females tend to be captured earlier in the season (Fig 1), which suggests that relying entirely on monitoring for males (as most growers do) may miss early detection and fruit infestation.

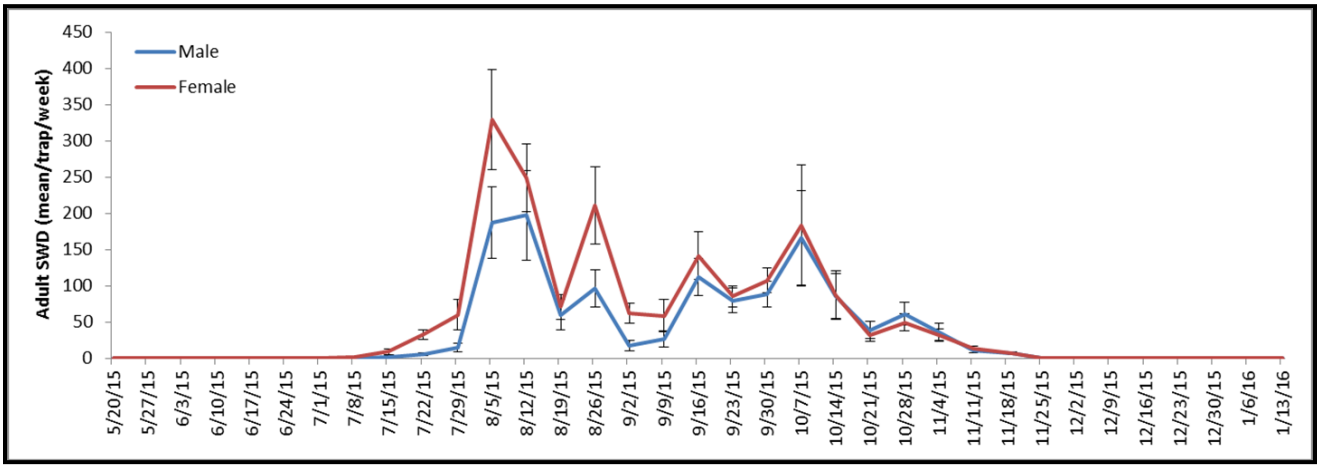
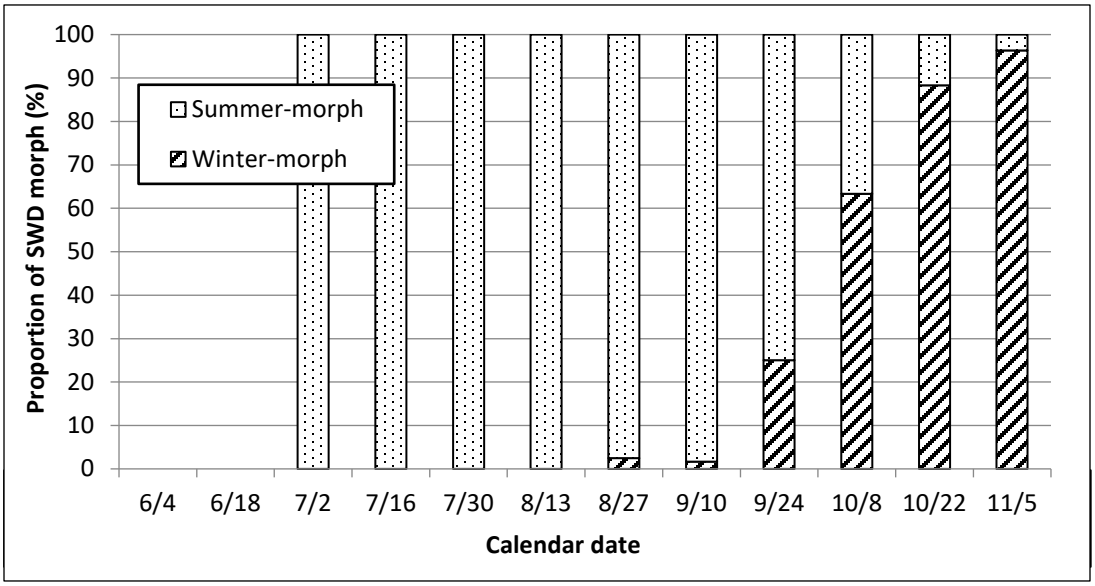



**Fig 1.** Seasonal phenology of SWD in South Central Wisconsin in 2015.

**Objective 2: Identify the possible presence of SWD seasonal morphs in Wisconsin and determine the reproductive output potential of females.**
To determine whether seasonal morphs, i.e. winter and summer morphs, occur in Wisconsin, we sub-sampled adults weekly from our seasonal field trapping. Male and female SWD flies were observed under dissecting microscope to determine the coloration of the 3rd abdominal segment in males and 4th abdominal segment in females, based on criteria defined by Shearer et al. (BMC Ecol 2016, 16:11 DOI 10.1186/s12898-016-0070-3). We did identify the presence of male and female winter morphs in Wisconsin in addition to the typical summer morph (Fig 2).


**Fig 2.** SWD adult flies. A) winter morph male; B) summer morph male; C) winter morph female; and D) summer morph female.

The phenology of seasonal morphs (Fig 3) reveals that the winter morph begins to appear in late summer, with its proportion compared to summer morph steadily increasing to nearly 100% in November, when the photoperiod is closer to 12:12 L:D and temperatures decrease (Shearer et al. 2016). The winter morph adult has been identified as the most likely stage to overwinter and was shown to sustain extended periods of cold temperatures (Shearer et al. 2016). The presence of a winter morph has important implications on the overwintering survival ability and rate of SWD in Wisconsin and subsequent spring populations.




To assess the reproductive output of females, a subsample of ten females caught per trap per week in spring and fall samples was dissected and the presence of immature eggs and the number of mature eggs (reproductive potential) was determined.

Winter morph females were found to less often harbor immature eggs compared to summer morph females (Table 1 and Fig 4; df = 1; n = 531; $\chi^2$: 47.72; P<0.001) and also to harbor fewer mature eggs (Table 2 and Fig 5; d.f. = 1; H = 84.918; p < 0.001). These results suggest that winter morph females probably undergo a reproductive diapause that is not obligatory and are probably able to lay eggs as soon as they come out of winter. This information has implications on the re-establishment of populations in the spring.

| | ***Immature Eggs*** | |
|---|---|---|
| ***Morph*** | Absence | Presence |
| Summer | 126 | 249 |
| Winter | 104 | 52 |

**Table 1.** Number of females for each seasonal morph observed with and without immature eggs.

| ***Morph*** | ***Mature Eggs (mean)*** | **± *SE*** |
|---|---|---|
| **Summer** | 3.03 | 0.29 |
| **Winter** | 0.08 | 0.05 |

**Table 2.** Number of females for each seasonal morph observed with and without immature eggs.

**Fig 4.** Ovariole containing immature eggs in SWD female (green oval).

**Fig 5.** Mature eggs with characteristic breathing tubes from SWD female.

In this objective, we also planned to determine the mating status of females by dissecting the spermathecae of females to assess the presence of sperm. The methods were long and tedious to develop and were barely established in the summer of 2016 after this project was completed. We thus do not have data for the flies dissected in this project and we explain below the outcome of this delay.

**Objective 3: Provide reports, field days, and timely updates to the berry, cherry, and grape industries.**

Results were presented at the Wisconsin Fresh Fruits and Vegetable Conference in January 2015. Fruit growers were regularly informed by emails to the WBGA of updates on SWD, on the SWD website http://labs.russell.wisc.edu/swd/, and in articles in the Wisconsin Fruit News. Presentations at annual WBGA field days and raspberry schools were presented with hands-on training on identification, monitoring methods, and management strategies for SWD. Impact on growers has been a growing knowledge of the seasonal phenology, identification, monitoring, management strategies, and overwintering ability of SWD in Wisconsin.

## III. Goals and Outcomes Achieved

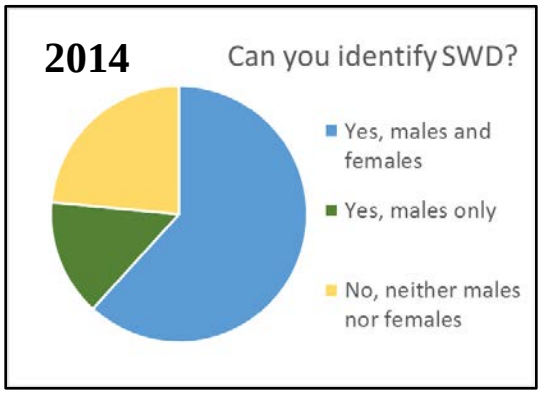
**A.** The activities completed include 1) documenting the complete seasonal phenology of SWD; 2) establish the presence of seasonal morphs and the timing of appearance of the winter morph in Wisconsin; 3) assess and compare the reproductive output of SWD females between seasonal morphs; 4) provide educational programming to fruit industries. The performance goals were measured through the surveys conducted with berry growers in 2014 (pre-project) and 2016 (post-project). Relevant results from the surveys are presented below.

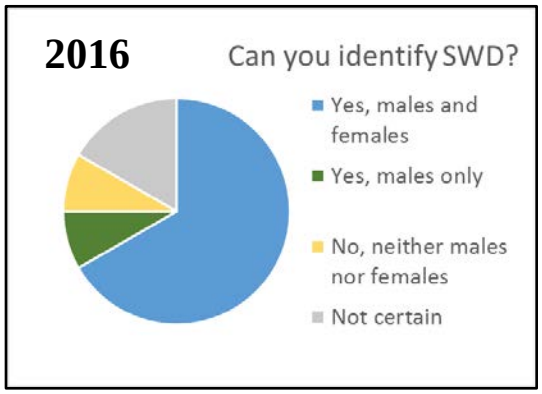
In 2014, 37 growers participated in the survey and 12 in 2016. The low turnout in the 2016 responses limits our ability to draw conclusions on the impact of our research. The target of >80% was highly optimistic and is not easily reflected with a low turnout. Different methods should be explored in the future to obtain a bigger sample size of growers surveyed.

Overall, Wisconsin berry growers show an increase in awareness of the extent of the damage SWD can causing to their fruit crops. Until recently, growers often reported (outside of these surveys) not implementing any type of management strategies to tackle SWD in their crops. Increasing the number of insecticide applications is unfortunately the first step in reducing populations of this damaging pest, going against the classical IPM strategies that growers usually implement. The surveys suggest an increase in management practices, including sanitation and cultural controls, which is very promising and hopefully indicative of our extensive outreach to growers about this pest.

Identification

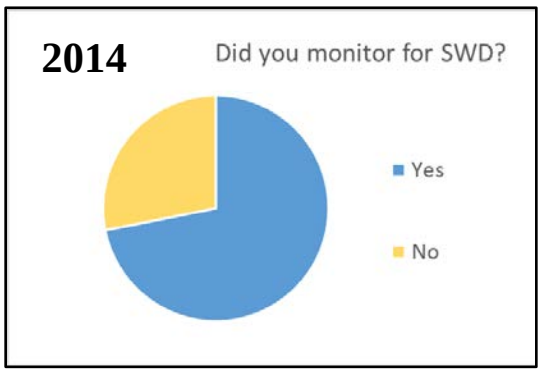
More respondents in 2016 identified themselves as able to identify both males and females, while fewer respondents identified as able to identify neither males nor females.

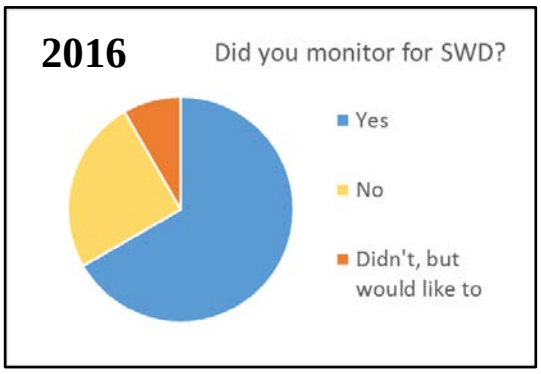



Monitoring

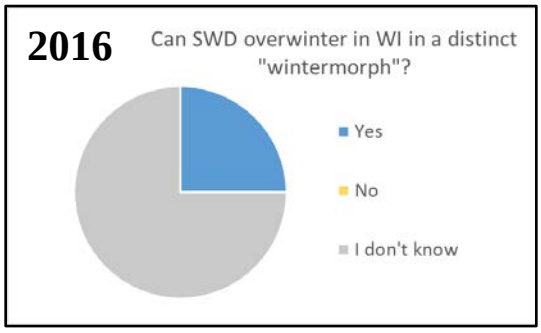
Approximately the same percentage of people monitored for SWD in 2014 (72%) as in 2016 (67%).



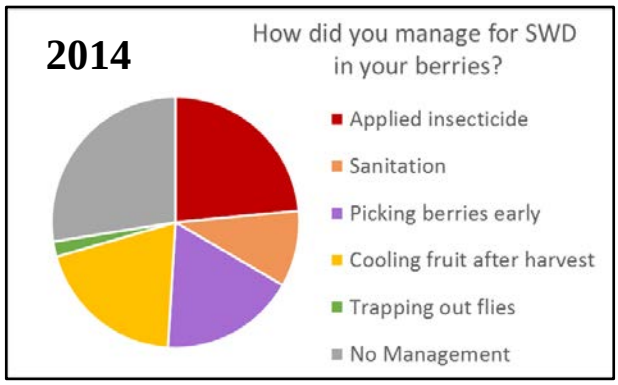

Overwintering

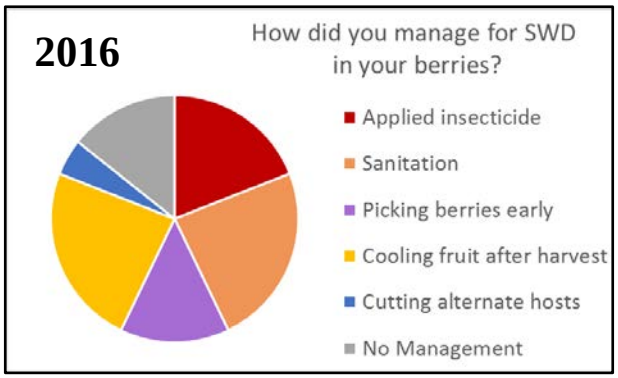
One quarter (25%) of respondents believe that SWD can overwinter, while the remaining did not know (75%). We will emphasize our results again at the next Wisconsin Fresh Fruit and Vegetable Conference in January 2017.



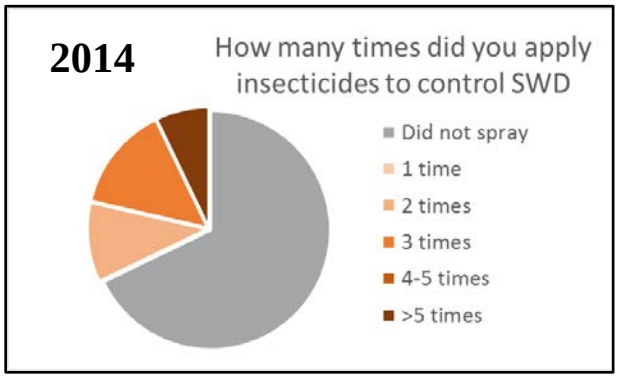

Management

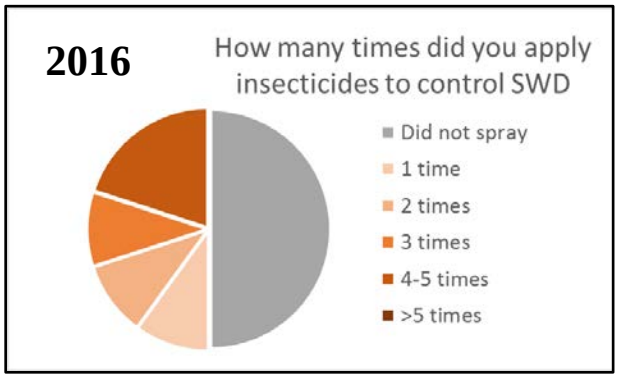
By 2016, fewer people report not managing for SWD. The number applying insecticides decreased slightly, while the number using alternative management strategies, in particular sanitation and cooling fruit after harvest, increased.



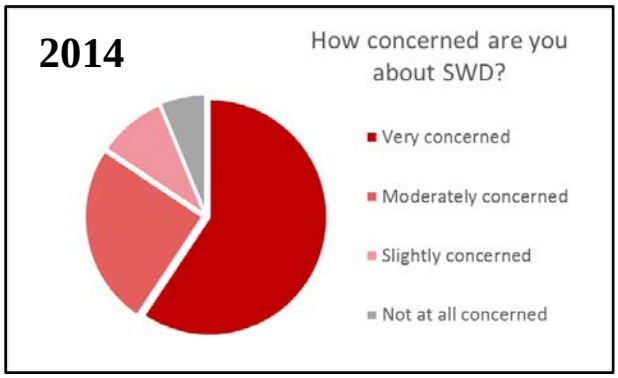

Although in this question, fewer people report never spraying for SWD in 2016 than in 2014, there was a reduction in the average number of sprays per season from 2014 to 2016, with no respondents spraying more than 5 times per season by 2016.

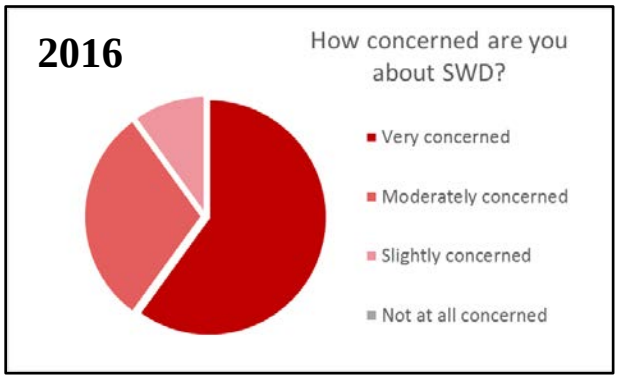


Level of Concern

Approximately the same percentage of respondents reports being very concerned in 2016 as in 2014. However, whereas several respondents in 2014 reported being not at all concerned, every respondent expressed concern over SWD by 2016.




**B.** We completed all the objectives we included in the proposal. We accomplished all but one activity (assessing the mating status) and obtained data for the objectives addressed. We expected an increase in knowledge by the growers and our pre- and post-project surveys indicate that the different outcomes expected are progressing towards the targets we planned.

## IV. Beneficiaries

Provide a description of the groups and other operations that benefited from the completion of this project's accomplishments. Include quantitative data that concerns the beneficiaries affected by the project's accomplishments and/or the potential economic impact of the project. If you have not yet discussed outreach efforts in section II or section III, add that here including dates, locations, and # of attendees for presentations, publications, or other forms of outreach to project beneficiaries.

The results of this study will directly benefit the grape, berry, and cherry industries of Wisconsin. The wine grape industry is rapidly growing in Wisconsin with over 700 acres of grape, an almost 50% increase in acreage since 2007 (USDA, 2013a). Production of strawberry in Wisconsin was 3,1M lbs. in 2012 on 720 acres and an estimated economic value of $4.7M. The cherry industry with 1,600 bearing acres had an economic value of $1.9M in 2012 (USDA, 2013b). In a 2014 survey, Wisconsin berry growers (n=37) identified SWD as their top pest concern (Guédot and Pelton, 2014) and so did grape growers at the October 2012 UW-Extension meetings. The increase in knowledge for all these growers will have a direct impact on their decisions to monitor and manage for this pest as some growers were hoping that SWD would die over the winter and we show that they most likely overwinter in Wisconsin.

## V. Lessons Learned

The project led us to develop a detailed protocol to assess the mating status of SWD females. A scientific manuscript was submitted to the journal Insects as a result of this project to provide a step-by-step protocol to perform the dissections properly. The project staff learnt to identify the

seasonal morphs and to dissect SWD females. We learnt a lot about the overwintering capability of SWD and the growers appreciate the work we all do in my lab on this detrimental pest.

## VI. Additional Information

The manuscript on the protocol to dissect SWD females was submitted as part of a special issue on invasive species with the journal Insects. Another manuscript describing the seasonal phenology, seasonal morphs and reproductive output is in preparation.

## VII. Contact Info

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# 17) Utilization of vermicompost and vermicompost tea to improve ginseng production (FY14-017)

**Report Date:** October 31, 2017

## I. Project Summary

**A.** Ginseng production in WI is an important economic venture, but the production of ginseng agriculturally has had little research. Currently, ginseng producers are limited in agrochemicals labeled for ginseng use. This has led some producers to investigate alternative disease control measures. The specific purpose of this project was to evaluate the utility of vermicompost (VC) and VC tea amendments for improved cultivation of Panax quinquefolius. This project has addressed a need in the ginseng growing community to improve disease control and investigate the utility of VC and VC tea as amendments to enhance ginseng production.

**B.** N/A

## II. Project Approach

The research site was established prior to the grant award in 2013 as an extension of field research inititated by Dr. Jonathan Rivin in 2010 investigating the use of vermicompost in ginseng production. The funding from this grant then allowed us to carry out the field research and lab analysis from a field site established in 2013. Unforseen events in the state legislature led to the loss of our initial PI, Dr. Rivin. University of Wisconsin Stevens Point PI (Jacob Prater) and CoPIs (Daniel Keymer and Robert Michitsch) applied VC treatments and the grower (Jerry Krautkramer) planted the ginseng. Jerry Krautkramer mixed and applied all VC tea treatments, and retained samples in a freezer for our analysis. Jerry Krautkramer also carried out all field operations (weeding, pesticide application, mulching etc…) for the ginseng fields for the duration of this project.

Scouting for ginseng diseases was conducted by UWSP in the first 2 years of the project, but proved to be inconclusive. Effort and funds for scouting were redirected to ginseng root analysis. Disease incidence and its relation to the applied treatments of VC and VC tea relied on rhizosphere soil DNA extractions to investigate disease suppression effects.

150 Rhizosphere soil samples were collected by UWSP in selected plots in year 2 and 3 of the project. These samples were lyophilized and had DNA extracted and analyzed to determine the presence of pathogens. For each of the 3 sites, 5 replicate plot samples were included for both 2015 and 2016 from each of the following treatments: no amendments, VC tea only, high rate VC (105 lbs/acre) without VC tea, and high rate VC with VC tea applied. We also included low rate VC (35 lbs/acre) treatments with and without VC tea application from 2016 only. Analysis of the DNA sequence reads, including sorting the reads by sample and assigning taxonomy information to each read is underway at present using QIIME software.

Stand counts (plant population) were measured by UWSP at all sites and in all 162 plots for each of the three years of the project. There were no major differences in plant population counts among treatments or sites. This result suggests that germination was not influenced by the application of VC as we had expected from previous work.

Short and fat roots are desirable in the ginseng market. Because of this desired root morphology we measured root length to width ratios. Root samples were collected by UWSP in year 2 (2015) and 3 (2016) of the project in all 162 plots. Between treatments roots showed some variability among treatments in morphology in year 2, but not in year 3 at harvest. VC tea and VC had no measurable effect on root morphology (length to width ratio) at harvest time.

Yield was measured by UWSP in year 3 of the project in all plots. Yield measurement consisted of digging the roots from a subplot in the center of each plot and gently removing the soil with a spray of water. Roots were then dried in mesh backs and massed after drying. Yield was increased with the application of VC tea by ~500 lbs $Acre^{-1}$ (average yield for the whole field trial was ~2 tons $Acre^{-1}$). This represents an economic gain to the producer that could be quite enormous depending on the price of ginseng and the number of acres in production considering that the cost to produce VC tea is $10 per acre plus application costs.

Roots from selected plots (72) were dried, ground, digested, and analyzed for nutrient content. The root nutrient status is being statistically analyzed to determine any correlations to treatments and other parameters. This analysis may help to discern the VC tea application effect observed on ginseng yield.

As there are no major commercial sources of ginseng seed, farmers must collect and save their own seed. Due to the necessity of seed production we chose to investigate the influence of our treatments on berry/seed production. Berries were collected by UWSP from all plots in year 3 of the project. Berry number and mass correlated negatively with VC tea application. In fact, berry production in plots with no VC tea was less than 40% of what it was in VC tea applied plots. Contrastingly VC application had no effect on berry production. There was a site effect on berry production with site 1 producing far fewer berries and berry mass than the other two sites. The ramifications of this reduced berry production are large. If a ginseng grower was not able to collect their own seed it may cause either an economic barrier (purchasing new seed) or a serious reduction in acreage planted the following year due to a decreased saved seed supply. Our recommendation is that VC tea if used is not used in the 3$^{rd}$ year of production as the crop nears harvest.

Soil samples were collected by UWSP from all plots in year three of the project and selected plot samples were analyzed for soil nutrient status, particle size distribution, available water capacity (AWC), and organic matter content. There were no correlations found between soil nutrient status and ginseng yield. This lack of correlation between soil nutrient status and ginseng yield suggests that there were no limiting nutrients among those tested in our soil samples (P, K, Ca, and Mg). VC application increased soil organic matter (SOM) content with increasing rate of application. VC application also increased soil AWC, but no other correlations or treatment effects were observed for VC application and rate. Soil pH did not seem to correlate with or

predict any of our other measurement or treatments within the range of pHs in our field trial (pH 5.3-6.9).

After Jerry Krautkramer made VC tea each time samples were collected and frozen for analysis. The VC tea samples were collected each year and analyzed by UWSP. VC tea samples had low nutrient status and represented only small annual inputs of N (0.2 lbs N $Acre^{-1}$ $year^{-1}$, Ca, and other nutrients. The amount of N in the VC tea, though small, was in plant available forms ($NO_3^-$ and $NH_4^+$) and represented a foliar feeding of N to the ginseng crop. This could have been the determining factor in the increased root yield and decreased berry production observed in this study. The yield and berry production being linked by plant stress responses (increased vigor) and vegetative growth versus reproductive growth (caused by N:P ratios being higher due to foliar feeding).

3 scientific presentations have been made by UWSP (PI, CoPI, and students) at two different scientific conferences. One of these resulted in a student winning the undergraduate oral presentation first prize at the Soil Science Society of America annual meeting in Tampa, FL (2017). While no presentation of the results of this project has been made as yet directly to ginseng growers, we are scheduled to present our results at the next Ginseng Board of Wisconsin meeting (Winter 2017-2018) (fact sheets will be made available at this time to the Ginseng Board as well). Results of the project have already been shared directly with our partner ginseng grower, Jerry Krautkramer.

## III. Goals and Outcomes Achieved

### A. Goal 1

Provide ginseng growers with decision-making tools (science based evidence) for making informed decisions about using alternative farming practices to enhance crop production

- Few ginseng farmers are aware of the benefits of using VC and VC tea in crop production. Presentations and workshops with field tours will be given after the 2nd and 3rd years of the project to educate the growers. Results of the project will be presented along with recommended farming practices and projected economic costs for using these alternative treatments.

**Outcome 1**

We have analyzed the effectiveness of both VC and VC tea on ginseng production at three sites in Central WI. From this analysis we have two basic recommendations and a third with one caveat: 1) VC additions have no significant effect on ginseng yield, 2) VC tea as applied in this experiment improves ginseng yield by ~500 lbs $Acre^{-1}$, and 3) VC tea applied in the third growing season reduces berry and seed production of ginseng (assumes previous year VC tea applications don't affect the following year).

We have communicated these results at Soil Science Society of America annual meetings (through poster and oral presentation) and directly to our grower partner Jerry Krautkramer. The results will be communicated to the Ginseng Board of WI at their next meeting in Winter 2017/18 (this will accomplish our goal of reaching at least 100 growers with this new information).

**Goal 2**

The second goal is to determine the field impacts of using VC and VC tea in ginseng production. Specific benchmarks, targets, and performance measurements are described as follows:

The overarching goal of this research studywais to discern the utility of VC and VC tea amendments for improved cultivation of *Panax quinquefolius*. Our hypothesized mechanism of growth promotion relied on the modification of the soil microbial community, such that beneficial microorganisms would be enhanced in number and soil-borne phytopathogens would be inhibited. To verify our hypothesis, we used statistical models to analyze the effects of different microbial indices (soil microbial composition or diversity) on ginseng fitness and disease incidence. We assessed the dependence of ginseng-soil microbe interactions on other measured soil factors including nutrient status and soil type. Finally, we attempted to identify 11 specific bacterial or fungal populations within the soil microbial community that have significant correspondence with enhanced ginseng fitness. The particular microbial taxa identified by this analysis may be promising bio-control agents and subjects of further study to identify mechanisms behind phytopathogen suppression.

**a)** Characterize changes in overall populations of soil bacteria and fungi in field plots resulting from VC and VC tea application.

Once per year, three to five ginseng plants and adhering rhizosphere soil were harvested from replicate plots from each of four treatments to assess the plant associated soil microbial community. Rhizosphere soil were brushed or eluted from roots into sterile centrifuge tubes, frozen as soon as feasible, and lyophilized at a later date. When appropriate, VC in contact with the root surface was also separately collected using sterile scoops and managed in the same way as the soil samples. DNA was extracted from 0.5-gram subsamples of each homogenized lyophilized soil or compost sample using E.Z.N.A.® Soil DNA Kits (Omega Bio-Tek).

The composition of soil fungi and bacteria in the rhizosphere of ginseng may aid in explaining why phytopathogens are successful or unsuccessful at colonizing susceptible plants growing in this soil. To characterize the composition of soil microorganisms within and among soil samples collected for this study, a molecular barcoding technique was used to identify taxa. Genetic fragments of the bacterial 16S ribosomal RNA gene and fungal intergenic transcribed spacer region of the ribosomal RNA were amplified from most taxa using broadly conserved primers (Toju et al., 2012; Caporaso et al., 2011), Genetic fragments will be pooled, purified, and paired-end sequenced at the University of Wisconsin Biotechnology Center using an Illumina MiSeq sequencer. Primers included 8-base pair long unique barcodes to identify samples from the pooled sequences. The total number of samples to be sequenced (48[1] samples per year per 2 microbial groups = 288) was run in a single MiSeq lane with an anticipated yield of 30,000 or more high-quality sequences per sample. Sequences were screened for quality and identifiable barcodes prior to stitching forward and reverse reads into a single fragment. Sequence analysis of quality fragments, including clustering them into operational taxonomic units based on sequence similarity and identifying fragments against reference databases, were conducted using the software QIIME (Caporaso et al., 2010). This approach has been successful used by Dr. Keymer to characterize bacterial and fungal microbial communities associated with forest soils and tree roots (manuscript in preparation).

1 4 replicates X 2 treatments X 2 tea application rates X 3 sites (soils)

**b)** Evaluate the impact of soil microbial community on ginseng health metrics, crop yield, and soil health indicators.

To determine the functional implications of any differences among soil fungal communities detected among our treatments, measures of soil and ginseng health were obtained. An active, growth promoting soil fungal community would be expected to increase soil fertility. In particular, nitrogen mineralization rate is a measure of soil health that should promote nutritional gains in the ginseng

plants. Higher availability of soil nutrients should also be reflected in plant elemental composition. Soil cores were obtained once a year from each plot and analyzed for soil nitrogen availability and nitrogen mineralization rate. Soil nitrogen availability was measured directly using the quantity and C:N ratio of soil organic matter and concentrations of extractable inorganic nitrogen. In the third year of growth, plant elemental composition was measured using a carbon-nitrogen analyzer and a full nutrient analysis performed from triplicate composite foliar subsamples per plot. Berry production (number and weight) and ginseng root production (weight) was determined at harvest.

Visual surveys of the ginseng crop for disease and growth inhibition were conducted monthly during the growing season. The abundance of diseased plants in each plot was estimated using the visual surveys. Samples of plants suspected of infection by phytopathogens were sent to the UW-Madison Plant Disease Diagnostic Laboratory for pathogen identification and/or confirmation.
Significant correlations between microbial community composition and metrics of plant or soil health, including crop yield, were analyzed using ordination-based techniques (ANOSIM) and permutational analysis of variance (PERMANOVA) in the R statistical software package (Team, 2013).

**c)** Assess the interactive effects of vermicompost/tea application and microbial community changes on previously measured indicators of plant health/disease, crop yield, and soil health to determine controlling factors

Generalized linear mixed models (GLMMs) were used to describe desirable or undesirable functional outcomes (e.g., increased ginseng fitness, reduced phytopathogen relative abundance) in terms of fixed and random variables. These models facilitate the identification of how local factors (e.g., soil characteristics) and practical operating factors such as compost application rate are likely to influence ginseng production.

**B. Goal 1** We have assessed the utility of VC and VC tea for ginseng production and have baseline recommendations for their use. The economic impact of our results is large with increased production with VC tea application at a modest cost (~100 lbs of VC are needed to make the tea for one acre each year, in bulk this about $10 with a return on investment of over 400% [depending on ginseng prices]). The influence of VC tea application on berry production was also an important result both operationally and economically for ginseng growers in WI. Since berry production is linked closely with the availability and cost of seed supply it was a critical outcome that we determined the negative relationship between VC tea application and berry production. Our results have been disseminated at scientific conferences as well. The only portion of this goal that has not been achieved is the hosting of workshops/field days and presentation at a ginseng grower conference. This was due to the loss of our initial PI Jonathan Rivin, early in the project (these were his areas of expertise and availability). Presenting at a ginseng conference will still occur this coming winter, and will include the dissemination of fact sheets (and will meet our goal of reaching 100+ ginseng growers with our new data and recommendations), but it has not been possible during the project term.

**Goal 2** has been realized with the remaining exception of analyzing our DNA extraction to determine if there is any link between microbial community, plant pathogens, and VC and VC tea application. Soil nutrient status did not have any effect on ginseng yield, thus VC and VC tea application effects on soil nutrient status were not important in this study either. Measured soil properties did not correlate with ginseng yield responses either in this study. The VC tea, however did effect yield and represented a foliar fertilization. Any augmentation of microbial

activity and disease suppression of VC tea and VC application will be revealed in our remaining statistical analyses.

## IV. Beneficiaries

**Beneficiaries:**

Jerry Krautkramer – farmer collaborator
Wisconsin Ginseng Farmers (attendees 100+) – upcoming at Ginseng Board of Wisconsin meeting.

Economic Impact: Our research showed that a grower can increase ginseng production per acre by up to 500 lbs ($40,000) (at a modest cost of $10 per acre plus application costs (5 field passes per year). This represents a large impact for an individual grower and may also represent an increased market share nationally and in the world market as more growers adopt the practice of using VC tea.

Presentations and Research Dissemination
Soil Science Society of America joint meetings with American Society of Agronomy and Crop Science Society of America (attendee estimate is difficult to obtain at poster presentations)

- Soil Science Society of America meetings 2017 *Effects of Vermicompost and Vermicompost Tea on Ginseng Production at 3 Wisconsin Sites,* Brooke Bembeneck, Lindsey E. Carlson, Jacob R. Prater, Daniel Keymer, and Robert C. Michitsch
- Soil Science Society of America meetings 2017 *Effects of Vermicompost and Vermicompost Tea on Ginseng Production and Soil Microbial Populations in Northcentral Wisconsin,* Lindsey E. Carlson, Brooke Bembeneck, Daniel Keymer, Jacob R. Prater, and Robert C. Michitsch
- Soil Science Society of America meetings 2016 *Effects of Vermicompost Application on Ginseng Production at 3 Wisconsin Sites,* Erik Halverson, Jacob R. Prater, Daniel Keymer, and Robert Michitsch

## V. Lessons Learned

- Unexpected outcomes include that the VC tea increased ginseng yield by ~500 lbs per acre! This was a completely unexpected outcome of this research as the PI and CoPIs were quite skeptical of the use of VC tea versus the application of VC as a general practice.
- Having the flexibility to change or add measures as their importance (or lack thereof) became apparent was vital to achieving our ultimate outcomes.

Some of our goals and outcomes were not achieved due to the loss of our initial PI. Perhaps on future projects a contingency should be developed to prepare for this.

## VI. Additional Information

Publications (in preparation)

- *Effects of Vermicompost and Vermicompost Tea on Ginseng Production at 3 Wisconsin Sites.* Prater, JR, Keymer D, Michitsch, RC. 2017
- *Effects of Vermicompost and Vermicompost Tea on Soil Microbial Populations in Ginseng fields in Northcentral Wisconsin.* Keymer, D, Prater, JR, and Michitsch RC.

Scientific Presentations

- Soil Science Society of America meetings 2017 *Effects of Vermicompost and Vermicompost Tea on Ginseng Production at 3 Wisconsin Sites,* Brooke Bembeneck, Lindsey E. Carlson, Jacob R. Prater, Daniel Keymer, and Robert C. Michitsch
- Soil Science Society of America meetings 2017 *Effects of Vermicompost and Vermicompost Tea on Ginseng Production and Soil Microbial Populations in Northcentral Wisconsin,* Lindsey E. Carlson, Brooke Bembeneck, Daniel Keymer, Jacob R. Prater, and Robert C. Michitsch
- Soil Science Society of America meetings 2016 *Effects of Vermicompost Application on Ginseng Production at 3 Wisconsin Sites,* Erik Halverson, Jacob R. Prater, Daniel Keymer, and Robert Michitsch

## VII. Contact Info

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# 18) Growing markets for Wisconsin apple growers with fresh and hard cider (FY14-018)

**Report Date:** October 27, 2017

## I. Project Summary

**A.** The popularity and production of apple cider in the United States and Wisconsin is going up, up, up! Hard cider is the fastest growing beverage category globally. Now was the time for Wisconsin to get into the game.

This project informed orchardists about the opportunity to improve their bottom lines by adding a new market for their low value fruit and adding new apple varieties specifically suited for fermentation to meet the demand from fresh and hard cidermakers in the state.

This project educated growers on the hard cider market, the fruit needs of hard cider makers, and how to access these new market opportunities. It developed an improved on-line presence for Wisconsin orchards so Wisconsin cider makers could find orchards growing the apples they needed.

This project looked to reestablish true cider apple varieties in the state. Growers were assisted in determining if planting a cider apple block fit their business model. The project provided education on cider apple varieties and their cultivation as well as providing contract templates for formal partnerships between orchards and cideries.

This project also educated the public about fresh and hard cider through an online presence, social media, press releases, the establishment of October as Cider Month and through tastings.

**B.** This project did not come out of a previous project.

## II. Project Approach

1 – Create an online presence where cidermakers can find orchards that are producing the apples they need for production of fresh and hard cider.

General orchard listings on the Apple growers website now include a list of apples grown. You can see those listings here http://www.waga.org/Apples

Orchards, who self-identified that they are growing cider-specific apples are now listed separately on the website. Ten orchards are identified here http://www.waga.org/cider

Orchards with fresh cider – pasteurized and unpasteurized – as well as cideries with hard cider are both listed in the All About Cider section. The list on the website is extensive, here is the link to the online listing http://www.waga.org/cider.

2 - Create a Grower Contract Template

A Grower Contract Template has been created, piloted, reviewed by the WAGA Board and is now posted on the website as an Orchard Cidery Agreement. At the Cider Apple Field Day in May 2016, Sara Ecker, WAGA President at that time, discussed the Orchard Cidery Agreement and offered tips on how to use it.

3 - Have 9 growers participate in informational sessions on growing cider apple varieties and complete the Economic Viability Assessment for growing cider apples.

The 2016 WAGA Cider Apple Field Day was held May 10, 2016 – hosted by Kickapoo Orchard in Gays Mills, WI. Over 40 growers attended a multifaceted program on growing cider apples. Participants got a chance to see grafts of cider apple varieties on top-worked Jonamac trees as the trees moved into the 2016 growing season. Andy and Bill Meyer from Kickapoo Orchard demonstrated their top-working techniques. Dr. Carol Miles, cider apple expert from Washington State University presented and shared her knowledge on cider-apple research in Washington State. Dr. Amaya Atucha, Wisconsin Fruit Crop Specialist discussed the cultivation of cider apples. Matt Stasiak, Supt. of the Peninsula Agricultural Research Station (PARS) provided an update on the cider apple research plot he established, while Matt Raboin from CIAS discussed his efforts to establish a cider orchard and a tool growers could use to gather data on their efforts.

4 – Reach consumers with information on Wisconsin cider.

Consumers can now find information on cider at the http://www.waga.org/cider website. There's a history of cider, orchards that sell cider, cideries that sell hard cider and orchards that have cider apples with links so consumers can connect directly. Our most recent "popup" featuring "October is Cider Month" was seen by 1,265 unique visitors and 55 of them clicked through to the All About Cider page of our website. In total over the last 12 months 901 unique people have visited the All About Cider page spending 3.5 minutes on the page.

Two Facebook Pages have been featuring posts about cider. Make It Farm Fresh, the Facebook Page for the Apple Growers and the Wisconsin Winery Association page. Cider postings on Make It Farm Fresh reached about 215 consumers on average. Cider postings on the Wisconsin Winery Association page averaged 3549 with the highest reaching 4980 with 18 shares.

5 - Participate in events to provide information and tastings to consumers and the industry.

Events that we participated in, included:

- Panel Presentation at the 2015 Wisconsin Fresh Fruit & Vegetable Conference in January 2015
- Presentation by Herdie Baisden at CiderCon 2015, the national meeting of the US Association of Cidermakers, entitled, "Growing Cider in Wisconsin – Comprehensive Approach
- WAGA Cider Apple Field Day was held April 23, 2015 featuring noted grower and cidermaker, Stephen M. Wood.
- Hard Cider Sampling during the Social Hour at the Wisconsin Fresh Fruit & Vegetable Conference in January 2015 and January 2016.
- Hard Cider Sampling at the Cold Climate Conference, sponsored by the Minnesota Grape Growers Association (MGGA) in February 2016.
- Hard Cider Sampling at the WAGA Cider Apple Field Day in May 2016.
- Presentation by Herdie Baisden at the MGGA Cold Climate Conference in February 2016: "Hard Cider in the US Market".
- Article by Herdie Baisden on WAGA Cider Apple Field Day published in the UW Extension biweekly newsletter, "Wisconsin Fruit News".

6 - Workshop participants will Increase their knowledge and awareness of Wisconsin cider apples

A total of 260 cider apple trees were distributed to 15 growers participating in Grower Field Trials. Preliminary information was provided on planting and care of the trees and the data growers needed to gather and report after the trees were planted. A follow-up survey was conducted in September 2016 by Matt Raboin to get a preliminary assessment of grower experience with their trees. Results were presented at a webinar in December 2016.

## III. Goals and Outcomes Achieved

**A.** Goal 1: Have 25 growers participate in the on-line directory.

Growers were surveyed to determine what varieties of apples they grew and if they made or sold cider. Special emphasis was placed on providing the varieties of cider apples they grew. The online directory featuring orchards that sell pasteurized and unpasteurized cider has 67 entries. The directory listing cideries with hard cider has 11 listings. The section featuring orchards that specifically grow cider apple varieties contains 10 listings.

Goal 2: Create a Grower Contract Template.

Project team members collaborated to develop a contract which was piloted and reviewed by the WAGA Board. The template is now posted on the WAGA website for anyone to download, modify and use.

Goal 3: Have 9 growers participate in informational sessions on growing cider apple varieties and complete the Economic Viability Assessment for growing cider apples.

Presentations were held at General Field Days, Cider Apple Field Days and the Winter Conference to educate growers about Cider Apples. Phone, email and orchard visits were then used to reach 11 growers personally relative to the economic viability of their adding cider apples to their operation.
Goal 4: Have 500 consumers request information on Wisconsin cider. Create web and social media presence for apple cider on the www.waga.org and www.wiswine.org websites, e-newsletters and FaceBook and have 500 consumers request information be mailed or emailed on Wisconsin Cider.

A new web presence was created for the Wis Apple Growers Assn that provided more information on apple varieties and cider. Cider postings were included on Facebook for Wis Apple Growers and Wis Winery Association.

Goal 5: Participate in 6 events providing information and tastings to consumers and the industry.

Events were attended, participated in or tastings were offered in Wisconsin, Minnesota and Illinois.

Goal 6: Workshop participants will Increase their knowledge and awareness of Wisconsin cider apples.

15 growers participated and learned in the various outreach efforts enough that they decided to participate in the Orchard Field Trials. 260 trees were distributed and the growers are monitoring the different varieties and evaluating their suitability for Wisconsin’s climate.

**B.** Goal 1: Have 25 growers participate in the created on-line directory in the Fall of 2015. 1. Performance Measure: Count the number of growers who list utility apples or juice on the online directory; provide the names in our report. 2. Benchmark: Online directory currently does not exist. 3. Target: 25 participating growers.

We actually created four comprehensive online directories: 1 for orchards that lists what apple varieties they grow; 1 for orchards that state they make or sell pasteurized and/or unpasteurized cider; 1 for orchards that grow cider apples specifically and the varieties they grow and 1 for cideries that sell hard cider. Participation in the various directories ranges from 10 to 150.

Goal 2: Create a Grower Contract Template. 1. Performance Measure: The posting of 2 or more contract templates on the www.waga.org website. 2. Benchmark: Currently does not exist. 3. Target: At least two grower contract option templates.

One Grower Contract Template has been created, piloted, reviewed by the WAGA Board and is now posted on the website as an Orchard Cidery Agreement. The contract can be modified by the grower so it was unnecessary to offer multiple options.

Goal 3: Have 9 growers participate in informational sessions on growing cider apple varieties and complete the Economic Viability Assessment for growing cider apples. 1. Performance Measure: We will track growers who participate in group sessions, webinars or one-on-one meetings with attendance sheets. 2. Benchmark: New program. 3. Target: At least 9 grower participants.

As reported previously 11 growers met with project team members to evaluate their readiness to add cider apple production to their business plans. 15 growers actually ended up participating in the field trials.

Goal 4: Have 500 consumers request information on Wisconsin cider. Create web and social media presence for apple cider on the www.waga.org and www.wiswine.org websites, e-newsletters and FaceBook and have 500 consumers request information be mailed or emailed on Wisconsin Cider. 1. Performance Measure: We will have an online signup for consumers to request branded information on Wisconsin fresh and hard cider. 2. Benchmark: New webpages and brochure. 3. Target: 500 consumer requests.

Because the industry is growing so quickly and because we were actively pursuing millennial consumers, we decided to focus on a web-based platform instead of paper. As stated earlier, 901 unique visitors landed on the All About Cider page on the WAGA website, spending 3.5 minutes on the page. Please note that statistics tell us that 44% of the visitors to the WAGA website do so from their phones. Hopefully these people are enroute to an orchard or cidery.

Goal 5: Participate in 6 events providing information and tastings to consumers and the industry. 1. Performance Measure: We will sign-up to participate in 6 events to present, have an informational booth or provide tastings. 2. Benchmark: No such organized effort now exists. 3. Target: Participate in 5 in-state and 1 national event educating consumers and growers about Wisconsin's cider industry.

We participated in 8 events.

- Panel Presentation at the 2015 Wisconsin Fresh Fruit & Vegetable Conference in January 2015
- Presentation by Herdie Baisden at CiderCon 2015, the national meeting of the US Association of Cidermakers, entitled, “Growing Cider in Wisconsin – Comprehensive Approach
- WAGA Cider Apple Field Day was held April 23, 2015 featuring noted grower and cidermaker, Stephen M. Wood.

- Hard Cider Sampling during the Social Hour at the Wisconsin Fresh Fruit & Vegetable Conference in January 2015 and January 2016.
- Hard Cider Sampling at the Cold Climate Conference, sponsored by the Minnesota Grape Growers Association (MGGA) in February 2016.
- Hard Cider Sampling at the WAGA Cider Apple Field Day in May 2016.
- Presentation by Herdie Baisden at the MGGA Cold Climate Conference in February 2016: "Hard Cider in the US Market".
- Article by Herdie Baisden on WAGA Cider Apple Field Day published in the UW Extension biweekly newsletter, "Wisconsin Fruit News".

Goal 6: Workshop participants will Increase their knowledge and awareness of Wisconsin cider apples. 1. Performance Measure: Survey workshop participants on how and what knowledge was increased after participating in a workshop and/or tasting. 2. Benchmark: Currently no baseline exists because no outreach has been done and growers and the public know little about cider apples. 3. Target: 70% of workshop attendees will show an increase in knowledge/awareness.

A total of 260 cider apple trees were distributed to 15 growers participating in Grower Field Trials. Preliminary information was provided on planting and care of the trees and the data growers needed to gather and report after the trees were planted. A follow-up survey was conducted in September 2016 by Matt Raboin to get a preliminary assessment of grower experience with their trees. Results were presented at a webinar in December 2016.

## IV. Beneficiaries

Beneficiaries include the 150+ apple growers who participated in the various events, online presence, field trials and individual consults on the economic viability. There was also a trial planted at the Peninsular Research Station. That planting will provide insight for years to come as well.

Cidermakers have also benefited as they now have a source where they can look to find apples for their production. They also benefit from the online presence the "All About Cider" section offers them.

Consumers have benefited as now there is an online location where they can receive up-to-date information on cider in Wisconsin.

## V. Lessons Learned

Since the apple trees have only been in the ground a couple of years, we still have about 3 years before production so it's hard to learn lessons from that as of yet. But surprisingly, we're already discovering that there was a virus problem in one of the rootstocks used for the Dabinett trees. The trees on G.935 are dying or have died. This does not appear to be a problem for other rootstocks, just G.935.

## VI. Additional Information

none

## VII. Contact Info

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# 19) Neonicotinoid concentrations in succulent snap bean, sweet corn and peas following at-plant concentrations of neonicotinoid insecticides following seed treatment application (FY14-019)

**Report Date:** September 25, 2017

## I. Project Summary

**A.** Many Wisconsin specialty crops rely on pollinators for fruit and seed production; as well they provide resources in the form of nectar and pollen to these pollinators. By doing so, specialty crops contribute positively to pollinator health and it is our hope that our current crop culture and plant protection strategies do not interfere with this positive contribution. This project has produced a novel contribution to this body of knowledge by examining the concentrations of neonicotinoid insecticides in important processing vegetable, while at the same time characterizing the pollinator assemblage present in these crops, which has not previously been explored.

Wisconsin specialty crop producers continue to rely heavily on neonicotinoid insecticides for the control of damaging, early-season pest insects including seed maggots (*Delia* spp.) in snap bean, sweet corn and peas, as well as Potato leafhopper (*Empoasca fabae* Harris) and Bean leaf beetle (*Cerotoma trifurcate* Forster) in these same crops. The registration of Cruiser® 5FS (thiamethoxam), Poncho® 600F (clothianadin) and Gaucho® 480F and 600F (imidacloprid) as seed treatments in the early 2000's, were regarded as EPA-designated, organophosphate alternatives, and highly significant in their capacity to increase the overall sustainability of the processing crops industry. Reported at-plant applications of soil-applied neonicotinoid insecticide seed treatments had the effect of collectively lowering the Environmental Impact Quotient (EIQ: Kovach et al. 1998) scores of snap beans from a high of 4.8 to 0.7 where it resides today (Nault et al. 2004) and was regarded as a very successful pest management transition.

Pollinators are essential to our environment and to agriculture. This is especially true for the production of specialty crops which rely almost exclusively upon pollinators for fruit and seed production. Some of the 4,000 species of wild bees native to North America can provide, at a minimum, a complementary source of pollination services and an insurance policy against fluctuations in honey bee supply. In addition, native pollinators are keystone species in many terrestrial ecosystems. The services they provide ensure that plant communities can provide food and shelter for many other animals, prevent soil erosion and assist the wildlife community.

In the particular case of processing vegetables in Wisconsin, these systemic insecticides are almost exclusively used as at-plant seed treatments. And such uses typically provide 14-21 days of post-emergence control, after which time concentrations of insecticides in the vascular system are presumed to decline well below effective doses to result in acute toxicity. So potentially, foraging pollinator species would unlikely be exposed, at a large scale, to insecticide residues present in floral structures or nectary's present on snap beans, sweet corn, or peas which develop considerable later in plant development. At the time this application was submitted, however,

we did not know the residual concentrations of these insecticides in processing crops relative to plant development. Nor did we have sufficient, comprehensive survey data to inform us of the identity, or seasonal sequence of pollinator species that frequent processing crops, especially during the critical flowering periods of crop development. Therefore, the primary goals of this research were to, a.) characterize the temporal patterns of insecticide residues in plants treated with seed treatments, and b) determine the pollinator species present in selected processing crops (e.g. succulent snap bean, sweet corn, and peas) at different times during crop development.

**B.** In part, the objectives of this research has been partially informed by outcomes from a previously funded project by the WI DATCP's, SCBG program and specifically entitled, "Neonicotinoid use patterns in Wisconsin's Central Sands", (funded in 2012 and 2013). The primary outcome of this previous project informed stakeholders of the extent of neonicotinoid concentrations present in Wisconsin groundwater as a result of leaching.

## II. Project Approach

We determined the in-plant neonicotinoid concentrations over the course of a growing season resulting from seed treatments. In our experiments, we used field grown succulent snap bean, sweet corn, and field peas provided by Del Monte foods and located at an experimental site in Plover, Wisconsin. Plants received a registered use pattern seed treatment rate of thiamethoxam (Cruiser® 5FS) delivered at 0.08 mg active ingredient/kernel in snap bean, sweet corn, and peas. Plants were arranged as three row plots with five experimental replicates per treatment. Replicate sets of plants were grown until the completion of the flowering interval and fruit set for each crop. Every 10 days, leaf and flower (pollen and nectar tissues) tissues were sampled from 3 individual plants/replicate and returned to the laboratory for insecticide residue detection. Whole flower structures (not exceeding 500 mg) were collected at two time points through the flowering interval. At the conclusion of each sample interval, all samples were prepared for assay using a methanol extraction procedure. We used ultra-high pressure liquid chromatography (UHPLC) to assess seasonal concentration changes of the neonicotinoid thiamethoxam within the wet mass of flower and leaf tissues of sweet corn, snap bean, and field peas grown with a thiamethoxam seed coating.

We also investigated the composition and species diversity of native and domestic pollinators present in flowering processing crops. In 2008, bee taxonomists performed the first comprehensive assessment of Wisconsin's native bees since the early 1900's. This assessment was based on published records, museum specimens, and recent field surveys. This combined total number of native bees consists of 351 verified species. The taxonomists also note that there are 200 other bee species documented in adjacent states, but not yet reported in Wisconsin, suggesting that bee diversity is potentially much greater, and may consist of over 500 species. We examined the abundance, diversity and timing of occurrence of pollinators in selected large fields of processing crops, again including snap beans, sweet corn, and field peas at each of three locations per crop type. We made attempts to locate farms throughout central Wisconsin to span a gradient of land-covers that range from highly agriculturally dominated to more highly diverse. Sampling of native pollinators used standard collection methods, to include pan traps and netting sampling, to ensure a complete sampling of bee species diversity and their relative abundances. Bees were collected weekly during the early production phases and into and through peak bloom.

## III. Goals and Outcomes Achieved

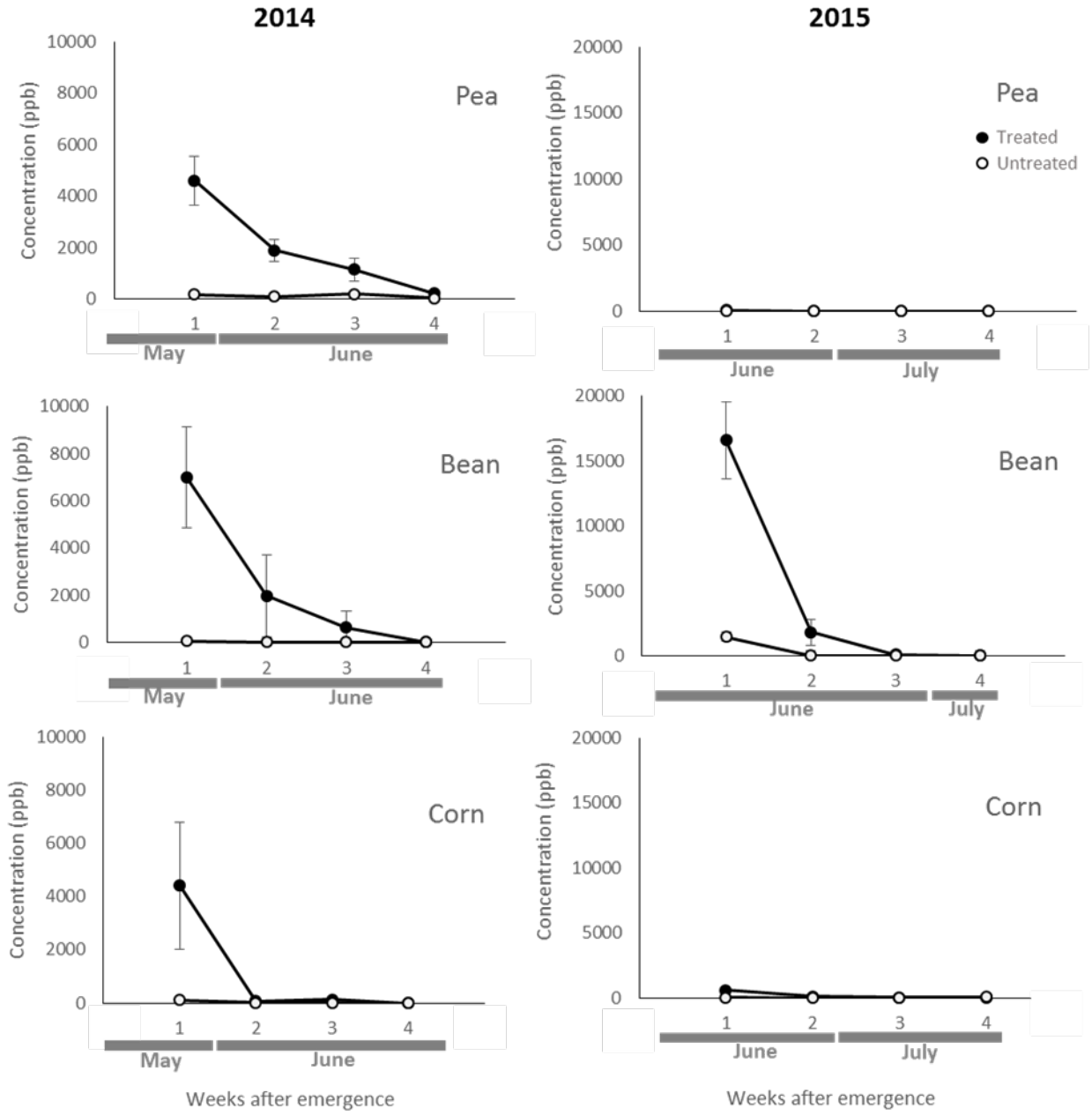
**A.** Of the total 1,233 individual bees captured across all study sites, 226 were collected from the margins of thirteen different conventionally grown vegetable fields, including 31 honey bees (14% of individuals captured). Fourteen bee species were unique to the large-scale farm, five were unique to the small-scale farm, and one was unique to organic margins. None of the bee species were uniquely found in semi-natural edge sites. One species, *Lassioglossum semicaeruleum*, was a new record east of the Mississippi river.

The bee communities of paired (n = 13) conventionally grown vegetable fields and conventional vegetable field edges varied significantly. The diversity of bees in conventional fields (mean = 1.182 ± 0.162 SEM) was significantly lower than the diversity of field margins (mean = 1.687 ± 0.466 SEM; $F_{1,24} = 5.92$, $p = 0.023$). The wild bee abundance within fields (mean = 0.145 ± 0.031 SEM) was also significantly lower than in margins (mean = 0.426 ± 0.077 SEM; $F_{1,24} = 11.55$, $p = 0.002$). Total bee abundance was only slightly lower in conventional fields (mean 0.261 ± 0.075 SEM) than in margins (mean = 0.494 ± .086 SEM; $F_{1,24} = 4.21$, $p = 0.051$). Likewise, the species richness of bees was only slightly lower in conventional vegetable fields (mean = 4.62 ± 0.82 SEM) than in margins (mean = 6.62 ± 0.62 SEM; $F_{1,24} = 3.80$, $p = 0.063$), and neither trend was significant at a 95% confidence level.

None of the floral tissues analyzed registered concentrations of thiamethoxam above our method detection limit of 30 ppb. Treated leaf tissue from both years had detectable thiamethoxam concentrations (Fig. 1). These concentrations decayed rapidly following plant emergence, and were near or below the detection limit after four weeks. Foliar thiamethoxam concentrations in all crop plants grown from treated seed were significantly higher than in plants grown from untreated seed one week after emergence in both years of the study. Treated bean leaves yielded the highest thiamethoxam concentrations, which were significantly greater than corn leaves in both years ($T_{71} = 3.12$, padj = 0.007 in 2014; $T_{69} = 13.93$, padj < 0.0001 in 2015) and significantly greater than pea leaves in 2015 ($T_{69} = 15.15$, padj < 0.0001). The concentrations of thiamethoxam in treated pea tissue were lower in 2015 relative to 2014. In untreated beans grown in 2015, however, the thiamethoxam concentration was significantly greater than zero (mean 1,444 ppb ± 147; $T = 9.822$, $p = 0.00\ 22$) during the first week.

**B.** Our goal in this experiment was to document whether detectable levels of thiamethoxam (Cruiser® 5FS) appear in foliage or flower structures of treated plants. We found that neonicotinoids from a seed coating can be transported into a plant's floral structures, but the floral thiamethoxam concentrations found were negligible across all crops in all years. These results are consistent with thiamethoxam non-detections other studies have reported from soybean flowers and maize pollen grown from seed-treated crop plants. Because the floral structures analyzed in this study included more than pollen and (in the case of legumes) nectar, the true thiamethoxam levels of thiamethoxam isolated in pollen and nectar could vary from what this study reports for floral tissues. From surveys of processors and pest management practitioners, seed treatment uses in snap beans, sweet corn, and peas continue to occur on a vast majority of processing vegetable crops at the time of planting. These annual surveys were administered at the Midwest Food Processors Association, Processing Crops Conference (MWFPA PCC), held December 2-4, 2015 in the Wisconsin Dells, WI.

**Figure 1.** Mean concentration ± standard error of thiamethoxam in the leaf tissue of field pea, snap bean, and sweet corn grown from plants receiving a thiamethoxam seed coat (black) and untreated plants (white) within Wisconsin's Central Sands region in 2014 and 2015.




Although foraging bees do sometimes collect pollen from corn, snap beans, and peas,[32] there remains no indication that this study's crops are visited preferentially by any bee species. Past research has observed bumble bees foraging for pollen from conventional field corn, but these

bumble bees did not favor corn as a pollen source and tended to have fewer workers when in proximity to corn fields. Beans of the species *Phaseolus vulgaris* bear flowers that may attract bees seeking nectar rewards but not pollen, while the structure of a pea flower is not designed for visitation by insect pollinators. Based on existing foraging records of wild bee species present in Wisconsin and the low or non-existent thiamethoxam concentrations in floral structures found by this study, it is unlikely that the flowers of neonicotinoid-treated processing vegetable crops commonly grown in Wisconsin's Central Sands region pose an elevated risk to foraging pollinators.

## IV. Beneficiaries

The final project is submitted by, and was supported by the Midwest Food Processors Association. In fact, the Association also supplied significant resources necessary for the UPLC analyses, not provided by this grant. As noted throughout the proposal, Wisconsin processing crops do currently use the neonicotinoid class of insecticides, as commercially applied seed treatments, for the control of key insect pests in succulent snap beans, sweet corn, and peas. A more comprehensive and sustainable management approach to document the potential for insecticide movement throughout plants, as well as determining the composition and timing of pollinators present in these processing crops has increased our understanding of the cumulative risks present in this ecologically important region of Wisconsin. The proposed goals and expected outcomes outlined herein were designed to benefit other grower groups such as the Wisconsin Potato and Vegetable Growers Association members.

Although the funding period of the project has ended, we will continue to summarize the results of our work resulting from sampling for native and domestic pollinator species in each of these same crops grown in a commercial setting. Specifically, we will plan to submit for publication, a manuscript tentatively entitled, "*Native and domestic pollinator diversity and abundance in relation to landscape composition and intensity in Wisconsin Central Sands eco-region*", and for submission to the journal, Agriculture, Ecosystems and the Environment (https://www.elsevier.com/journals/agriculture-ecosystems-and-environment). In this specific manuscript, we will specifically examine the abundance, diversity and timing of occurrence of both native and domestic pollinators captured in our study from selected large fields of processing crops, again including direct comparisons of bee communities within conventional and organic farming operations. We will relate these response variables to measures in the landscape generated from the USDA National Agricultural Statistics Service, Cropland Data Layer (https://nassgeodata.gmu.edu/CropScape/) throughout central Wisconsin to span a gradient of land-covers that ranges from highly agriculturally dominated to more highly diverse.

Summaries of these results have been presented at: (1) the 2017 Processing Crops Conference portion of the Midwest Food Processors annual meeting, and (2) the 2017 Wisconsin Agribusiness Classic annual meeting.

## V. Lessons Learned

Thiamethoxam concentrations in leaf tissue from seed-treated processing vegetable crops were highest one to two weeks following emergence, and were at or near zero by the fourth week. The

concentration range and rapid decay pattern of thiamethoxam in the leaf tissues of this study's crop plants are consistent with previous findings in seed-treated crop plants. Although this study found concentrations of thiamethoxam as high as 18,375 ppb in leaf tissue, the dose a non-target insect would actually be exposed to is variable. It is unlikely, for example, that a bee would be exposed to a thiamethoxam dose at the concentrations this study recorded because bees do not ingest leaves. Natural enemies of crop pests, however, may experience lethal or sub-lethal neonicotinoid toxicity by consuming early-season prey like aphids that feed upon treated crops, or by consuming the crop leaves themselves at an omnivorous life stage.

It is possible that the lack of temporal alignment in sampling caused the peak thiamethoxam concentration in tissue to be missed in these two crops, or that the coated seeds of peas and corn remained un-germinated in the ground longer and thus more thiamethoxam was leached from the seed prior to foliation. It is also possible that the differences in thiamethoxam concentration in treated plants between years was due to differences in planting time. Thiamethoxam is transported through a plant primarily via xylem. As such, the compound's translocation through plant tissues may have been slowed by temperature-dependent metabolic rates of crops planted earlier. Planting and harvesting dates for processing vegetables in central Wisconsin are highly variable. Field peas are planted first, usually by mid-May, and have a very short flowering window before being harvested around mid-June. Sweet corn is typically planted later than peas, between late April and June, and sweet corn fields throughout the region bear pollen at times that can vary by as much as three weeks. Snap beans display the greatest phenological variety, since multiple staggered plantings occur between mid-May and late July. Subsequently, there are snap beans in flower across the Central Sands from late June through early September. Since snap beans are planted at such a high frequency, the window of elevated thiamethoxam concentration 1-2 weeks post-emergence in this crop especially may be recurrent in central Wisconsin. Further research is needed to compare field-level tissue concentrations such as these to the phenology of non-target insects in central Wisconsin.

## VI. Additional Information

Information provided in the current study has been made available through two publications. One has recently been submitted to Pest Management Science, 2017, and another is in preparation for submission to Agriculture, Ecosystems and the Environment, 2017-18.

Outcomes outlined in these investigations have also been included in the University of Wisconsin-Madison, Vegetable Entomology web-page (http://labs.russell.wisc.edu/vegento).

## VII. Contact Info

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# 20) Clarifying Marketing Labels for Wis. Farmers' Market Vendors (FY14-020)

**Report Date:** September 25, 2017

## I. Project Summary

**A.** Through the *Clarifying Marketing Labels for Wis. Farmers' Market Specialty Crop Vendors* project, the Midwest Organic and Sustainable Education Service offered resources and support to farmers' market managers and vendors to clarify how various labels, including "organic," can be used to market specialty crops. Through presentations at meetings, the distribution of clear educational materials, a website, and customized answers to questions, MOSES increased the clarity of marketing materials used to describe production practices by specialty crop vendors at 200 farmers' markets throughout Wisconsin. Consumer confidence in farm vendor labeling increased, as will access to organic specialty crop products at farmers markets, as more farmers choose organic production practices and certification after they understand the value of the proper use of the certified organic label on specialty crops.

**B.** Not Applicable

## II. Project Approach

Through this project we interfaced with Wisconsin Farmers' Market Vendors to first understand and then educate about their knowledge of various labels they can use to highlight the specialty crops they sell. We began with a presentation at the 2016 Wisconsin Fresh Fruit and Vegetable Conference about organic production and labeling. There, we got feedback from farmers' market managers about what resources would be most useful to share with specialty crop vendors at their markets about labeling.

We created a packet of materials early in 2016 to share at the meeting and then mail out to markets, but, after feedback at the meeting, decided to totally revamp the packet. Our initial plan was to do presentations at farmers market meetings or regional farms for vendors, but after feedback, we were turned away from this plan. The meetings are short and packed with market-focused information, and we could not get agreement from market managers that a short presentation from us was welcome. Feedback from market managers led us to revise the project to instead create a beefed up packet. This included enhanced marketing materials that organic produce vendors could display to help identify their certified organic products. In addition, we developed consumer-focused materials that vendors could share with their customers to educate these buyers about different labels.

A webpages were set up so vendors, market managers, and consumers can access the materials we created about labeling. (https://mosesorganic.org/farmers-market/). Articles were printed in the Organic Broadcaster newspaper, and announcements made on social media about the need and the materials we created. Two direct mailings to Wisconsin Farmers' Market managers as well as certified organic vegetable farmers were done in August 2017 with packets of the

resources we created. Letters were included indicating more packets could be ordered upon request.

Packets contained:
For Market Managers

- Introductory letter with information about the packet and MOSES assistance
- Fact sheet about Wisconsin specialty crop direct market labeling
- Fact sheets translated into Hmong and Spanish
- Pocket guides for market shoppers helping them understand how to shop for produce that meets organic standards
- Information folder for vendors that are not certified organic
- Invitation to order additional resources as needed

For Market Vendors

- Pocket guides for market shoppers helping them understand how to shop for produce that meets organic standards
- Information about education programs about organic
- Fact sheet: Guide to using "Organic" at markets
- Fact sheet: Transition to organic vegetable production
- Info sheet: Know how to label your produce at farmers markets
- Info sheet: Farmer finds organic certification opens doors
- Invitation to order additional resources as needed

For Certified Organic Specialty Crop Vendors

- Introductory letter with information about the packet and MOSES assistance
- 20 Pocket guides for market shoppers helping them understand how to shop for produce that meets organic standards
- Invitation to order additional resources as needed

Working with the Wisconsin Farmer's Market Assn, an evaluation was emailed in late August to market managers who received the packets to assess the value of the information in helping their labeling and marketing of Wisconsin specialty crops.

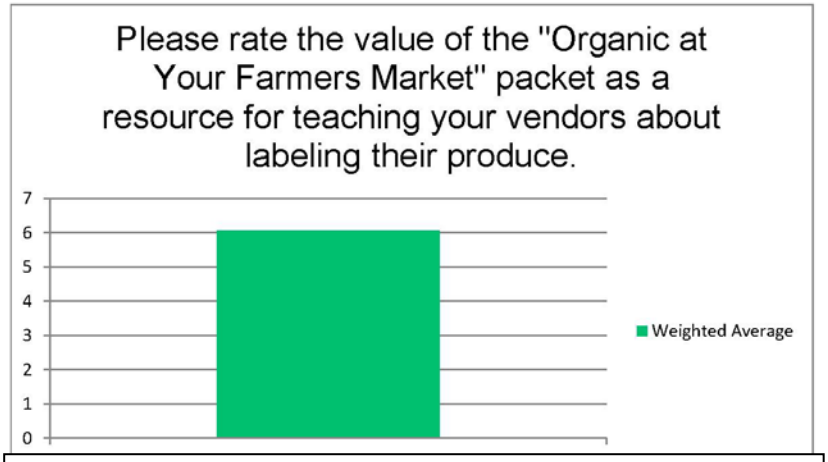
## III. Goals and Outcomes Achieved

**A.** At the end of the project we planned to measure the change in availability of certified organic produce, and clearly labeled produce, to consumers at Wisconsin farmers markets. However, changes and delays in the project deliverables made this impossible. We worked hard to create very high quality, clear and informational resources which we know will be valuable to the vendors that received them. We will continue to distribute and make available the products of this project for the foreseeable future, extending the project's impact long into the future.

**B.** We had hoped to see an increase of 6% in the amount of certified organic specialty foods sold at Wis. farmers' markets. We also expected an increase in calls from market managers to both MOSES and to certification agencies. Because of the late timing of the distribution of the

project materials, we were not able to assess these increases. Assessment will occur, but it will be after the project is completed.

However, an evaluation sent out at the end of the project gave us some interesting information. We only received 14 responses to an email sent out to 125 farm market managers. Overall, they told us that requests for organic produce has been increasing in their markets. Most thought the materials we gave them would be useful to venders and customers, but a few felt the delicacy of their positions as neutral parties at the market meant they could not distribute the materials.




Survey responses, scale 1= not useful, 10=extremely useful

## IV. Beneficiaries

In January 2016 we made a presentation to 35 Farmers Market Managers in Wisconsin Dells about specialty crop labeling. We distributed our first set of packet materials.

In August 2017 we mailed packets of informational materials about labeling to:

- 220 certified organic Wisconsin specialty crop farmers
- 125 Wisconsin farmers market managers

We will continue to send out additional packets at manager's or vendor's requests, and have the materials available for free download from the MOSES website https://mosesorganic.org/farmers-market/. We included 20 copies of the Pocket Guide for Market Shoppers in each farmer packet, expanding outreach to at least 4,400 Wisconsin specialty crop consumers.

Articles in the Organic Broadcaster newspaper were distributed to 1,914 Wis. households directly through the mail and another 2,194 Wis. electronic addresses.

## V. Lessons Learned

Over the timeline of this project we learned that time spent up front before the project is designed to plan effective outreach is well spent. Our entire project was based on some initial feedback from project partners, as well as our own assumptions. Early in the project we found out that the core activity of our project, presentations to groups of farmers associated with farmers markets and through market meetings, wasn't feasible. We had to regroup, which set the project timeline way off course. By this time new staff were involved, and we chose a new route. The materials we were able to create are fantastic, and we are sure they will have strong impact, but the delays we experienced mean that we were not able to fully evaluate the project as

planned. We know there will be long-ranging results, but they will unroll over the next year or so, and are not measurable within the active timeframe of the project.

We found that the documentation required for reporting was excessive. It took several days each year of the project to compile the records needed for each report, and a lot of back and forth with the (very helpful) administrator to ensure every penny spent was accurately documented. We recommend future applicants plan for easily 60+ hours for reporting and financial management.

## VI. Additional Information

None

## VII. Contact Info

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# 21) Testing a sustainable production model to support WI beekeeping (FY14-021)

**Report Date:** October 3, 2017

## I. Project Summary

**A.** Beekeepers contribute millions of dollars annually to the WI and national agricultural economy. This is done directly by honey and wax production/sales and indirectly through essential pollination services throughout the nation. However the industry has undergone huge changes over the past twenty years as a result of the changing economics of beekeeping, as well as threats from introduced pathogens and altered agricultural practices. The result is a significant decline in the number of large commercial beekeepers, but an apparent increase in the number of smaller hobbyist/sideliners.

Most small beekeepers are not migratory, i.e. they manage their hives locally and maintain them year-round in Wisconsin. These beekeepers have been experiencing annual colony losses of 30–50% as a result of the introduced parasitic *Varroa* mite, the increased use of neonicotinoid pesticides, and critical habitat loss. Losses of this magnitude are obviously unsustainable for any agricultural operation. This project was initiated to try and help mitigate the effects of these losses by testing an approach for replacing lost hives through the production and overwintering of smaller "nucleus" colonies, called "nucs" that can be created from existing hives within an apiary. These nucs can then be used as backups to either replace or supplement lost hives. One of the goals was to try and determine if a particular queen's genotype might perform and overwinter better in northern states such as Wisconsin.

**B.** N.A. This was a first time project.

## II. Project Approach

The primary objective of this project was to determine whether small nucleus colonies could be successfully overwintered under Wisconsin conditions as well as whether specific genotypes of queens performed better than others for overwintering ability. The first year included a steep learning curve. The goal was to establish and overwinter a total of 50 nucs, 10 nucs each headed by a different genotype of bee. Queens chosen were various strains of Carniolans, Buckfasts, Caucasians, Russians and "Northern Survivors". The choices were made on the basis of expected overwintering ability. The most common honey bee strain, Italians, was not included because they tend to build huge brood nests and bee populations which are not traits that promote overwintering ability. The decision was also made to use 4-frame medium nuc boxes rather than the traditional deep box. This was done because many hobbyist/sideliner beekeepers are taking the hobby up at an older age and find that using the smaller, lighter boxes is much easier. It is also more convenient to manage an apiary if all the equipment is a single, interchangeable size. In order to provide what I thought was enough overwintering space, I decided to standardize on using a 3-deep, 4-frame nuc box. This results in an overwintered nuc having 12 total frames in three boxes stationed on top of a bottom board and a single modified top cover to provide

additional ventilation and entrances. The rational for this was that honey bees tend to move their winter clusters up, rather than out, when seeking fresh honey sources during the winter months: a taller, narrower box seemed to be a better choice than a short, wide box.

The project was initiated in the winter by identifying appropriate queen suppliers, and getting the queens reserved. Bee packages were also ordered as they were used as resource hives for the nucs. The nuc boxes, bottom boards and top covers were all purchased unassembled. One hundred fifty boxes, 50 bottom boards and covers were all assembled, glued, stapled and given two coats of paint in very early spring of the first season. Bee packages arrived in mid-April, when there was virtually no natural food for the bees to collect. The packages were installed into full sized hive boxes to get them established. Each of the 20 packages had to be fed sugar syrup and pollen patties for the first few weeks until there was enough natural forage for them to survive on. To provide this, several hundred pounds of sugar and high fructose corn syrup was used to make a thick sugar solution the colonies need to draw out the new foundation so that the queen can lay eggs and nectar/pollen reserves can be stored. Pollen patties were made up using commercially available pollen substitute and blended with sugar syrup.

Queens had been ordered on staggered arrival dates. Not having established nucs before, it was a guess as to the best time to get them started so they could build and become strong enough to overwinter. The first queens arrived in late June and the last ones in mid-July. This allowed about a 3-week window to get all 50 queens installed. The nucs were made up by setting out nuc boxes on bottom boards in the apiary containing the source hives. Source hives were opened and the resident queens were found, caged and set aside. Frames of capped brood, larvae nectar and pollen were transferred to each nuc box. The boxes were sealed up and moved two miles to a different overwintering apiary to avoid having the bees simply return to their original hives after release. The nucs were left sealed overnight to make sure they recognized that they were queenless. Queens were introduced in queen cages and directly released three days after introduction. Approximately seven days after making up the nucs each of the twelve frames were inspected for the presence of queen cells. All queen cells found were destroyed. Approximately two weeks after queen release, all nucs were inspected for the presence of an accepted and laying queen. Nucs were monitored weekly, weather permitting, to assess the overall quality of the nuc, i.e., was the queen present, were they bringing in adequate nectar/pollen stores, did they appear to have any disease or mite problems, etc. These checks continued through the summer and into fall. In September, all nucs were treated with either to knock down mite levels going into winter and assure they were as healthy as possible. Food reserves were monitored and supplemental feeding was done if necessary. During October and November, several hundred pounds of sugar were used to make up winter candy boards as a feed supplement. In October, all black cardboard winter covers were prepared and nucs were weighed.

The 3-deep nuc configuration used permitted commercial winter covers to be used. Each cover slid over two adjacent nucs that had been strapped together using pallet straps. Having two nucs abutted tightly against one another also permits the sharing of heat generated by the winter cluster. A single styrofoam, full-sized outer cover was placed over two nucs that were each wintered in the following configuration: a bottom board with a 3/8” entrance, 3 4-frames nuc boxes (12 frames total), an outer cover/supplemental candy board feeder with a 1” lip and two

entrances, (one at each end). The pairs of nucs were held tightly together with a pallet strap, the cardboard winter sleeve was placed over each pair and a single full sized outer cover was placed on the top. Winter entrance reducers with a 1" opening were also placed into each nuc. All nuc pairs were overwintered on tables in order to keep them off the ground and minimize potential mice problems. Nucs were not opened during the winter months except for one time about the middle of January (during a warm spell) when the candy boards were replaced. The same procedure was used for each of the two years of the study. Problems and lessons learned are addressed in a different section.

## III. Goals and Outcomes Achieved

**A.** Over the course of the two-year project we followed the same general procedure in carrying out the study. Given the nature of the study, certain modifications had to be made and unexpected challenges had to be addressed. However, all activities that were proposed,—and then some—were completed

**B.** The results of the two-year overwintering study actually turned out better than anticipated. In order for a small beekeeper to maintain their hive numbers, it was assumed that two nucs might have to be overwintered for every hive that was expected to be lost based on their past experience. In other words, if a beekeeper routinely lost three hives from an apiary, he might be expected to make up and overwinter six nucs as replacements given a 50% loss rate. This would provide him with enough replacements to avoid having to purchase new bee packages and since nucs tend to build much faster in the spring than packages, they should, in theory at least, provide a greater honey yield.

What we found in our study was that rather than a 50% expected survival rate, we achieved a two-year average of 70%, substantially higher than anticipated. We also learned several other important lessons that are detailed in section V. Ultimately, we were able to overwinter approximately 100 nucleus colonies over the course of the two-year study. But it's a bit difficult to say with confidence that we had a "true" 70% survival rate. The measure of survival we used was simple: did the hive survive the winter with a viable queen. One issue was that nucs came out of winter at surprisingly different strengths. Some nucs survived with large numbers of bees and were able to start building a strong colony as soon as the spring flowers emerged. Other nucs survived, but with very diminished numbers of workers. These nucs had a successful overwintered queen, but the nuc would have to be supplemented with a frame or two of brood/bees in order to really take off. These successfully overwintered queens could also be used, not as a stand-alone nuc, but simply as a replacement queen for a hive where the workers survived, but for whatever reason, the queen didn't. We were able to take a weak, understrength nuc and place it above a strong nuc with a queen excluder and the weak one often caught up within a couple of weeks.

One of the primary questions we were hoping to answer was whether the different genotypes of queens performed better than others. Unfortunately, there were too many other variables that came into play to conclusively answer that question. Two of the most important variables we had to deal with that affected this outcome were a) queen quality in general, and b) "drifting" of bees from nuc to nuc. It was surprising to see how different queen quality can be. Our Buckfast

queens were sourced from a certified supplier in Canada. The queens had to go through customs and be inspected. This process took an extended amount of time and some queens arrived dead in the cage while others were "superseded" by the colony in short order. Only about 3 of the original 10 queens even made it to winter. Another "queen" problem was the queen supplier. Even though queens are typically ordered and reserved in January or so, sometimes the queens simply either aren't available when requested, or worse, the supplier simply doesn't respond or ship them. Even when you do get all the ordered queens there can be a huge difference in the "quality" of the queen. By that we mean some aren't mated very well or have unknown issues that dramatically decrease their quality, resulting in a weak nuc or hive. We experience both of these problems throughout the course of the study and as a result it wasn't possible to separate out whether certain queen strains overwintered better than others. Our observation was that all strains overwintered well as long as the nuc was well provisioned and healthy throughout the winter.

The bottom line was this: nucleus hives CAN be successfully overwintered at rates equal or close to those seen when overwintering full sized hives. The queen genetic source appears to be no more important than the overall quality of the queen. In other words, if a queen is healthy and well bred, it appears there is no real difference between strains. Smaller beekeepers should strongly consider integrating the creation of nucleus hives into their operations to minimize having to purchase packages each spring. The nucs they create can be stocked with pretty much any queen source they choose, though we'd suggest not using Italians based on their brood nest size. The other advantage of using nucs is that the resources from strong hives can be used to stock the nucs at a time when the hives are preparing to swarm. By removing brood and bees to stock the nuc and replace it with fresh/new foundation it may well help to minimize swarming and the subsequent loss of honey production.

## IV. Beneficiaries

Over the course of this grant several talks and/or interviews to various beekeeper groups were given and are listed below:

1. Eau Claire Chippewa Valley Beekeepers: May 15, 2016. Approximately 50 attendees.
2. The Northern District of the WHPA members were given an overview of the project by Dr. Gordon Waller, October 2015. Approximately 100 attendees.
3. Green Bay Beekeepers Association talk October 2016. Approximately 100 attendees.
4. Northern District WHPA meeting talk, March 2017. Approximately 55 attendees.
5. Dunn County Beekeepers Association talk October 2016. Approximately 40 attendees.
6. Dunn County Beekeepers Association talk May 2015. Approximately 50 attendees.
7. St. Croix Valley Beekeepers Association talk September 2015/6. Approximately 100 attendees total.
8. NW Iowa Conference Call on overwintering nucs. May 2015. Approximately 8 on call.
9. Team taught 2 community education classes. Approximately 25 total attendees.

10. Taught a hands-on beekeeping class using nucleus colonies. Summer 2017. Approximately 15 attendees.
11. Answered many phone call inquiries regarding beekeeping with nucleus colonies.

## V. Lessons Learned

Throughout the course of this study we encountered several unexpected problems/surprises that are addressed below.

1. Queen quality. Even though there are many reports of poor queen quality, we were surprised to see how common it was in the queens we purchased. Several suggestions as to why queens either fail or don't produce have been proposed. They range from poor breeding, either because of inclement weather during the mating flights, or mating with drones with low sperm viability. In either case the queen simply doesn't produce a good brood pattern and the colony bee numbers don't build well. There is also evidence that low levels of neonicotinoid pesticides are having a negative impact on queen quality. In any case, a significant number of queens we obtained were less than ideal. Another unknown regarding queen quality is the impact of shipping. Virtually all queens are bred and mass-produced in southern states and must be shipped by air to the buyer. The queens are normally sold long before they can actually be evaluated so the combination of shipping stress tied to an unknown quality in the first place can also result in sub-standard queens.
2. Drifting. Drifting of worker bees from one hive to another is common within an apiary. However, it was a particularly frustrating problem within the nuc apiary. All nucs were initially stocked with approximately the same amount of bees, brood and resources. T nucs were then moved, placed in their wintering location, and left closed for at least twenty-four hours. In multiple cases, within a week of being released after queen introduction, the majority of bees within a nuc would have drifted into another. This resulted in one nuc having very few bees while another has too many. This resulted in a significant amount of extra work moving bees/brood to try and equalize the nuc sizes. In some cases it worked, and in others it did not. It's not clear why this was such an issue with the nucs. Perhaps certain queens release significantly more queen pheromone that attracts bees from adjacent nucs. We don't have a huge apiary to work with so the nucs must be placed fairly close together after they've been made up. For a small beekeeper who is making up say, 5–10 nucs to be used as replacements, it would probably work best to space the nucs as far away from each other, and full-sized hives, as possible.
3. Feeding. Because the nucs were all started using fresh frames and foundation, it was surprising how much feed they consumed. In addition to drawing out comb, strong nucs with productive queens reared brood well into October. As a result, the bees were unable to collect natural resources in quantities large enough to build their winter supplies. Therefore, it was important to supplement their feeding much longer than expected.
4. Diseases. Over both years of the study, we had to deal with a level of an undiagnosed disease problem. The problem manifested itself with symptoms of very spotty brood patterns and some larval discoloration. A frame from a hive showing the typical symptoms was sent to the USDA Bee lab in Beltsville, MD and was diagnosed as "parasitic mite syndrome". I disagreed with their conclusion as the hive sampled had very few mites. The symptoms persisted throughout the course of the study which again slowed colony buildup. One of the observations we made was that the disease seems to have responded well to antibiotic

treatment. This was unusual because it had been suggested by others that the problem looked to be viral in nature and viral infections don't respond to antibiotic treatments. We currently still don't have a conclusive answer to the cause even though we tested samples for the presence of a common bacterial disease and it came out negative. We're hoping to be able to definitively diagnose this problem in the future as other beekeepers in the area were experiencing the same problem. We also felt it important to use new frames/foundation each year as much as possible to minimize the contamination of wax with pesticides.

5. Hive weights mean almost nothing. Hive weights were taken going into each winter for all nucs. It was initially felt that the availability of resources was going to be the primary indicator of success for overwintering nucs. We were wrong. It turned out that what seemed more important was something we had no control over, the location of the cluster going into winter. Many of the nucs emerged from the winter with plenty of honey stores in their bottom boxes. It appears that if the cluster starts the winter in the middle box that it rarely goes down, and even if it did, it may end up starving out if it consumed all the resources in the bottom box but were then unable to reach the top box honey stores because the middle box had been depleted.

   It became fairly obvious early in the study that different nucs positioned their clusters poorly going into winter. As a result, the decision was made to add candy boards to every nuc at the time of winter wrapping, typically the third weekend in November. We believe that adding candy boards was far more important to the overwintering success of the nucs than the actual hive weight. Candy boards appeared to provide two main advantages:
   a. Nucs with poorly positioned clusters, i.e., too high in the box, were able to access feed provided in the candy board without having to push themselves downward, something they rarely do,
   b. The sucrose in the candy boards appeared to act like a moisture sponge and absorbed much of the moisture given off by the cluster during the winter. This kept the cluster dry (long known to be a problem in overwintering), and also moistened the sugar making it easier for the bees to access the resource. In addition, the candy boards were made with two entrances, one on each end, which provide additional air-flow to dissipate moisture.
6. Timing of creating nucs. During the first year of the study, queens were ordered and arrived primarily in mid-late July. Although this timing worked well for the most part, it became a problem if there was significant drifting and nucs had to end up being supplemented with additional bees as it didn't seem to leave enough time for the nuc to build. As a result, queens were ordered and arrived starting in June during the second year of the study. This gave the additional time to equilibrate the nuc populations somewhat, but resulted in the challenge of having to manage the strong nucs much more intensively to try and avoid swarming due to too high of a bee population. It seemed to be a trade off in the end. Nucs that were established after July 15 or so, just didn't seem to build as well and did not have the resources available to them to raise a large number of healthy "winter bees", those bees produced after about the third week of August that are physiologically different and far more prepared to survive the winter months.
7. We found out there are two methods to make nucs and one seems to work better than the other. The standard method of making a nuc was to take capped brood, larvae and resource frames from source hives to populate the nuc prior to queen introduction, about a day later

once the bees recognize they are queenless. We used this approach for the first two years of the study. One major problem with this is that you must then inspect every nuc approximately one week later and destroy all newly made queen cells. This adds significant extra work and it would be easy to miss a queen cell resulting in the potential for a supersedure. We tried a "bulk bee" approach going into the third year of the study (a separate SCBG grant) which seemed to work much easier. This will be discussed in the progress report filed later.

## VI. Additional Information

I have hundreds of digital images of the study available. These include summer preparation, candy board, winter prep, and other slides. All are available upon request. PowerPoints used for the outreach talks are also available.




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# 22) On-farm sustainability for small acreage vegetables – documenting practices and using results to promote sales and improve performance (FY14-022)

**Report Date:** January 5, 2017

## I. Project Summary

**A.** This project focused on working toward documenting on-farm sustainability for small acreage, commercial specialty vegetable crops in Wisconsin. Funds were provided to work with these specialty industries to help them take advantage of surging consumer and supply chain demand for sustainably-produced crops by promotion of existing achievements and defining pathways to continual improvement. With this funding, we focused on **onions, carrots, cucumbers and peppers for pickling, cabbage for kraut, beets and kidney beans**. We worked in late 2014 and early 2015 directly with growers and their corresponding growers' associations and organizations to implement a coordinated strategy that:

1. Developed entry level assessment tools to engage a majority of growers
2. Documented sustainability for individual crops in a whole-farm context

As a result of this grant, we developed a simple, yet accurate and research-based assessment to help the industry establish this documented baseline of current practices. We engaged these industries in the development, data collection, and results from the assessment to scientifically document and measure on-farm sustainability progress. We worked collaboratively with growers to use the resulting data to help promote and market these achievements.

**B.** This project builds directly upon previously funded Block Grant projects in cranberries and strawberries where procedures for designing and collecting information on sustainable practices were initially developed. Previous Block Grant projects on potatoes and processing vegetables have also contributed to this proposal by developing and testing sustainable practices for those crops which were used in the current proposal.

This project expanded on efforts and helped with the overall structure and procedures to document industry assessments. The results from strawberries and cranberries were used for public relations and sales, as these industries as there were able to document progress toward sustainability. The current funds enhanced this model and approach to advance sustainability for small acreage, small production specialty crops. The small acreage crops would not normally have access to these type of products, but were able to work on this project by banding together and collaborating with University of Wisconsin specialists.

## II. Project Approach

To complete the objectives of this proposal, we worked with the growers, industry and stakeholders to develop and employ an entry level self-assessment tool for whole farm on our seven targeted specialty crops (onions, carrots, cucumbers and peppers for pickling, cabbage for kraut, beets and kidney beans) and conducted the on-line assessments to document baseline sustainability. In early 2015, we worked with growers, association members and processors to

develop an assessment tool that included all appropriate whole-farm practices that relate to sustainability. We held in-person, phone and webinar meetings with associated participants to review and edit drafts to ensure that individual crop assessment include appropriate practices. To further ensure this process would be viable for specific supply chain sustainability requirements, industries were asked to review and comment on the assessment. Participating companies included Del Monte Foods, Seneca, Lakeside, Great Lakes Kraut, Bay Valley Foods, and Chippewa Valley Beans.

We collected assessment data from a large segment of the targeted industries with more than 25 operations from these small crop assessment reporting data which represent over 28,570 acres of total farm acres, of which over 23,700 of these acres were owned specifically by the farms and just over 6,500 acres rented. All reported results were from family owned operations where multiple generation of families worked on these operations with an average of 2.9 generations actively participating in the farming business.

For the seven targeted specialty crops in this project our goal was to establish the baseline sustainable practices used on the farm covering all areas of sustainability - environmental, economic and social. We analyzed aggregate data from all participants. In total, there were 131 discrete variables which growers answered involving all aspects of sustainability (environmental, economic and social) and included information specifically on their farms. We documented the percentage of growers using practices which encourage sustainable agricultural advancements. This data was highlighted and returned to the growers and their associated industries.

## III. Goals and Outcomes Achieved

**A.** With the high percentages or growers utilizing the assessment we have achieved a direct measureable outcome. We then developed an overall benchmark for these combined specialty crop industries, and we developed measurements of each practice related to sustainability. This measurable outcome ensured a reliable and verifiable benchmark of where the industries and growers stand on the sustainability continuum, and these numbers can be used to track sustainable practice adoption in the future.

For each of the grant objectives, the activities and timelines are described below.

**Objective 1:** Develop entry level self-assessment tools and conduct on-line assessments with growers.

- This process started in the fall of 2014 after formal funding was received, and continued throughout the winter and spring of 2014/15 to work directly with growers and promote the program at several state and regional meetings. A summary of these activities are presented sequentially below.
    - Nov/Dec, 2014- draft protocols written and developed for each 7 crop
    - Meetings attended to discuss and introduce project:
        - Dec 2 – Processing Crop Conference, WI Dells
        - January 21 – SCRI Advisory Committee Meeting – Madison
        - Feb 2 – WPVGA UWEX Educational Meeting – Stevens Point
        - March 4 – Central WI Processing Crop Conference – Hancock

        - March 4 – IPCM TAC Meeting – Madison
    - Provided large group e-mail to introduce program and provide drafts of protocols to key contacts and advisory group (on February 16th) where we asked for direct feedback
    - Developed outreach webinars for industry, growers and key contacts where we asked and received valuable input to enhance the program. A series of webinars occurred for large groups on March 9th and March 11th, then company specific webinars followed.
    - Launched on-line and paper assessments (March 27th) to gather information on the 2015 production year.
    - Individual follow up with growers and industry contact occurred at multiple time throughout the summer and early fall to assess as large of swath of the industries as we could pursue.
    - Finalized and closed assessment process on September 7th.

**Objective 2**: Conduct analyses of resulting sustainability data and develop pathways to improve research and education for improvement over time

- In late 2015, Deana Knuteson worked with the aggregated data set, data from all seven of the crops included based on grower and industry feedback, to determine grower involvement and adoption of practices based on responses.

**Objective 3:** Develop aggregated report and work with growers and association partners to produce bulleted worksheets.

- Using the completed data set, Deana Knuteson and Jeff Wyman reviewed the data and worked with growers and their related industries to identify research and outreach needs and communicate progress on the sustainability continuum to supply chain partners through 2016.

**B.** For each of the seven targeted specialty crops in this project our goal was to establish the baseline sustainable practices used on the farm covering all areas of sustainability - environmental, economic and social. We proposed to engage 50-70% of our grower communities which was achieved (66% of growers that reported acres, over 70% in terms of number of growers per crop). Thus our first measurable outcome was the development of a reliable and verifiable benchmark of where each group of growers stands on the sustainability continuum.

The analyzed data provided information to help design efficient strategies that allow groups and individuals to correct deficiencies and improve performance. This is a second positive outcome represented by increased knowledge that has not previously been available. These efforts will continue now that an assessment has been developed and a baseline established, and we will stress the need to collect additional data to demonstrate continuing improvement on their farms which will be used to inform consumers and respond to value chain requests.

## IV. Beneficiaries

Impacted stakeholders, growers and industry partners of the seven specified specialty crops and their associations directly benefited from this work as they are now able to document and measure sustainability outcomes long-term and ensure advancements along the sustainability continuum. This project is helping them answer supply chain requests for sustainability information and also avoid the redundancy of filling out multiple surveys because of their diversified crop rotations. These specialty crop growers are now able to use their own farm sustainability data for marketing and public relation needs.

## V. Lessons Learned

One lesson learned is when working with small groups of growers, there are needs to ensure confidentiality and therefore data must be combined to ensure its integrity. A few growers produce large amounts of these crops, which may make it too easy to identify individual farms. To fix this, grouping industry assessments across specialty crops worked effectively.

The second lesson relates to long-term measurements. An important component of sustainability is the ability to document improvement through time, and the Wisconsin small acreage specialty crop vegetable growers, and their associated industries and associations are committed to this goal. Since this is a short term grant, we are now actively working with the associations to keep the program momentum going and are encouraging growers and industries to use the results to promote specific accomplishments to consumers and the public, help identify improvements can be made, and helping measure progress over time. We are looking at re-assessing with the industry at a future timeframe.

## VI. Additional Information

none

## VII. Contact Info

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# 23) Specialty crop outreach activities (FY14-023)

**Report Date:** October 23, 2017

## I. Project Summary

**A.** The initial focus of this project was two-fold:

1. Share the results of research projects funded by the Specialty Crop Block Grant.
2. To provide general outreach to producers to encourage the production of specialty crops and farm diversification.

After learning that many growers of specialty crops in Wisconsin aren't exposed to the discoveries of Specialty Crop Block Grant projects. Project managers for this grant planned to share the knowledge had already been created through previously Specialty Crop Block Grants with a larger audience across the state to remedy that issue.

**B.** N/A

## II. Project Approach

First steps in this project were to create promotional materials about Specialty Crop expertise at the Wisconsin Department of Agriculture's Division of Agricultural Development (DAD). 1500 brochures were created to share at different grower conferences, meetings and events. Over 8 conferences were attended with these brochures available, potentially reaching 6,550 growers.

In addition to creating outreach brochures, DAD staff held two field day events in the summer of 2017 that had 42 attendees total. The first field day event was located in Bayfield, Wisconsin. A rural community that is known for growing apples, raspberries, blueberries, and grapes. The event visited four farms over two days. The second field day event visited three farms over two days and looked at juniper, cherry, and grape production in Door County, Wisconsin. Holding these events in the communities we selected was significant, as these areas are often over-looked for specialty crop outreach and education in the state. In addition to the rare locations selected, we focused on juniper. To our knowledge, juniper, a specialty crop with interesting potential in the state, hasn't before been the subject of a field day.

Project managers deviated the original project proposal after realizing more growers could be reached by hosting our own outreach events and speaking engagements in addition to traveling to conferences and others' events. This deviation created a more robust outreach and created stronger connection to specialty crop growers allowing for continued sharing of specialty crop grant outreach, even now that the grant has ended.

## III. Goals and Outcomes Achieved

**A.** Activities completed to achieve goals include: creation of outreach materials to share specialty crop expertise and specialty crop block grant results, attending conferences and other outreach events to connect with growers and disseminate information about specialty crops and

the Specialty Crop Block Grant program, creation and execution of two specialty crop field day events looking at 6 different specialty crops being grown in Wisconsin. The original goal of the proposal was to reach 200 producers, which we feel confident we reached.

**B.** Our application targeting outreach to 200 growers, this goal was achieved and exceeded. Additionally, we proposed a minimum of 75% of participants will increase their knowledge of specialty crop growing practices and/or state trends about specialty crops by a minimum of 1 step on the likert scale. A minimum of 50% of the participants will increase their knowledge by at least 2 steps on the likert scale. We surveyed attendees of the field days we hosted and received a 15% response rate. From respondents we found that 100% of them gained knowledge after attending. 20% increased knowledge by one step and another 20% increased knowledge by two steps on the likert scale.

## IV. Beneficiaries

Growers producing specialty crops, specifically crops we discussed at our field days benefited. Please see above for quantitative data.

## V. Lessons Learned

We had an initial goal to work with growers associations on this project, but that relationship was never forged, though not for lack of trying. As a result, we found it difficult to connect with more specialty crop growers. Involving the growers associations from the onset of planning the field day events could have resulted in greater attendance numbers for us.

## VI. Additional Information

Project managers collected information from each of the growers visited including farm history, photographs, and growing suggestions that will be included in a publication focused on marketing local foods in the state. The information gathered will be featured as “Grower Profiles”. Additionally, we created the following report to share internally and externally-attached.

## VII. Contact Info

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# 24) Enhancing the stability and mutual profitability of specialty crop sales through written contracts (FY14-024)

**Report Date:** December 28, 2015

## I. Project Summary

**A.** Sales by Wisconsin fruit and vegetable growers to Wisconsin buyers are increasing drastically as both parties realize the economic benefits of working together. To give just one example, the Institutional Food Market Coalition reports that local sourcing by its members jumped from practically zero in 2007 to $1.8 million in 2011, with total sales over the five years of at least $4.3 million. These increases are reflected region-wide with USDA AMS reporting direct-to-consumer sales increasing in the North Central region at nearly 100% over the past 10 years, which is nearly double the growth experienced by non-direct agricultural sales. If these sales relationships are to continue to grow, buyers and sellers need written agreements that create clear legal obligations. This project is essential, in part, because farmers use attorneys at rates far below other small business owners. Where 78% of U.S. small business owners have used an attorney in the past three years, about 16% of farmers have ever used an attorney for anything. Although buyers may have more access to legal education and services, they may want to work with farmers but don't have the time to investigate the rules and regulations that apply. Agricultural law has many exceptions as compared to commercial law as a whole, and specialized advice is sorely necessary.

Farmers need guidance to create legally resilient sales relationships. They need product availability sheets and invoices that protect their investment and the quality of the product. Farmers need recourse in the event a buyer does not uphold the terms of the agreement and the farmer is negatively impacted. Yet, legal issues can't be addressed in isolation. Farmers also need information to help set up sales relationships for success including: 1) Finding the buyers that work for you, 2) Developing a relationship with buyers, 3) Negotiating and memorializing the agreement, 4) Maintaining sales relationships, and 5) Rectifying the sales relationship gone wrong.

Lastly, a new approach to legal services is needed. Research shows farmers aren't using attorneys because attorneys do not understand farming and do not offer tangible benefits to their business. This made legal services available to project participants for review of contracts or insurance policies. Farm Commons provided legal services to individuals attending the workshops and webinars as requested; and the organization networked with additional attorneys who took referrals beyond Farm Commons' capacity.

**B.** Farm Commons began addressing specialty crop sales and legal risks with a 2013 SCBG grant. In 2013, we received a grant totaling $8,450. Half of that was directed to produce a webinar and basic print guide on writing a sales contract. Although the financial commitment was very small, we saw great success. Literally 100% of our survey sample set (about 40% of all participants) made at least one change to their business as a result, from among the following options: Create new or different procedures for sales, Create or modify availability/sell sheets,

invoices, or other sales documentation, Create or modify a sales contract, and Modify communication techniques with buyers. We delivered this result with just one webinar (attended by 70 farmers) and a simple, brief guide that outlined only the most basic terms of a sales agreement.

This project leveraged the initial success of our 2013 project and expanded it for a much wider impact. We produced a comprehensive guide to selling with invoices and availability sheets, and a second guide to overall legal aspects of direct sales of specialty crops. We also built on the broad webinar offered in 2013 by offering a narrower, interactive webinar that delves into more innovative and detailed issues in 2014. Farmers had the opportunity to receive feedback on assignments, draft contract language themselves, and build strong networks for the future through the webinar.

## II. Project Approach

The following is our Work Plan from the project proposal, amended to indicate what we actually did.

| Project Activity | Who | Timeline |
|---|---|---|
| Conducted individual farmer/buyer interviews to develop content and focus for the guide. | Rachel Armstrong | Nov and Dec of 2014 |
| Researched and wrote guide, including the following: Comprehensive guide to legal aspects of fresh fruit and vegetable sales including contract law, state and federal regulations, and insurance, with a focus on selling product through availability sheets and invoices. Checklist for discussing sales relationship/contract. Expanded model sales availability sheets and invoices. Expanded information on addressing dispute resolution, communication strategies, food safety responsibilities. | Rachel Armstrong | Nov 2014 to Jan 2015 |
| Have resources reviewed by a farmer. | Project Coordinator | Jan 2015 |
| Scheduled webinar and did outreach: submit to calendars, write newsletter articles, announce on list serves and blogs. | Project Coordinator | Nov 2014 to Feb 2015 |
| Wrote and conducted webinar. | Rachel Armstrong | Jan to Feb 2015. |
| Had resources formatted, posted online, disseminated, and conducted outreach on resources using web, social media, email and newsletter articles, leveraging connections already established in 2013 SCBG project. | Project Coordinator | July –Aug 2015 |
| Processed evaluations of webinar and resources via survey. | Project Coordinator | July-Aug 2015 |
| Assessed results of the resource surveys and make | Project Coordinator | |

| | | |
|---|---|---|
| any necessary changes to the resources. | | July-Aug 2015 |
| Do follow up meetings with individuals, upon request, who attended webinar. | Rachel Armstrong | April- Aug 2015 |
| Project Reporting. | Rachel Armstrong | Aug 2015 |

## III. Goals and Outcomes Achieved

We reached 180 farmers through our webinar tutorial. Over 136 farmers downloaded our two print guides. Based on our evaluation, 90% of the farmers using our materials increased their knowledge. 61% of farmers using our resources planned to make a change to their operation, while 31% had already made a change within 3 months of using our resources. The following are specific outcomes:

219 Farmers/Buyers will increase their knowledge of the following: basic contract law: creating, fulfilling, and modifying a contract; advanced contract law and regulations specific to fruit and vegetable sales, food safety liability, risk management overall.

200 Farmers/Buyers will feel more comfortable with skills in negotiating sales with buyers.

203 farmers will understand basic insurance policies and the risks they cover (and do not cover) regarding sales relationships.

148 Farmers/Buyers drafted and implemented written contracts.

This project also created a permanent, lasting framework to continue the positive results of this project beyond the term of the grant request here. These resources and webinars are available well beyond the project end date. Aside from the tangible results, legal education and legal services improved the stability and resiliency of purchasing relationships by increasing communication. When buyers and sellers understand each other's needs and opportunities, they are able to address those needs. Clarity is also essential to make informed business choices as the market changes into the future. *All materials created and presentations given specifically targeted specialty crop fresh market produce growers.

**B.** see above

## IV. Beneficiaries

This project benefited 316 fresh vegetable and fruit farmers. These farmers benefitted because they both learned how to manage legal risk of sales and took steps to do so, by insuring their operations and by drafting more legally resilient sales materials. We also benefited a small number of Extension agents and agricultural educators. These folks benefitted by understanding contract law themselves, making them better able to share their knowledge with farmers in the future. Lastly, a few buyers benefitted. The buyers were also farmers- for example, a farmer that was starting up a distribution network. These folks benefited by being able to both sell their product more fairly and to buy from other farmers through clear, legally- resilient arrangements.

## V. Lessons Learned

We learned that the community of specialty crop farmers may not be as ready for more advanced sales contracting materials as we had anticipated. Buying and selling is still a very informal enterprise with very little paperwork. We thought there might be more appetite for creative arrangements such as contracting ahead of production or for farmers selling their labor to produce a product rather than the product already grown. This wasn't exactly the case. To better satisfy the demand among specialty crop growers, we modified our approach slightly by emphasizing invoices and availability sheets. IN the future, we anticipate the market will be more ready for more complex sales relationships- hopefully ones that provide greater security to both parties.

## VI. Additional Information

None

## VII. Contact Info

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# 25) Healthy Hospitals (FY14-025)

**Report Date:** September 18, 2017

## I. Project Summary

**A.** The goal of the Farm to Hospital Community of Practice project was to increase the amount of WI-grown specialty crops procured for use in WI hospitals. The Community of Practice was designed to build upon the momentum generated during the first WI Healthy Hospitals and Clinics Forum in September 2015 and link interested hospitals to each other and technical assistance providers. Additional resources including a website, success stories and other resources were created to further support this work.

**B.** Not Applicable

## II. Project Approach

Thirteen hospitals signed up to participate in the Farm to Hospital Community of Practice and made a commitment to increase their farm to hospital initiatives. Unfortunately, three did not participate beyond the initial meeting, citing lack of leadership support or conflicting priorities as their reasons for not participating. The 10 remaining hospitals completed the CDC Healthy Hospital Food and Beverage Environmental Scan with additional WI Farm to Hospital questions and developed action plans for change. In addition, participants attended an in-person kickoff meeting, networking calls, online networking via yammer, optional field trips to participating hospitals, and an in-person wrap-up meeting to share successes. In 10 months, we saw the following highlights:

| Farm to Hospital Highlights | Pre-Survey (Spring 2016) | Post Survey (Spring 2017) |
|---|---|---|
| We are purchasing local fruits & vegetables in our facility. | 7 | 9 *all others are considering it* |
| Does your facility have a garden? | 3 | 4 |
| Does your facility serve as a Community Supported Agriculture Share drop-off site for staff? | 4 | 6 |
| Does your facility have a Farmer's Market? | 2 | 3 |
| Do you promote these Farm to Hospital activities? | 9 | 13 |

Surprisingly, while technical assistance was available and provided to the group via networking calls and in-person meeting, very few teams took advantage of individual TA. During the evaluation, teams shared that they often did not know what to ask and recommended that we integrate TA into their planning process earlier in the project.

In addition to organizing the Farm to Hospital Community of Practice, we created a healthy hospitals website with a specific farm to hospital webpage that we continue to add resources to – wicancer.org/healthyhospitals. Two success story videos, three written success stories and a Farm to Hospital infographic can also be found online at wicancer.org/healthyhospitals.

The 2016 WI Healthy Hospitals and Clinics Forum was held on September 30 and was a very successful event with over 160 people in attendance. The event featured a Farm to Hospital track with four breakout sessions that showcased successful initiatives from around the state.

*It should be noted that although some of the participating hospitals may have chosen to include local meat, eggs and dairy in their healthy initiatives, only specialty crops were discussed and promoted in the program. No funds were spent on non-specialty crops and none were mentioned in resources, meetings, or any function run by the staff during the project. Any non-specialty crop information was strictly added post-project by participants in the healthy hospitals initiative, not by staff presenting this program.

## III. Goals and Outcomes Achieved

### A. Goal 1: Increase resources available for WI hospitals with a focus on Farm to Hospital

There were multiple resources created to support WI hospitals including the WI Healthy Hospital website (wicancer.org/healthyhospitals), a Farm to Hospital infographic, and an online toolkit that links to pre-existing resources-https://wicancer.org/healthyhospitals/farm-to-hospital-resources/.

**Goal 2: Increase participant hospitals ability and knowledge (using stages of change) to source WI specialty crops.**

Community of Practice participants indicated on the pre/post environment scan an increase of 2 facilities now purchasing local fruits and vegetables (from 7 to 9) and all others are now considering it. Participants in the community of practice unanimously said that the project was worth the time and effort.

### B. Potential Impact Updates:

1. A minimum of 20 hospitals will receive education and assistance on how to purchase WI-grown specialty crops
    - Over 160 people attended the WI Healthy Hospital and Clinics Forum on September 30 in Madison, WI. Farm to Hospital was one track that offered four different breakout sessions related to successful farm to hospital initiatives. In addition 10 hospitals participated in the Community of Practice and were able to access resources and TA to assist with their Farm to Hospital initiatives.
2. Approximately 50 people will attend the WI Healthy Hospitals and Clinics Forum and increase their knowledge of procuring WI-specialty crops.
    - Over 160 people attended the forum on September 30, 2016
3. A minimum of 20 WI specialty crop producers will access the institutional market via direct sales or thru an intermediary.
    - This became less of a focus as the Forum planning committee decided against allowing exhibitors. The TA providers including REAP, SLO Farmers and Fifth

Season had an opportunity to interact with participating hospitals in the Community of Practice and hear firsthand from the hospitals about their needs and challenges.

4. The project will directly impact the patients, visitors and employees at each participating hospital.
    - From the seven participating hospitals that provided meal numbers, they showed a combined total of 1,268,072 meals served in 2016.
5. Public resources will be available for all 203 WI Hospitals via the Healthy Hospitals website.
    - The website has been created and is publicly available – wicancer.org/healthyhospitals

## IV. Beneficiaries

The ten hospitals that participated in the community of practice benefitted. One of the key benefits that they mentioned was the value of being part of a cohort, which yielded new ideas, new contacts and strong support. The new website (wicancer.org/healthyhospitals) allows any hospital in WI to access the many tools and resources that were utilized in the Community of Practice.

## V. Lessons Learned

We learned about the value of the Community of Practice model. As mentioned above, most participants mentioned the value of being part of a cohort in order to hear new ideas, make new connections and support each other. It's important to identify an assessment tool that can be used in the Community of Practice to help identify evidence-based opportunities for participants. It also requires a staff coordinator to organize and run the Community of Practice.

We noticed that our TA providers were not as well-utilized as we had anticipated. Despite multiple reminders about the availability of support, not many teams took advantage. As mentioned above, in the future we would consider integrating TA in a meaningful way at the beginning of the project instead of passively waiting for teams to reach out to the TA providers. With that being said, the expertise of the TA providers as the project coordinator was extremely valuable and I'd recommend the availability of TA for future Communities of Practice.

## VI. Additional Information

Much of the resources can be found online at www.wicancer.org/healthyhospitals.
A summary of the Farm to Hospital Community of Practice is attached.

## VII. Contact Info

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