Final Report

Grant No. 12-25-B-1264
Specialty Crops Block Grant Program
Wisconsin Department of Agriculture, Trade and Consumer Protection

Report Date: December 8, 2014

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INTRODUCTION

The Wisconsin Department of Agriculture received $$977,022.39 from the Specialty Crop Block Grant Program, Grant No. 12-25-B-1264. The Department was able to fund 21 projects initially to promote and improve specialty crops industries in the state of Wisconsin or the Midwest and fund a SCBG Manager to administer and promote the Specialty Crop Block Grant program. Due to efficient use of funds, 4 additional projects to promote and improve WI specialty crop industries were also funded. WI DATCP used 10% of the funds to cover administrative costs for the finance department to track and disperse the funding.

Enclosed are the reports submitted by all 26 grantees.

Grant Projects:

FY11-001 Prevention of sugar end defect in WI potatoes
FY11-002 Optimizing resource use in potatoes with drip irrigation
FY11-003 Assistance for underserved fresh market growers
FY11-004 Pest management strategies to replace Mancozeb and Diazinon for ginseng
FY11-005 Grower-driven sustainability standards for cranberry production
FY11-006 Making SavorWisconsin.com Mobile Web Capable
FY11-007 Cultivating alternative apple pollinators
FY11-008 Improving nitrogen use efficiency in sweet corn production
FY11-009 Retail Promotional Tools for "Wisconsin Potatoes" Buy Local Effort
FY11-010 Market expansion for Wisconsin grown grapes, Phase II
FY11-011 GAP/GHP cost share
FY11-012 Development of new commercial strawberry, plum/apricot and Aronia cultivars
FY11-013 Bayfield fruit crop diversification
FY11-014 Integrated systems to improve mint persistence in Wisconsin
FY11-015 Evaluating soil moisture probes for water use efficiency in cranberry beds
FY11-016 Promotion of Wisconsin farm-grown Christmas trees
FY11-017 Control of powdery mildew and leaf spot disease using low-risk pesticides
FY11-018 Assessing soil fumigation and fumigation alternatives in WI potato production
FY11-019 Survey of Christmas tree fields for a new root rot disease
FY11-020 Development of best management practices workbook for Wisconsin cranberry production
FY11-021 Optimizing calcium rates for pickles
FY11-022 Specialty Crop Block Grant Manager
FY11-023 Disease and Canopy Management in Northern Wine Grapes
FY11-024 Herbicide Drift Awareness Campaign
FY11-025 Development of Good Manufacturing Processes for the Wisconsin Hop Production Industry
FY11-026 Cranberry trade mission with China

1) Prevention of sugar end defect in WI potatoes (FY11-001)

Report Date: November 27, 2013

I. Project Summary

A. The Wisconsin potato industry has had price incentives to improve fry color of processing potatoes since 2006, but prior to 2010 did not reject potato lots because of unacceptable fry color. The economic loss to potato growers with rejected potatoes due to unacceptable fry color is significant, as spot market prices for fresh potatoes are much less than contract prices for processing potatoes. Managing sugars and fried color are key issues for McCain Foods, the largest processor of Wisconsin potatoes. Improved fry color and quality will likely improve the demand for Wisconsin produced processing potatoes and contribute to the economic success of the Plover, WI processing facility and ultimately – Wisconsin potato growers. A reliable supply of high quality processing potatoes is needed to ensure the long-term economic health of the processed potato industry in Wisconsin.

The goal of this project is to improve the raw product value and improve finished product quality of processed potatoes by minimizing the negative effects of sugar end defect. Improved finished product quality will increase the marketability of processed products from Wisconsin. Improved fry color of processed products will lower acrylamide levels and enhance processed potato product safety. Unique approaches will be employed to develop new potato varieties with resistance to sugar end development. We accomplished this goal by 1) conducting on-farm trials that demonstrate optimal management of irrigation, vine desiccation, and harvest timing, 2) developing raw product evaluation techniques for use in storage that allow for prediction of sugar end development, 3) creating potato varieties with resistance to sugar end defect development and cold-induced sweetening, and 4) screening available processing russet potato varieties for resistance to sugar end development.

B. Previously funded project was Potato Sugar End Defect 10-001. Previous accomplishments included development of Russet Burbank transgenic lines with silenced acid invertase under objective 3. We also completed projects related to objective 2 and will be evaluating 80 breeding lines from across the country related to objective 4.

Additional efforts included expansion of objective 1 and 4 as we screened potato germplasm for higher specific gravity (solid content) as this is a tremendous challenge for Wisconsin potato growers as well. A second year of funding allowed for completion of initial steps proposed in this grant and further implementation for improved sugar end management systems. Preliminary data generated through this research facilitated the submission of USDA SCRI proposal.

II. Project Approach

1) Conduct on-farm trials that demonstrate optimal management of irrigation, vine desiccation, and harvest timing.

This was completed during summer 2011, 2012, and 2013. Umatilla, Bannock Russet, Canela Russet, and Russet Burbank were tracked for growth, bulking, nitrogen uptake and maturity during the 2011 growing season. Trials have been completed on irrigation response in Umatilla, Bannock Russet, Canela Russet, and Innovator during the 2013 growing season and will be evaluated for processing quality over the next 6 to 8 wk. Agronomic recommendations are being completed for Umatilla, Bannock and Canela.

Commercial scale bins were stored in cooperation with McCain foods in the 2011-12, 2012-13, and 2013-14 storage season. Umatilla and Alpine Russet were evaluated for long term storage in 2011-12. Umatilla and Sorana were stored during the 2012-13 storage season. Innovator and Umatilla are being evaluated in the 2013-14 season under funding from the USDA SCRI competitive grant funding. The 2013-2014 storage trials have been completed and data are presented in the attached file; Sugar End Storage 2013-2014.pdf.

2) Develop raw product evaluation techniques that can be used after harvest to predict the likelihood of sugar end development in processing potatoes.

Enzymatic assays have been conducted to determine variety sensitivity to environmental conditions that contribute to sugar end defect in potato. The enzymes of interest include acid invertase and sucrose synthase.

Several varieties with resistance to sugar end defect have been identified. This includes Umatilla and others.

3) Develop potato varieties with resistance to sugar end defect as well as cold-induced sweetening.

Russet Burbank has been genetically modified with silencing genes for acid invertase and asparagine synthase. These have been grown in the greenhouse with improved cold induced sweetening tolerance and improved tolerance to sugar end defect. These modified potato clones were grown in field trials during summer of 2012 and 2013. Preliminary results indicate that modified clones are not sensitive to sugar end defect. Furthermore, these clones have lower levels of acrylamide. WARF, UW-Madison, and Simplot are cooperating in taking these clones to commercial market in partnership with other processors (including McCain) and QSR (Quick Serve Restaurants). Modified clones are scheduled to be approved by FDA by March 2014.

4) Screen available processing russet potato varieties for resistance to sugar end development.

Screening trials were conducted during 2011 and 2012. Over 180 clones were evaluated in 2011, 2012 and 2013. We proposed to evaluate three clones from the Wisconsin trial for consumer attributes and for potential for finished frozen processed potato product quality. However, there were actually 30 to 40 clones evaluated for consumer attributes following 2012 and 2013 growing season. These activities will continue during 2014 and 2015 through USDA SCRI competitive grant funding as is commercialization efforts, seed cleanup, and other activities. These data are available online at vegetables.wisc.edu/acrylamide.

III. Goals and Outcomes Achieved

-completed evaluation of irrigation practices by processed potato growers. Growers are managing soil moisture to greater than 80% of field capacity during early bulking when the crops are most sensitive to sugar end defect. Growers water less frequently later in the season. During 2012 and 2013 (still not complete picture), sugar end was less of an issue and gravity or processing potatoes looks improved. This could be an environmental effect, but 2012 had heat stress during much of the early bulking period. Improved varieties, better irrigation, and better overall crop management has led to improved sugar end prevention.

-screened 180 breeding lines for yield, size, specific gravity, fry color, and sugar content under Wisconsin growing conditions. Lines are also being evaluated for acrylamide content. This is part of nationally coordinated trial

-developed several transformed lines of Russet Burbank with silenced Acid Invertase expression of over 93%. Field trials were completed and confirmed that silencing Acid Invertase confers resistance to sugar end. These transformed varieties are under regulatory approval in cooperation with J.R. Simplot Company.

Evaluating long term storage of Umatilla, Sarona, Innovator and Alpine in commercial scale storage trials in the SRF. About half of the processed acres are now planted to varieties other than Burbank including: Canela, Umatilla, Innovator, and Bannock.

B. All goals were accomplished. Furthermore, we received competitive funding in separate, but related project focused on mitigation of acrylamide in processing potatoes.

Goal: Improve raw product quality and decrease rejection rate of processed potatoes based on fry color.
Performance Measure: proportion of potatoes that are acceptable for processing.
Benchmark: 85% of potatoes grown for processing are acceptable and being processed.
Target: 100% of potatoes grown for processing are acceptable and processed

During 2011 and 2012, 100% of processed potatoes in Wisconsin were accepted for processing. This appears to be the case for 2013 as well. In fact, producers with issues related to quality in the past now have some of the best processing quality coming out of storage. In reality, Russet Burbank is highly susceptible to stress conditions that occur during the growing season. Russet Burbank growers have adopted practices related to irrigation management to reduce impacts of climate on sugar end and solid content of potatoes. However, extreme conditions were to reoccur could jeopardize this record going forward.

Goal: Varieties other than Russet Burbank are grown for processing.
Performance Measure: acres of potatoes planted for processing with varieties other than Russet Burbank
Benchmark: 15% of acres for processing are planted with Bannock Russet
Target: 50% of acres planted for processing are planted with varieties other than Russet Burbank or with genetically modified Russet Burbank within 5 years.

Russet Burbank acreage for 2013 was only 40 to 50% of the total crop. Proposal for 2014 is that only 30% of the processed acres be planted to Russet Burbank. McCain has contracted production of 4 new varieties – Umatilla, Innovator, Canela, and Bannock. These varieties were grown on nearly 6,000 acres of the 12,000 acres of processing potatoes grown. Expansion of new varieties is being planned including securing additional seed production to allow for more planted acres. These new varieties could increase total processing potato production in Wisconsin in the future.

Third accomplishment not linked to a specific goal
Another accomplishment is commercialization of modified potatoes. J.R. Simplot company has developed Innate concept whereby potato are transformed with potato genetics with no foreign DNA within the potato crop. Tier 1 is low acrylamide by silenced asparagine synthase and Tier 2 is low color with silenced asparagine and acid invertase expression. UW-Madison is collaborated in this effort primarily supported by the activities funded through this grant.

IV. Beneficiaries

This includes 100% of the processed potato growers in Wisconsin affecting roughly 12,000 acres. There are 42 processed potato farms in Wisconsin with 30% of crop processed into fries. Each farm employs 5 to 20 employees depending on farm size and time of year. Potato farms also support diverse and extensive associate industries including chemical suppliers, equipment dealers and manufacturers, irrigation companies, storage companies, technical advisors, potato seed growers and others.

Affects McCain Foods in Wisconsin Rapids which employs several hundred people at the potato processing plant. Increased quality of raw potatoes will improve plant efficiencies and economic returns insuring continuing positions or potentially leading to expanded processing volumes and more jobs. This will also potentially benefit Wisconsin Seed Growers as they move to sell the new varieties to processed potato growers.

In the past, similar research has leveraged USDA SCRI grant funds. Chip and proceed growers may benefit from additional funds leveraged by this work in the future.

Additionally, processed potato consumers have better quality end product quality with lower acrylamide.

V. Lessons Learned

Heat stress plays a substantial role in the development of sugar end defect in Russet Burbank. Heat also lowers solid content and specific gravity of potato also lowering processing quality.

To move forward and achieve substantial improvements in processing quality will require planting of transformed Russet Burbank, that will still have unsatisfactory gravity, or identification of new varieties. New varieties are grown on nearly 6,000 acres. Umatilla and Innovator planted acres has increased the most.

Umatilla is susceptible to black spot bruise and subsequent infection by dry rot in storage. Umatilla must be harvested at pulp temperatures above 55 F to prevent bruising. Previous storage research in other regions has showed Umatilla can be stored at 45 F long term and we stored the 2012-13 storage bin until May at 45 F (three months longer than typical for Umatilla). Innovator can be stored as low as 42 F and we will attempt to do this during the current storage season.

VI. Additional Information

Photo of (left to right) standard russet Burbank and three silencing lines with 98, 96, and 96% silencing of vacular acid invertase in the leaf tissue.

VII. Contact Info

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2) Optimizing resource use in potatoes with drip irrigation (FY11-002)

Report Date: October 10, 2014

I. Project Summary

A. Wisconsin potato production requires intensive management of water, nutrients and pesticide inputs to optimize yield and quality. Documented reductions in groundwater depth in Central Wisconsin have concerned the public as well as growers. The finding of pesticides and nitrates in the groundwater in Central Wisconsin also creates concern about the impact of farming systems on water quality. Long-term sustainability of the potato and vegetable industry in Central Wisconsin will require modified production systems to improve resource use efficiency and optimize production as well as preserve and enhance groundwater resources.

The goal of this research is to develop potato production systems that incorporate drip irrigation technologies and unique planting bed configurations to improve water and resource use efficiencies in order to improve long-term sustainability. Specific objectives of this project were designed to: 1) evaluate the yield and quality of potatoes in response to plant population in bed planted versus conventionally hilled potatoes, 2) evaluate the water and nutrient use efficiency of overhead sprinkler versus drip irrigated potatoes, 3) evaluate the effects of deficit irrigation on yield and quality of fresh market and processed potatoes, and 4) evaluate the efficacy of insecticides delivered through drip irrigation systems compared to in-furrow applications at planting. These objectives were initiated in commercial scale, on-farm research trials near Coloma, WI, in 2010. Three seasons of research plot-scale drip irrigation trials were then conducted at the Hancock Agricultural Research Station from 2012-2014 in the hope to validate results under lower precipitation conditions. Additionally, nitrogen management trials were implemented as a component of the trial in combination with drip irrigation system.

B. This project built off of a 2010 SCBG with the same title. This project replicated some of that project's plan of work in order to validate the results of the research with more than one season of data. It also changed parameters of some of the experiments based on the 2010 project results.

II. Project Approach

Objective 1) Evaluate the yield and quality of potatoes in response to plant population in bed planted versus hilled potatoes.

- Conducted second year of small plot trials evaluating bed planted potatoes. We screened 4 population densities of potatoes in rows vs. beds of Russet Norkotah and Snowden potatoes.
- Conducted 4 on-farm trials with bed planted potatoes with Okray Family Farms, Plover River Farms, Coloma Farms, and Wysocki Produce Farms.

- Both trials were accomplished with a new planter configuration specifically designed for bed planting. This specific planter was made available by Big Iron equipment and plans are to continue to evaluate the performance of the planter into the 2014 crop year.

Results

In both 2012 and 2013, overall yield increased with planting density in both hills and beds. Other results that were consistent over both years of study include a smaller tuber size distribution in beds when given comparable population densities. Glucose levels at harvest were much higher (2-3 fold) from bed plots than for hills. This was opposite of what was expected. Specifically, beds were hypothesized to mitigate environmental stress such as temperature extremes and thus result in lower reducing sugar content. However, following a 6 month storage interval, no significant differences in simple sugars was observed between treatments in March, 2013.

Yield gains from bed planting (compared to conventional hill planting) were inconsistent over the two years of the trial. In 2012, the trial was planted only to the potato cv, 'Norkotah," and beds yielded significantly lower. In 2013, the trial was planted to both cvs. 'Norkotah' and 'Snowden.' Bed plots yielded slightly higher than hills for both varieties; however, there was no significant difference in any of the 4 population densities or bed / hill configurations. For Norkotah in 2012 and 2013, and Snowden in 2013, there were more small tubers (2-4 and 4-6 oz) in the beds and more 10 oz and above tubers in the hills. There was no significant difference in 6-10 oz tuber range in either year across population densities or between either variety.

Volumetric moisture measurements showed that beds may lower water movement beyond the rooting zone, thus maintaining more moisture in the crop root zone.

Challenges

Bed planters are not currently constructed to deliver liquid starter fertilizer or pesticide, which can make management difficult. Further research is needed to understand why glucose levels were unacceptable in the bed plots.

Objectives 2 and 3) Evaluate the water and nutrient use efficiency of sprinkler versus drip-irrigated potatoes, and evaluate the effects of deficit irrigation on yield and quality of fresh market and processed potatoes.

- The second year of small plot trials evaluating drip-irrigated potatoes has been completed. The third year is in progress. All three years, drip irrigation was applied at 100, 86, and 75% of ET demand.
- Three varieties were evaluated, Snowden (chipping), Russet Norkotah CO8 (fresh market), Russet Burbank (processing and fresh market).
- Each year we evaluated yield and quality (grade, size, sugar end, storability, solids, etc…), water movement through the hills, soil temperature and petiole nitrates.
- In 2012, 2013 and 2014, Russet Norkotah was treated with three levels of Nitrogen fertilizer across all irrigation treatments.
- In 2013 and 2014 total nitrogen of harvested tubers was or will be evaluated.

Results

Irrigation and Yield: In 2012 and 2013, overhead sprinkler irrigation delivery resulted in the highest overall yields across all varieties tested. Among only drip treatments, there was no significant difference in 2012, but there was in 2013. In 2013, the 75% ET treatment yielded significantly higher than the 100, but not the 86% treatment. In 2012, yield trends differed between varieties—Snowden and Burbank yielded the highest under 86% ET, and Norkotah yielded highest under 75% ET. In 2013, all varieties yielded highest under the 75% ET drip treatment. US#1 yield followed total yield trends.

In 2013 there was no significant difference between drip versus overhead sprinkler irrigation for two out of the three varieties evaluated; only Russet Norkotah yielded significantly higher under sprinkler irrigation.

Fertility and Irrigation: In 2012 and 2013, there was no significant difference between fertility treatments in Russet Norkotah across all irrigation treatments. In 2013, yield positively correlated to fertilizer rate. No interaction between nitrogen rate and irrigation treatment was observed.

Post Harvest Quality: In 2013, average tuber weight and specific gravity were not significantly different between treatments. Hollow heart rates were similar between the 100% ET drip treatment and sprinkler treatment. Rates were highest under the 86% ET drip treatment. Results from the 2014 season are forthcoming. In 2012, sugar end scores of Russet Burbank fries were lowest in the sprinkler irrigation treatment. Overall, scores were similar between treatments. Stem-end scores of Snowden chips were also similar between irrigation treatments.

Soil Moisture: Soil moisture was higher in the furrow under sprinkler irrigation than under drip irrigation. At 4” and 8” below the hill, moisture was highest under the 100% drip treatment. Soil moisture was highest in the furrow under sprinkler irrigation especially toward the end of the season when squatted vines no longer contributed to preferential flow.

Conclusions: Sprinkler irrigation is still recommended for commercial potato production. Water and nutrient savings of drip irrigation does not appear to be substantial enough to offset labor and equipment costs associated with its use. However, it can be a viable alternative if restrictions on water use are sufficient to warrant its use. Overwatering may have occurred in the 100% ET drip treatment. Drip allows for a more targeted water application, which may have led to possible leaching of fertilizers out of the roots zone.

Objective 4) Evaluate the efficacy of insecticides delivered through drip irrigation systems compared to in-furrow applications at planting.

The long-term goal of this portion of the project has been to refine and even replace current insect management programs in key eastern US production regions – which rely on frequent foliar applications of broad spectrum insecticides – with an economically viable, reduced-risk system. The replacement system has focused on EPA classified reduced-risk and OP-replacement insecticides and application technology that will minimize worker exposure to pesticides and mitigate adverse effects on human health, the environment, and non-target

organisms, including biological control agents and pollinators. This project has focused on a combination of fruiting vegetables, cucurbit crops, as well as potato in field production systems. A focus on these crops results from their reliance on insecticide inputs, the high degree of hand labor needed to grow and harvest crops, and the economic importance of these crops in the region. Results generated from these new pest management strategies devised for these crops has improved production efficiency and grower profitability, reduced human health and societal costs associated with pest management, and increased the long-term sustainability of these crops. This research was completed and described in previous reports.

III. Goals and Outcomes Achieved

Goal 1: Improve water and resource use efficiency of potato production in Central Wisconsin.

Performance Measure: Yield and potato value per inch of applied irrigation water and per kWatt of electricity for irrigation pumping.

Benchmark: Yield and potato value per inch or kWatt in sprinkler irrigated and hilled potato.

Target: Improve yield and potato value per inch or kWatt by 5 to 10% with drip irrigation and bed planting.

Data Source: Yield and market value of potato and water and electrical usage from irrigation monitoring in field scale research at Coloma Farms.

Data Collection: Yield and quality data will be collected from plots and in commercial harvest. Value will be quantified by marketing potatoes from different treatments. Water and electrical usage for pumping will be metered from commercial irrigation well.

Data usage: Crop value will be used to determine profit over cost of bed planting, increased seed costs, and drip irrigation.

Accomplishments: Yield of potatoes at Isherwoods with drip irrigation was identical with sprinkler irrigation. Furthermore, irrigation with 15% less water led to yields that were identical to irrigation at full ET. With drip irrigation at HARS in 2012, yields were reduced compared to sprinkler irrigation. We believe this was due to over irrigation in many plots leading to leaching of nutrients. In 2013, yields from drip plots at HARS irrigated to 75% ET were comparable to sprinkler irrigation.

At Coloma Farms in 2010, drip irrigation was treated with almost 50 lb acre^{-1} less nitrogen, which greatly reduced potential impacts on the environment and indirect energy consumption by 20 to 25%. At HARS in 2013, drip plots irrigated with 25% less water and 100 lb acre^{-1} of fertilizer yielded comparably to sprinkler irrigated plots. If 2014 results show similar trends, this could indicate significant potential savings in water, energy and fertilizer savings.

Goal 2:	Refine/replace insect management programs in Upper Midwest potato production with decreased reliance on foliar sprays.
Performance Measure:	Reduce use of broad spectrum insecticides (e.g. endosulfan, phosmet, synthetic pyrethroids) with and economic viability of reduced risk delivery systems.
Benchmark:	Economic value of broad spectrum insecticides that pose worker exposure, environmental and non-target risks
Target:	Increased profitability of lower risk systemic insecticides applied in furrow or through drip irrigation systems leads to reduced use of and other products.
Data Collection:	Yield and quality data from plots and commercial harvest and crop value assessed through commercial marketing. NASS data will assess endosulfan, phosmet, and synthetic pyrethroids use.
Data Usage:	Crop value will be used to determine increased profits of low risk pest management programs.
Accomplishments	Endosulfan, phosmet, and pyrethroid use has been greatly reduced over past several years. In part this is due to discovery of new low risk pesticides including the anthrylic diamides. Drip irrigation has been shown to reduce pesticide use by at least 50% in multiple crops including potato.

B. At this point no potato farms have adopted drip irrigation as a means for watering potatoes. Cost and labor requirements are prohibitive and a barrier to adoption at a large scale. If water becomes restricted/limiting or has greatly increased value then drip will become a potential tool for improved irrigation water use efficiency. The use of drip continues to be important and a primary means of irrigating on smaller scale vegetable operations.

Growing potatoes in bed configurations has become of high interest to many growers. Growers and I will be leasing a bed planter to facilitate field scale research and demonstration projects as well as small plot trials at Hancock Ag Research Station. The planter may be used on 3 to 4 commercial potato farms. Several farms are discussing planting of 80 or more acres to beds during the summer of 2013. No commercial planting of beds was done prior to 2013.

Potential impacts from beds could be substantial in short term, and offer more readily adoptable solutions for increasing sustainability of potato production. Drip irrigation economics need to be improved before practical. Research and investment into modified machinery that can facilitate use of drip irrigation on a larger scale should also be explored. Research and demonstration will continue to provide critical data for growers to make informed decisions.

IV. Beneficiaries

Wisconsin potato growers: improved production efficiency should improve yield per acre and therefore lower costs. Lower costs will improve profit margin. Early results suggest that 10 to 15% yield improvements are possible through bed planting. Immediate impact is one grower with 80 acres under bed planting. If demonstration trials are successful, this could expand to

many more growers in the industry quickly and current adopters will likely expand acreage in potato beds.

Wisconsin residents: improved yields will improve potato production efficiency reducing water and nutrient use in the crop with the largest resource demand. This will decrease acres of potatoes and potential decrease impacts on ground and surface waters. Over 100,000 people live in Central Wisconsin and all would benefit from improved water resource management. There are over 200,000 people that visit the region as tourist on an annual basis.

V. Lessons Learned

We have learned a great deal on the management of drip irrigation. Throughout the duration of this project, numerous presentations have been made on drip irrigation. Audiences include potato and vegetable growers at the WPVGA annual conference, as well as hops, fresh market vegetable, and berry growers. The impact has affected far more producers than just the vegetable growers.

Commercial scale management of drip irrigation was not fully reflected in small plot trials. If drip irrigation is to be used on a commercial scale, then investments will need to be made in automation of the systems as well as in farm equipment that will be capable of laying down large areas of drip tape. To further increase the sustainability of drip irrigation, machinery could be developed to roll up tape at the end of season for future re-use. This would help to cut down on annual costs associated with drip tape use as well as negative environmental impact of tape disposal.

We have also learned how to manage the bed planting and harvest operations. We have modified the bed planting process to decrease the greening of potatoes and increase recovery. We have also discovered that the bed planting alone could potential reduce water use by 5 to 10% and the nitrogen fertilizer by 20 to 40% with little effect on yield. This is because water and therefore nutrients remain in the root zone better in bedded potatoes vs. hills. The use of beds will require training in modified irrigation management, as irrigation events must be longer in duration and less frequent to meet soil moisture needs.

VI. Additional Information:

Conference Proceedings:

Bussan, AJ, Y. Wang, S. Page, B. Miller, L. Dickman, W. Schmitt, M. Drilias. 2014. Bed Planting Potatoes. *In Proceedings of Wisconsin's Annual Potato Meeting,* UW-Madison College of Agriculture and Life Sciences, Research Division and UWEX, Feb. 4 – Feb. 6, Steven's Point, WI, 27: 41-46.

Page, S. AJ Bussan, BS Miller, Y. Wang, W. Schmitt, M. Drilias. 2014. Drip irrigation delivery in potato: a comparison of four irrigation systems. *In Proceedings of Wisconsin's Annual Potato Meeting,* UW-Madison College of Agriculture and Life Sciences, Research Division and UWEX, Feb. 4 – Feb. 6, Steven's Point, WI, 27: 47-52.

Photos:

Drip Irrigation Trial 2014 Location: Hancock ARS

Drip Irrigation Trial 2014. Location: Hancock ARS. Nozzles are turned off over drip plots; soybeans are being irrigated on the left (not part of this grant funding).

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3) Assistance for underserved fresh market growers (FY11-003)

Report Date: October 31, 2014

I. Project Summary

A. Assistance for Underserved Fresh Market Growers builds on our continuing effort to help underserved fresh market farmers implement production, marketing and financial management practices that will enhance their sustainability. This project works in partnership with a recently funded RME project, "Financial Planning for Hmong Fresh Market Growers." The RME project introduced a mentor training component for Hmong producers. Developing expertise from within the community is an important method of successfully bringing information to Hmong producers. This SCBG project provided support to the trained mentors, who were also connected to the Producers First program. With Producers First, other Hmong producers could submit funding requests for consultant services. Developing a cadre of consultants from within the community will result in a higher comfort level and better utilization of this technical assistance program by underserved farmers.

For the past several years, DATCP has been working on an outreach and assistance project to reach underserved farmers. The majority of them have been fresh market growers. These underserved farmers do not typically participate in educational workshops and technical assistance programs from mainstream sources. From workshop evaluations, surveys, and individual conversations with these farmers, we have learned a great deal about the educational needs of these farmers. They want:

- to improve their farming and financial practices
- programming that is culturally relevant and in their native language
- to learn proper methods of using pesticides and herbicides
- to integrate more organic practices into their farming methods
- to increase their production and sales
- hands-on, one-on-one, farmer-to-farmer learning
- information on safe food handling

This project focused on developing and delivering workshops to address pest and disease control and safe food handling procedures specifically for these underserved growers. Improving producer knowledge and skills in these areas enhanced their markets as they were able to tell customers about their good food safety practices and pest and disease management. This project also provided support to the trained mentors to coach and provide services to their local minority farmers.

B. This project developed and delivered workshops and follow up assistance to address these identified needs of underserved growers. It built on a 2010 Specialty Crop Block Grant, *Workshops for Underserved Fresh Market Growers*, which laid the groundwork and format for successful workshops with Hmong fresh market growers. This grant expanded the workshops offered specifically to food safety practices, and pest management techniquest. It also expanded

the audience to Hmong Ginseng growers as well as fresh market growers. **Only specialty crop growers were served in this grant.

II. Project Approach

Hmong fresh market grower attence at DATCP organized workshops has topped 300 over the past 3 years. We added a second Hmong staff member to help our current Hmong staff to coordinate workshops and reach out to the Hmong fresh market growers. We also recruited and trained a group of Hmong fresh market growers to become Hmong mentors to coach other Hmong fresh market growers in the local areas. This group was pre-selected with the qualifications of being a good role model, being able to read, write & understand English and being willing to help others.

We had several presenters for the workshops. Our trained Hmong staff presented four (4) workshops on safe food handling and constructing a portable hand-washing stations. A professor from UW Marathon County presented three (3) workshops on "Identifying & Solving Insect, Disease and Soil Fertility Problems in Fresh Market Vegetable Crops". A ginseng expert and her team from the Michigan State University gave presentations on ginseng diseases and fungicide application at the Wisconsin Ginseng Growers Conference. We partnered with UW-Extension, Farm Service Agency, Wisconsin Hmong Chamber of Commerce, Hmong community centers and Ginseng Board of Wisconsin for presentations as well.

In the winter 2013-14, we hosted 3 workshops on pest managements, took a group of Hmong fresh market growers to attend the 2014 MOSES Organic Farming Conference and hosted the first Wisconsin Ginseng Growers Conference with Ginseng Board of Wisconsin for ginseng growers including Hmong ginseng growers.

The three (3) workshops on pest management called "Identifying & Solving Insect, Disease, & Soil Fertility Problems in Fresh Market Vegetable Crops" were conducted in Eau Claire, La Crosse and Wausau. These workshops were requested by the Hmong fresh market growers and approved by WI SCBG Grant Manager. Below are the summary evaluations collected after each workshop.

Identifying & Solving Insect, Disease, & Soil Fertility Problems in Fresh Market Vegetable Crops Evaluation Summary
December 7, 2013
Eau Claire, Wisconsin

Number of Evaluations: **_10__**

Please help us serve you better by completing this evaluation.

1. Please rate how much you learned from this workshop using a scale of 1 to 5.
   1 = I didn't learn anything new
   2 = I learned a couple of new things
   3 = I learned enough to start using the information
   4 = I learned enough to feel confident about using the information
   5 = I could teach others about this subject

Knowledge/skills	**Circle number that best describes how much you learned from this workshop**
A. Know how to identify insects & diseases in my garden	**3.5**
B. Understanding the life cycle of insects	**3.9**
C. Know how to prevent or control the insect & disease problems in my garden	**3.4**
D. Know how to manage soil fertility in my garden	**2.9**

2. List the knowledge/skills you learned today that you will put into practice.

_4__ I can identify the good insects from the bad insects
_6__ I will biological methods to solve any insect & disease problems in my garden first. I will use pesticide application as my last resource.
_7__ I will test my garden soil before adding any fertilizers or soil amendments
___ Others:_____

3. Demographic Information

   Gender: **1** ☐ Male **6** ☐ Female

   Age: ☐ < 30 ☐ 31-40 **4** ☐ 41-55 **3** ☐ 56-65 **3** ☐ > 65

4. Do you sell your fresh produce at farmers' market/other places? **6** ☐ Yes ☐ No

5. How many years have you been in farming/gardening? **__5 years - 15 years___**

6. What will you like to learn/know more about next time? Any comments or suggestions?
   - **Want to learn to get a pesticide license**
   - **Many things that I still want to learn about farming**
   - **How to use fertilizers and pest application**

Identifying & Solving Insect, Disease, & Soil Fertility Problems in Fresh Market Vegetable Crops Evaluation Summary
December 7, 2013
Eau Claire, Wisconsin

Number of Evaluations: **_10__**

Please help us serve you better by completing this evaluation.

1. Please rate how much you learned from this workshop using a scale of 1 to 5.
   1 = I didn't learn anything new
   2 = I learned a couple of new things
   3 = I learned enough to start using the information
   4 = I learned enough to feel confident about using the information
   5 = I could teach others about this subject

Knowledge/skills	**Circle number that best describes how much you learned from this workshop**
A. Know how to identify insects & diseases in my garden	**3.5**
B. Understanding the life cycle of insects	**3.9**
C. Know how to prevent or control the insect & disease problems in my garden	**3.4**
D. Know how to manage soil fertility in my garden	**2.9**

2. List the knowledge/skills you learned today that you will put into practice.

_4__ I can identify the good insects from the bad insects
_6__ I will biological methods to solve any insect & disease problems in my garden first. I will use pesticide application as my last resource.
_7__ I will test my garden soil before adding any fertilizers or soil amendments
___ Others:_____

3. Demographic Information

   Gender: **1** ☐ Male **6** ☐ Female

   Age: ☐ < 30 ☐ 31-40 **4** ☐ 41-55 **3** ☐ 56-65 **3** ☐ > 65

4. Do you sell your fresh produce at farmers' market/other places? **6** ☐ Yes ☐ No

5. How many years have you been in farming/gardening? **__5 years - 15 years___**

6. What will you like to learn/know more about next time? Any comments or suggestions?
   - **Want to learn to get a pesticide license**
   - **Many things that I still want to learn about farming**
   - **How to use fertilizers and pest application**

Identifying & Solving Insect, Disease, & Soil Fertility Problems in Fresh Market Vegetable Crops Evaluation Summary
December 14, 2013
La Crosse, Wisconsin

Number of Evaluations:_14__

Please help us serve you better by completing this evaluation.

1. Please rate how much you learned from this workshop using a scale of 1 to 5.
   1 = I didn't learn anything new
   2 = I learned a couple of new things
   3 = I learned enough to start using the information
   4 = I learned enough to feel confident about using the information
   5 = I could teach others about this subject

Knowledge/skills	**Circle number that best describes how much you learned from this workshop**
A. Know how to identify insects & diseases in my garden	**3.8**
B. Understanding the life cycle of insects	**3.7**
C. Know how to prevent or control the insect & disease problems in my garden	**4.3**
D. Know how to manage soil fertility in my garden	**3.7**

2. List the knowledge/skills you learned today that you will put into practice.

_6__ I can identify the good insects from the bad insects
_6__ I will biological methods to solve any insect & disease problems in my garden first. I will use pesticide application as my last resource.
_8__ I will test my garden soil before adding any fertilizers or soil amendments
_1__ Others:_**I learned crop families today!**_____

3. Demographic Information

   Gender: **5** ☐ Male **7** ☐ Female

   Age: ☐ < 30 **1** ☐ 31-40 **10** ☐ 41-55 ☐ 56-65 **1** ☐ > 65

4. Do you sell your fresh produce at farmers' market/other places? **11** ☐ Yes **3** ☐ No

5. How many years have you been in farming/gardening? _**1 year - 30 years**_

6. What will you like to learn/know more about next time? Any comments or suggestions?
   - **How to become a business man**
   - **Learn to farm chemical free**

Identifying & Solving Insect, Disease, & Soil Fertility Problems in Fresh Market Vegetable Crops Evaluation Summary
January 11th, 2014
Wausau, Wisconsin

Number of Participants:_**24**__

Please help us serve you better by completing this evaluation.

1. Please rate how much you learned from this workshop using a scale of 1 to 5.
   1 = I didn't learn anything new
   2 = I learned a couple of new things
   3 = I learned enough to start using the information
   4 = I learned enough to feel confident about using the information
   5 = I could teach others about this subject

Knowledge/skills	**Circle number that best describes how much you learned from this workshop**
A. Understand how crops are grouped as families	**4.0**
B. Understand the disease triangle – crop, disease, environment to prevent disease problems	**3.7**
C. Understand the 3 number (24–10–8) on the chemical fertilizers container	**3.5**
D. Understanding the importance of the pesticide label	**3.5**

2. List the knowledge/skills you learned today that you will put into practice.

_**15**__ I plan to use crop families identification for crop rotations to reduce pests & diseases
_**18**__ I will use the disease triangle to solve any insect & disease problems in my garden.
_**14**__ I will read to understand the pesticide label before using the chemical.
_**14**__ I will test my garden soil before adding any fertilizers or soil amendments
_**2**__ Others:_**I understand the benefits & will be able to guide parents when they question something.**_

3. Demographic Information

   Gender: **10** ☐ Male **13** ☐ Female

   Age: ☐ < 30 **1** ☐ 31-40 **12** ☐ 41-55 **10** ☐ 56-65 ☐ > 65

4. Do you sell your fresh produce at farmers' market/other places? **19** ☐ Yes **2** ☐ No

5. How many years have you been in farming/gardening? _**From 1 year – 30 years**__

6. What will you like to learn/know more about next time? Any comments or suggestions?
   - Watch video tape in Hmong or teach in Hmong
   - Using pesticide application
   - I want to learn more about pesticide, grants, loans or any programs that support farmers
   - I would like to learn more about organic fertilizers and pesticide.
   - I want to learn more about top soil that good for plants.

We were able to attract and coordinate 67 Hmong fresh market produce growers to attend the Midwest Organic and Sustainable Education Services (MOSES) Organic Farming Conference. MOSES supported attendance by providing 15 reduced-rate scholarship for Hmong fresh market produce growers to attend their conference. At the conference, we were able to hold a special session and invite a Hmong farmer to give a presentation on the process of how to get organic certification to Hmong fresh market produce growers. A DATCP staff person accompanied participants to help with interpretation and assimilation into this large conference setting. He also organized an evening social event to motivate, help and prepare Hmong growers for what to expect at the conference and to build community with this group. It was the biggest contingency of Hmong growers to attend the conference. As a result, MOSES is looking into having some of their workshops at the next conference for Hmong growers. Below are a few pictures and evaluation results from the MOSES Organic Farming Conference on February 27, 2014 – March 1, 2014. **Although the MOSES conference has some sessions related to non-specialty crops, only Hmong specialty crop growers attended with SCBG funds. They only attended sessions related to specialty crops, particularly food safety and organic pest management and funds did not pay for meals or refreshments.

Organic Farming Conference Evaluation Summary

February 27 – March 1, 2014
La Crosse, Wisconsin

Number of Participants:__**31**__

Please help us serve you better by completing this evaluation.

1. How long have you been farming or growing vegetables for market? **_1 year – 16 years__**

2. What is the size of your farm? **_1 acre – 40 acres__** **15** ☐ Leased **14** ☐ Owned

3. How many people work with you on the farm? **_1 person – 7 people__**

4. What did you learn from the conference?
    - I learned and found a tomato variety that is the best.
    - I learned that spray in the evening was very effective in cloudy day.
    - Weed & pest control
    - Growth of plants
    - How to plant my plants.
    - How to grow crop to meet the harvest schedule.
    - How to keep soil healthy
    - I learned that American farmers have good manner and show respect to the presenter
    - I learned how to plant vegetable without using chemical and how to care for the crops. I also learned that when will be a good time to plant seeds so the pest will not eat them, how to protect the crops when there were disease and a lot of insect on my crops.
    - It's helpful to learn how to take care your vegetables or crops.
    - I got more ideas about farming in this country
    - I learned how to grow fruit trees and cope with Mother Nature for best farming practices.
    - I learned how to control weeds.
    - I learned the soil structure and nutrients for better farming, planting in a row for easy weeding and harvesting. I also learned how to bundle flowers to attract customers.
    - I learned one thing about when is the right time to apply fertilizers.
    - I got to meet and gather information from the vendors to help me enhance my business.
    - I learned how to take care my flowers.
    - I learned how to take care my crops, weed control and pest management.
    - Now I learned and knew the meaning of "Organic". I also learned how to hire someone to work for me at the farm.

- I learned crop rotation today.
- I learned that government has money for farming.
- I learned a lot of new things that I have never thought about.
- There were so much that I have never knew. Now I saw and learned from them.
- I learned that there were lots of farming opportunities.

5. Do you plan to do something differently because of what you learned? **30** □ Yes □ No

6. Will you plan to attend the conference again? **29** □ Yes **1** □ No

7. Do you recommend this conference to others? **30** □ Yes □ No

8. What will you like to learn/know more about next time?
    - I want to learn about fertilizer/soil amendment and pesticide application
    - I prefer the workshops present in Hmong.
    - I want to learn how to nurture and protect my crops from pests and diseases.
    - Weed control and fertilizers
    - How to improve the soil condition at the farm
    - How to make profit on a small land.
    - How to extend shelve life of fresh flowers.
    - How to get organic certification
    - Seed saving
    - How to seedling so it survive during the transplanting stage.
    - I want to take the pest applicator training course and get my pest applicator license.
    - I want to know where to get financial support if I want to farm more acres.
    - I will look into getting license.
    - If I want to grow my business, what are the things that I need to know?
    - If there is an event, don’t forget me.
    - I want to learn more about pesticide application
    - I would like to know more about pesticide and its safety.
    - I want to learn about financial management and records keeping.
    - I like to learn new thing and new ideas.
    - I like to learn how to quality seedling
    - I want to learn more about pesticide application and fertilizers.
    - I like to borrow money to buy more farmland.
    - Learn more about organic farming.
    - Learn more about pesticide application
    - I want to learn more and more about organic farming practices.
    - I like to know more markets to sell our produce.

9. Any other comments/feedbacks?
    - I want to learn how to germinate seeds and pesticide application instruction
    - I want to see more collaboration and unity within our community.
    - How to make my soil healthy again
    - Not to have side conversation while workshop in session.
    - Everything offered at the conference was very important to me.
    - I know how to make fresh flowers to have a long shelve life.
    - Looking for grant to purchase equipment to do our work.
    - I need financial assistance and government programs to expand my business.
    - I need more farming education.
    - There are lots of things that I don't know so I like to learn them all.
    - Thanks to Jack & Ying. We are so fortunate to have someone like you to represent and find ways to help us learn to be safe, be more about organic, disease, pest control, etc…
    - I want to how to make money.

The Ginseng Board of Wisconsin reached out for help with building a relationship with its Hmong ginseng growers as they represent about 1/3 of the ginseng grown in the state and often wanted help with pest and disease management. The first Wisconsin Ginseng Growers Conference was held to cover these topics and recruited 31 out of 42 Hmong ginseng growers to participate this conference. We offered a separate track in Hmong language for the Hmong ginseng growers who had limited English literacy. We also offered a round table discussion with the experts toward the end of the conference. As a result, Hmong ginseng growers told us that they have been waiting for this kind of educational event for a long time. They shared their ginseng root samples with our Hmong Outreach staff. They had a chance to meet the Secretary of the Wisconsin Department of Agriculture, Trade and Consumer Protection and shared their concerns. The ginseng experts also learned from the Hmong ginseng growers during the round table discussion that the Hmong ginseng growers were lacking fundamental knowledge and supports. They will help the Hmong ginseng growers to build their foundation. Below are a few pictures and the summary from the conference evaluations:

WISCONSIN GINSENG GROWERS CONFERENCE EVALUATION

Saturday, March 22, 2014

Stoney Creek Hotel & Conference Center

1. Please rate how much you learned from this workshop using a scale of 1 to 5:

1 I didn't learn anything new
2 I learned a couple of new things
3 I learned enough to start using the information
4 I learned enough to feel confident about using the information
5 I could teach others about this subject

KNOWLEDGE/SKILLS	Circle number that best describe how much you learned from this workshop					Avg. Scale
A. Learned and understand about Common Ginseng Diseases	1	2	3 (11)	4(17)	5 (3)	3.7
B. Learned and understand Tips and Tricks for Applying Fungicides	1	2 (4)	3 (6)	4 (17)	5 (4)	3.7
C. Learned and understand about Noninsured Crop Disaster Assistance Program	1(1)	2(10)	3 (8)	4 (9)	5 (3)	3.1
D. Learned and understand about Annual Registration & Certification	1	2(2)	3 (6)	4 (21)	5 (2)	3.7
E. Learned and understand about Seed to Ensure Top Quality and Yield	1(2)	2(2)	3 (4)	4 (20)	5 (3)	3.6
F. Learned and understand about Who Can I Go To When I have Questions	1(1)	2(5)	3 (8)	4 (15)	5 (2)	3.4
G. This conference is what I have expected and have gained valuable knowledge	1(1)	2(4)	3 (3)	4 (19)	5 (4)	3.7

2. How many acres of Ginseng do you own? Circle the number that best fits your garden.

_(17)__1-5 acres _(9)__6-10 acres _(5)__11-15 acres _(2)__16-20 acres _____21 + acres

3. Do you read and understand the newsletter from the Ginseng Board?

__(19)__Read and understand _(11)__Read but do not understand _(1)__Do not read

4. Have you brouse or used the Ginseng Board of Wisconsin website? _(13)__Yes _(18)__No

5. Demographic Information

Gender: Male (23) Female (7)

6. Number of years in Ginseng farming?

_(6)__1-5 Years _(10)__6-10 Years _(5)__11-15 Years _(8)__16-20 Years _(2)__21 + Years

7. Are you a member with the Ginseng & Herb Coop? _(4)__ Yes _(27)__No

8. What are the problems you are facing in your Ginseng garden?

_(13)_Blight and root rot _(1)_Wet and heavy Soil _(4)_No berries, no seeds

_(6)_Weather _(5)_Weed control and rusty roots

9. What will you like to learn/know more about next time.		
•	What are the pesticide and fungicide that can and can not be combine together for spraying	
•	The type of soil that is suitable for growing ginseng	
•	How to handle heavy soil	
•	How to produce good berries	
•	Growing healthy, quality roots	
•	Would like to learn on how to produce	
•	How to prevent root rot	
•	Rusty root	
•	Pesticide and Fungicide	
•	Preventing root rot and produce more seeds	
•	Effective Pesticide, Fungicide, and Insecticide	
•	Chemicals	
•	Managing weeds and preventing rusty roots	
•	Produce berries and gain seeds	
•	What to do in unexpected weather- too much rain/summer heat	
•	Soil- What to expect and what level do they need to be at	
•	Applying effective pesticide and insecticide	
•	Preparing soil before planting	
•	Record keeping	
•	Good Ginseng farming practices	

One of our Hmong staff took the Cornel University Good Agricultural Practices (GAPs) training and with additional mentoring by Ms. Schermann from the University of Minnesota, is now able to lead workshops on safe food handling and advise growers on GAP himself. This is building the State's capacity to provide training in food safety to minority fresh market produce growers. Staff also offered a hands-on workshop on how to construct a mobile hand washing station. This was done to show growers how a simple had washing station can be constructed out of scrap materials and used in the field for washing hands.

Below are picture of minority fresh market produce growers who adopted the skills from the workshops presented by our Hmong staff. They were able to build their own mobile hand washing station.

Hand-washing Station at Vang CC Farm in Jefferson

Proper Hand-washing Technique at Blooming From the Heart Farm in Hatley, WI

Participants in the workshops were asked to list the knowledge/skills they learned at the workshop that they will put into practice. The responses were:

- I can wash my hands properly.
- I can teach others the proper hand wash technique.
- I can build my own hand washing station after this training.
- I can teach other people to create a hand washing station.
- I can apply the skills I learned today to other project.

III. Goals and Outcomes Achieved

We conducted 9 workshops and reached to 183 minority fresh produce growers in geographic locations that included Hmong communities as followed:

- 1 Safe Food Handling workshops = 6 minority fresh produce growers
- 3 Hand Washing Station Construction = 22 minority fresh produce growers
- 3 Pest Management workshops = 57 minority fresh produce growers
- 1 MOSES Organic Farming Conference = 67 minority fresh produce growers
- 1 Wisconsin Ginseng Grower Conference = 31 minority fresh produce growers

Total minority fresh produce growers = 183

Workshop evaluations indicated that respondents increased their knowledge about the workshop level well enough to put it into practice. Evaluations also gathered information about what participants would want to learn in future workshops. Suggestions included:

- Watch video tape in Hmong or teach in Hmong
- Using pesticide, herbicides and fertilizers
- Government grants, loans or any programs that support farmers
- Organic farming
- Top soil and nutrients for plants.
- Pesticide Applicator training and pesticide licensing
- Farmed businesses
- Marketing

We also provided trainings to Hmong mentors so they could help the Hmong fresh produce growers in the local areas. Below are the activities and services that were provided by our Hmong mentors:

- Coached 2 Hmong families on how to farm (hands on experience from start to finish) in Wisconsin instead of moving to California for farming. The Hmong mentor helped the families find farmland, how to prepare the land for planting, crops selection and planting, weeding, harvesting and marketing at the farmers markets. The families were able to generate additional income to support their family and decided not to move to California
- Helped 2 Hmong fresh produce growers selected and order plastic film for their small green house/hoop house
- Coached 3 Hmong fresh produce growers on how to store and plant flowers
- Coached 1 Hmong fresh produce grower on how to plan the growing season, select and order the right amount of seeds for the season

- Coached 5 Hmong fresh produce growers on how to select and order vases for flower bouquets to display
- Taught 10+ Hmong fresh produce growers on how to achieve long-term farming (e.g. buying land, investing farm equipment & machinery, think big and work smart, etc…)
- Promoted workshops to the Hmong community through local Hmong radio programs and word of mouth
- Recruited Hmong fresh produce growers to attend workshops
- Encourage Hmong fresh produce growers to attend farming events like MOSES Annual Farming Conference and think outside the box

B. Our goal was to reach 180 minority fresh produce growers through 12 educational workshops. We did hold 9 workshops, 3 workshops were canceled: One workshop was hosted in early April and it was a perfect day for outdoor activity so no growers showed at the workshop. The second workshop date was conflicted with a local community event in house so we needed to find different date. The available dates were in the early summer so we decided to cancel this workshop. The third workshop fell into the Hmong Heritage Month so there were many activities going on in the Hmong community. There would be a very low attendance if we decided to move it forward so we cancel the workshop. However, we were able to reached 183 minority fresh produce growers – 102% of our target goal. Workshops were evaluated. Overall, participants felt they had learned enough to feel confident about using the information provided at the workshop.

The project planned to follow up with workshop attendees to offer additional support and referrals for technical assistance. These participants were planned to be surveyed to see how well they implemented the knowledge they gained by attending workshops. The survey showed that 68% of the workshop attendees have moderately improved their skills from the workshops. 57% of them were satisfied with the selected workshop topics. 55% said the training material provided were very useful. See more results from the survey below.

SCBG FY11 Assistance for Underserved Fresh Market Growers
Post Evaluation

52 Growers Participated the Post Evaluation

1. How much have your skills improved because of the training workshop?

Extremely improved	12%
Moderately improved	68%
A little	20%
None at all	0

2. Overall, were you satisfied with the event?

Extremely satisfied, why?	35%
Slightly satisfied, why?	57%
Neither satisfied nor dissatisfied	8%
Moderately dissatisfied	0
Extremely dissatisfied	0

3. Was the training better than what you expected?

Much better, why?	29%
Somewhat better, why?	37%
About what was expected	34%
Slightly worse	0
Much worse	0

4. How useful was the materials provided to you during the training?

Extremely useful, how?	27%
Very useful	55%
Somewhat useful	13%
Neither, don't know	3%
Not useful	2%

5. How comfortable did you feel asking questions at the event?

Very comfortable	42%
Moderately comfortable	38%
Slightly comfortable	20%
Not at all comfortable	0

6. Did the presenter allow too much time for discussion, too little time, or about the right amount of time?

Much too much	0
Somewhat too much	3%
Slightly too much	6%
About the right time	53%
Slightly too little	15%
Somewhat too little	23%
Much too little	0

7. How skilled in the subject was the presenter?

Extremely skilled	3%
Very skilled	61%
Moderately skilled	36%
Slightly skilled	0
Not all skilled	0

8. How experienced in the subject was the presenter?

Extremely experienced	5%
Very experienced	65%
Moderately experienced	30%
Slightly experienced	0
Not at all experienced	0

IV. Beneficiaries

The Hmong farmers sell primarily at farmers markets across the state. Hmong people are tightly knit groups and share information and impressions via word of mouth in their clan units. As word spreads about how to practice safe food handling, more fresh market growers in this ethnic group will put these practices to use. Those that participated in workshops are also better able to answer questions from their customers about their growing methods and sanitation methods. Customers at farmers markets are the end beneficiary of the project's accomplishments. As these underserved growers implement the food safety techniques they've learned, customers will feel more secure about the food they are buying.

Several Hmong community organizations collaborated with us on this project by hosting and helping to promote the workshops. This provided them with an opportunity to build value for their membership.

In addition, the State of Wisconsin now has a Hmong person trained in GAP procedures and safe food handling techniques for fresh market growers, thereby increasing reach beyond the end of this grant for teaching these methods to other fresh market growers.

V. Lessons Learned

At first, we were struggle at the beginning due to some staff changing. One lesson learned was that conducting any surveys during farming seasons was a challenge in reaching the Hmong fresh produce growers. However, we had better success with attendance at workshops in the last year of this project. We believe this was due to increased trust in the community and word of

mouth endorsements from previous workshop participants. We achieved our target on number of participants. Planning for 10-12 participants per workshop would have been closer to an achievable target at this stage of working with the population.

VI. Additional Information

None

VII. Contact Info

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4) Pest management strategies to replace Mancozeb and Diazinon for ginseng (11-004)

Report Date: December 16, 2013

I. Project Summary

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

II. Project Approach

To determine the effectiveness of newly or soon to be registered fungicides, six experiments were placed at grower cooperators' ginseng gardens in Wisconsin in 2013. Growers are becoming more aware of the newly registered fungicides, however, due to the high disease pressure observed in 2013, the efficacy of these products were questioned. Two trials were conducted to determine the effectiveness of these newly registered products in 2- and 3-year-old gardens. These trials included comparisons of industry standards, reduced-risk, experimental fungicides and rotational programs. Three trials were conducted on seedling or 2-year-old ginseng gardens to determine if applications based on environmental conditions could reduce the number of applications applied over a growing season while still providing adequate protection from Alternaria blight. The overall goal of using environmental data to trigger fungicide applications is to reduce the amount of applications when disease pressure is at its lowest and hence lower the overall amount of pesticides applied per acre per year.

At selected intervals in the early portion of the 2013 growing season, insect populations were surveyed using a combination of sweep sampling and direct soil sampling techniques. These experiments were implemented in 2nd year ginseng gardens to document and compare new insecticidal options implemented at stand establishment. The research was focused on, 1) investigating combinations of protectant insecticides applied at-planting and delivered as seed, in-furrow, and broadcast applications, 2) documenting the range of non-target arthropods present in ginseng during the mid to late summer growing season, and 3) developing interpretive information for pest identification and control of insect pests in ginseng.

In 2012, candidate, new potential insecticide treatments were evaluated alongside registered standards as at-plant treatments. Treatments were arranged in a randomized complete block design with 10 treatments and three experimental replications resulting in 30 plots total. Experimental plots were established on single beds, each 12-ft long. After seedling emergence, stand counts were taken from a randomly selected 4 ft^2 section of each experimental bed and insect populations sampled to relate associated stand losses with insect populations. In 2013, plots were surveyed at early stand emergence to evaluate the residual effects of the at-plant insecticides.

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

III. Goals and Outcomes Achieved

To achieve the project goals, experimental, newly-registered, and industry standards were tested against Alternaria blight. These experiments were placed in grower cooperators' 2- and 3-year-old ginseng gardens in Marathon County, WI. To determine the effectiveness of spray application timing, three trials were conducted using disease severity values thresholds. Lastly, a trial was initiated in late June to determine if tank-mixes of the most effective products can be effective after infection is observed in the plot. Trial results were observed by growers at the 2013 Ginseng Research Field Day and will be presented to growers again at the winter meeting in March 2014.

Disease pressure was severe in both experimental fungicide trial screens with the untreated control beds averaging 145.3 and 139.3 infected plants (Tables 1 & 2). The experimental fungicide GWN-10087 was not effective in both trials and will not be tested again in future studies. Newly registered reduced-risk fungicide fluazinam (Omega) was effective and significantly reduced infection compared to the untreated control. Surprisingly, fluazinam was statistically more effective than the industry standard and B2 carcinogen chlorothalonil (Bravo) in the experiment on 3-year-old ginseng. The BASF experimental products BAS 703 (both formulations) were also effective and will be noted for future registration. The reduced-risk fungicide Scala SC (IR-4 'A' priority) was effective and will hopefully be implemented into growers' *A. panax* control program after its section 3 registration on ginseng (~ summer 2014). When effective fungicides were tank-mixed and applied to plants with *A. panax* symptoms already developed on the foliage, infection was statistically reduced by the three spray programs tested against the untreated control (Table 3).

Table 1. Evaluation of experimental, newly-registered, and industry standard fungicides for the control of alternaria blight on 3-year-old ginseng, 2013.

Springbrook New Fungicide Screen Treatment and rate per 50 gal applied every 5 days	Incidence (No. infected plants)						Disease severity	
	7/9		8/8		9/12		9/12	
Untreated control	145.3	a*	145.3	a	145.3	a	10	a
Endura 70WG 6.8 oz	30.3	ef	35.0	de	35.5	cde	2.5	d
Bravo WeatherStik 6SC 2 pt	103.8	b	80.0	b	93.3	b	6.3	b
Switch 62.5WG 14 oz	17.8	f	10.0	f	13.5	de	2.3	d
Tanos DF 8 oz	93.0	bc	52.5	cd	82.8	b	9.0	a
Fontelis SC 16 fl oz	47.8	de	39.3	cde	37.5	cde	3.3	cd
Omega 500F 1.5 pt	67.3	cd	61.0	bc	42.8	cd	5.0	bc
Cabrio EG 12 oz	30.5	ef	17.3	ef	14.8	de	2.0	d
GWN-10087 EC 12 fl oz	151.0	a	141.3	a	154.8	a	9.8	a
Scala SC 18 fl oz	17.8	f	26.5	ef	50.0	c	3.5	cd
BAS 703 01F SC 6 fl oz	37.8	ef	24.3	ef	18.0	de	2.0	d
BAS 703 02F SC 5.5 fl oz	24.3	ef	17.3	ef	14.5	de	2.0	d
Switch 62.5WG 14 oz -alt- Bravo WeatherStik 6SC 2 pt -alt- Endura 70WG 6.8 oz	32.5	ef	16.3	ef	13.3	de	2.0	d
Cabrio EG 12 oz -alt- Dithane 75DF 2 lb -alt- Omega 500F 1.5 pt	31.0	ef	16.3	ef	9.8	e	2.0	d
Endura 70WG 6.8 oz -alt- Switch 62.5WG 14 oz -alt- Cabrio EG 12 oz -alt- Omega 500F 1.5 pt	38.3	ef	27.5	ef	17.5	de	2.3	d

Table 2. Evaluation of experimental, newly-registered, and industry standard fungicides for the control of alternaria blight on 2-year-old ginseng, 2013.

33rd Ave New Fungicide Screen Treatment and rate per 50 gal applied every 7 days	Incidence (No.infected plants)				Severity (scale 1-10; 1=no disease, 10=all plants dead			
	8/15		8/26		8/15		8/26	
Untreated	70.0	a*	139.3	a	4.8	a	5.8	a
Endura 70WG 6.8 oz	0.8	c	3.0	c	1.5	cd	2.0	c
Bravo WeatherStik 6SC 2 pt	2.0	c	6.5	c	2.0	c	2.0	c
Switch 62.5WG 14 oz	0.3	c	1.3	c	1.3	cd	1.8	c
Tanos DF 8 oz	3.0	c	9.8	c	1.8	cd	2.3	c
Fontelis SC 16 fl oz	1.5	c	4.5	c	1.8	cd	2.0	c
Omega 500F 1.5 pt	0.5	c	2.8	c	1.3	cd	2.0	c
Cabrio EG 12 oz	0.0	c	0.5	c	1.0	d	1.5	c
GWN-10087 EC 12 fl oz	39.8	b	75.5	b	3.0	b	4.5	b
Scala SC 18 fl oz	0.0	c	2.8	c	1.0	d	1.8	c
BAS 703 01F SC 6 fl oz	0.3	c	0.5	c	1.3	cd	1.3	c
BAS 703 02F SC 5.5 fl oz	2.3	c	1.8	c	1.3	cd	1.3	c
Switch 62.5WG 14 oz -alt- Bravo WeatherStik 6SC 2 pt -alt- Endura 70WG 6.8 oz	0.8	c	3.8	c	1.5	cd	1.5	c
Cabrio EG 12 oz -alt- Dithane 75DF 2 lb -alt- Omega 500F 1.5 pt	0.8	c	1.0	c	1.5	cd	1.5	c
Endura 70WG 6.8 oz -alt- Switch 62.5WG 14 oz -alt- Cabrio EG 12 oz -alt- Omega 500F 1.5 pt	1.0	c	2.5	c	1.5	cd	1.8	c

Table 3. Evaluation of fungicide tank-mixes for the control of alternaria blight on 3-year-old ginseng, 2013.

	Springbrook New Fungicide Screen Treatment and rate per 50 gal applied every 5 days	Incidence (No. infected plants)		Disease severity	
		8/2	8/27	8/2	8/27
1	Untreated control	96.3 a*	94.0 a	7.5 a	8.5 a
2	Endura 70WG 4.5 oz + Cabrio 20EG 12 oz –alt- Bravo WeatherStik 6SC 2.0 pt + Switch 62.5WG 14.0 oz alt. Omega 500F 1.5 pt + Quadris SC 15.5 fl oz alt. Bravo WeatherStik 6SC 2.0 pt + Iprodione 4L 1.5 pt	83.0 a	59.0 ab	3.5 b	4.3 b
3	Endura 70WG 4.5 oz + Cabrio 20EG 12 oz alt. Dithane DF 75DF 2 lb + Switch 62.5WG 14.0 oz alt. Omega 500F 1.5 pt + Quadris SC 15.5 fl oz alt. Dithane DF 75DF 2 lb + Iprodione 4L 1.5 pt	84.5 a	56.5 ab	4.8 ab	6.0 ab
4	Endura 70WG 4.5 oz + Cabrio 20EG 12 oz alt. Dithane DF 75DF 2 lb + Bravo WeatherStik 6SC 2.0 pt alt. Omega 500F 1.5 pt + Quadris SC 15.5 fl oz alt. Bravo WeatherStik 6SC 2.0 pt + Iprodione 4L 1.5 pt	79.0 a	45.0 b	4.8 ab	5.3 b

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

When DSVs were used to determine spray application timing vs. 7- or 10-day intervals, due to the high disease pressure in 2013, the 7- and 10-day intervals were more effective compared to the 10 and 15 DSV threshold applications (Tables 4 & 5). The application schedule of rotating the protectant fungicide chlorothalonil with reduced risk products/newly-registered fungicides was designed to limit the repeated applications of B2 carcinogens, such as mancozeb (Dithane DF). Although the 10 and 15 DSV treatments limited infection compared to the untreated control, infection in these plots were at levels unacceptable to growers and could result in increased infection in the garden the following growing season.

Table 4. Evaluation of TOM-CAST disease forecaster for the control of Alternaria blight on 2-year-old ginseng, 2013.

	Springbrook (2-year-old) Treatment and rate per 100 gal	Schedule	Incidence (No. infected plants)			Disease severity		
			7/18	8/15	9/12	7/18	8/15	9/12
1	Untreated	--	5.7 a*	49.2 a	110 a	2 a	3 a	9.3 a
2	Bravo WeatherStik SC 2 pt alt. Endura 70WG 4.5 oz alt. Quadris 500F 15.5 fl oz alt. Omega 62.5 1.5 pt alt. Switch WDG 14 oz	7 days	1.7 b	2.2 b	5.7 c	1.7 ab	1.8 b	1.8 c
3		10 days	2.5 b	1.2 b	7.2 c	1.7 ab	1.7 b	2 c
4		10 DSVs	1.3 b	5.8 b	31.5 b	1.5 b	1.8 b	3 b
5		15 DSVs	3.2 ab	6.0 b	15.0 c	2 a	1.8 b	2.2 c

Table 5. Evaluation of TOM-CAST disease forecaster for the control of Alternaria blight on ginseng seedlings, 2013.

Hwy X (seedlings)	Treatment and rate per 100 gal	Schedule	Incidence (No. infected plants)						Disease severity					
			7/9		8/15		9/19		7/9		8/15		9/19	
1	Untreated	--	31.3	a*	132.2	a	276.8	a	2.3	a	4.2	a	7.2	a
2	Bravo WeatherStik SC 2 pt alt. Endura 70WG 4.5 oz alt. Quadris 500F	7 days	19.2	a	42.2	b	101.2	b	2.3	a	2.2	b	2.3	b
3	15.5 fl oz alt. Omega 62.5 1.5 pt alt. Switch WDG 14 oz……	10 days	25.5	a	64.5	b	150.5	b	2.3	a	2.5	b	3.0	b
4		10 DSVs	14.3	a	55.3	b	149	b	2.0	a	2.3	b	3.0	b
5		15 DSVs	31.3	a	50.8	b	161.8	b	2.5	a	2.3	b	3.0	b

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

Six emails were sent to growers throughout the growing season in 2013. One email, titled 'Alternaria Threatens Ginseng Crops Early' was a sent to warn ginseng growers that disease pressure was unusually high early in the 2013 growing season. Five emails were sent to help with fungicide recommendations based on disease pressure determined by field scouting by Dr. Hausbeck's technician. The reduced-risk fungicides were included whenever possible to replace the older standard fungicides often relied on by growers. These emails were sent to approximately 60% of the growers in Wisconsin. Dr. Hausbeck also provided information and an update in the Ginseng Newsletter, which is mailed to all registered ginseng growers. Also available to growers at the Ginseng Board of Wisconsin website were the DSVs from two areas of Marathon County. DSVs are calculated on a 0 to 4 scale; 0=environmental conditions not favorable for disease, 4=conditions very favorable for disease development. The DSV data can be used by growers to modify their fungicide application intervals or to apply their most effective products when disease is most likely to develop. During past Ginseng Field Research Days we have explained to growers how to interpret this data and how to use it to adjust their fungicide applications.

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

Table 6: Ginseng pesticide use survey results.

1. How many years have you been growing ginseng? (50 growers)

1 (5 growers), 3 (2 growers), 5 (2 growers), 7, 11 (2 growers), 13, 20 (5 growers), 21, 22, 23 (3 growers), 25 (2 growers), 28, 30 (6 growers), 31 (3 growers), 34, 35 (3 growers), 37 (2 growers), 40, 46 (3 growers), 50, 66

2. How many acres of ginseng do you grow?

<5	5-10	11-25	26-50	51-100	>100
23	16	4	0	1	2

3. Of the following fungicides listed below, circle any that you used in 2013:

Bravo WS	Cabrio	Cannonball	Captan	Dithane	Endura	Fontelis	Forum	Omega
37	37	29	49	44	38	34	33	6
Quadris	Reason	Rovral/Ipro	Switch	Topsin M				
45	32	12	17	27				

4. Of the fungicides that you circled above, please list any that you used for the first time in 2013:

Bravo WS	Cabrio	Cannonball	Captan	Dithane	Endura	Fontelis	Forum	Omega
2	5	7	2	2	4	8	7	0
Quadris	Reason	Rovral/Ipro	Switch	Topsin M				
2	1	0	4	2				

5. Of the fungicides listed above that you DID NOT use, please circle any of the statements below that describe your reasoning:

Familiarity	Cost	Availability	Effectiveness	Plant/Seed safety concerns	Other fungicides already purchased
18	13	2	7	3	13

6. How likely are you to use one or more of the newer disease management tools/products discussed at the Ginseng Field Day?

Highly likely	Somewhat likely	Not likely
34	17	0

7. How satisfied are you with current disease management recommendations?

Very satisfied	Somewhat satisfied	Not satisfied
35	15	2

In 2013, we continued to evaluate candidate, new potential insecticide seed and in-furrow treatments with currently registered standards for the control of key insect pests in ginseng crops. Treatments included in the foliar plot evaluations at both Veer Ginseng Farms and Heil Ginseng were comprised of:

Table 7. Effect of insecticide treatment on plant health and proportion stand established in early summer, 2013, Heil Ginseng.

Treatment	Application Rate	# Emerged plants ft^{-1}	# Damaged seeds per plot	Proportion damaged plants
Belay 2.13 SC	12 fl oz/a	6.2	0.0	0.02
Brigade 2 EC	6.4 fl oz/a	7.1	0.2	0.12
[a]Coragen 1.67 SC	1.67 fl oz/a	5.5	0.1	0.16
Diazinon 4 EC	1 pt/a	4.9	0.1	0.14
[a]Cyazypyr 10 SE	13.5 fl oz/a	6.8	0.0	0.08
[a]Cyazypyr 10 SE	20 fl oz/a	6.1	0.5	0.13
Ferterra 0.4 GR	1.15 lb/ 1000 ft^2	5.5	0.3	0.11
Lorsban 15 GR	10 lb/a	4.7	0.3	0.14
Lorsban 15 GR	13.5 lb/a	5.3	0.2	0.08
Platinum 75 SG	4.01 oz wt/a	6.8	0.4	0.12
Regent 4 SC	3.2 fl oz/a	7.7	0.2	0.18
Untreated control	--	4.6	0.1	0.09
	P	0.37	0.55	0.64
	LSD	2.7	0.29	0.09

a-MSO 100 EC added at 0.5% v/v

No significant differences in the number of emerged plants or damaged seeds per square foot were observed. It is important to note that the number of seeds collected varied across plots and was not standardized. Therefore, proportion damaged plants is the most balanced measurement for putative seed damage. Ginseng plots treated with Brigade applied at 6.4 fl oz/a or Cyazypyr applied at 13.5 fl oz/a had the greatest number of healthy and emerged plants in plots. Plots treated with Lorsban applied at 13.5 lb/a had the lowest number of emerged plants in plant surveys. While not significant, plots treated with Coragen (1.67 fl oz/a) had the highest proportion of damaged plants apparently due to Hempiteran feeding.

Table 8. Effect of insecticide treatment on plant health and proportion stand established in early summer, 2013, Veer Ginseng.

Treatment	Application Rate	# Emerged plants ft^{-1}	# Damaged seeds per plot	Proportion damaged plants
Belay 2.13 SC	12 fl oz/a	3.9	0.0	0.08
Brigade 2 EC	6.4 fl oz/a	4.2	0.0	0.04
[a]Coragen 1.67 SC	1.67 fl oz/a	4.1	0.0	0.03
Diazinon 4 EC	1 pt/a	3.7	0.0	0.06
[a]Cyazypyr 10 SE	13.5 fl oz/a	3.8	0.2	0.07
[a]Cyazypyr 10 SE	20 fl oz/a	2.1	0.1	0.10
Ferterra 0.4 GR	1.15 lb/ 1000 ft^2	2.4	0.0	0.03
Lorsban 15 GR	10 lb/a	3.0	0.0	0.02
Lorsban 15 GR	13.5 lb/a	3.1	0.0	0.02
Platinum 75 SG	4.01 oz wt/a	3.4	0.0	0.04
Regent 4 SC	3.2 fl oz/a	2.9	0.1	0.05
Untreated control	--	2.6	0.0	0.10
	P	0.82	0.24	0.31
	LSD	2.1	0.2	0.06

a-MSO 100 EC added at 0.5% v/v

Here again, no significant differences in the number of emerged plants or damaged seeds per square foot were observed among any of the treatments. It is important to note that the products had been applied almost 18 months prior to these final readings in both experimental locations.

During the growing season of 2013, we continued to survey insects present in the ginseng crop at both locations. A surprising number of beneficial insects were observed in spring and summer surveys and results are summarized in **Appendix A**. of this 2013 Final Report. In 2014, we plan to continue this survey along with the development of a sustainability survey tool to evaluate the perception of growers for the value of these non-target organisms present in the garden. Also, our laboratory has generated a tri-fold, insect identification guide to be distributed among producers for easy access and identification of pest insects relative to the numerous non-target, beneficial insects present within the ginseng garden. Results here are summarized in **Appendix**

B.

- There were over 100 attendees (>70% total attendees were growers) at each of the 2011, 2012, and 2013 Ginseng Research Field Days. The following topics were discussed:
    - Applying fungicides based on the environmental conditions conducive to increased disease pressure.
    - Using TomCast weather forecasting and Disease Severity Values as thresholds for the timing of fungicide applications for the control of Alternaria blight.
    - Scouting for foliar blights and determining the causal pathogen based on observed symptoms.
    - Rotating and tank mixing fungicides to delay the development of resistance and for increased efficacy.
    - Updating growers on newly registered fungicides.
- Winter Research Update meetings averaged 50-70 people (ginseng producers >80 % of attendees) from 2011-2013. The following topics were discussed:
    - Review of results from previous years field, greenhouse, and laboratory experiments.
    - In-depth explanation of using FRAC codes to determine which products can be rotated successfully.
    - Update from IR-4 on the current status of products in the pipeline for future registration.

Growers have responded positively to the current status of research conducted to replace Mancozeb and Diazinon for ginseng. Data collected from the returned surveys show that growers are continuing to implement the newly registered reduced-risk fungicides into the their spray programs. At the various meetings, growers have stated that the information we have presented has increased their awareness to the relation between leaf wetness, temperature, relative humidity the ability of *Alternaria panax* to infect their ginseng. Feedback from growers at the Winter Research Meetings has helped develop protocols for the following years spray trials, such as testing the safety and efficacy of the newly registered fungicides when applied in a tank mix. Results from the 2013 Field Research Day survey shows that two-thirds of growers were ‘highly likely’ and the remaining one-third ‘somewhat likely’ to implement one or more of the newer disease management tools/products.

IV. Beneficiaries

The beneficiaries of this project were the 65 + Wisconsin ginseng growers and the environment at large. The returned surveys, along with the attached trial results, show that growers are continuing to implement the newly-registered, reduced-risk fungicides. With seed prices at ~$100 per lb., the application of effective fungicides can save growers up to $1 million from the loss of seed due to Alternaria blight. If growers applied two applications of either Switch or Omega in place of Dithane, for example, the amount of mancozeb applied to the environment would be reduced by roughly 4,400 lbs. This is not only a decrease in the amount of B2 carcinogen applied to ground, but also a decrease in worker exposure for the pesticide applicators. We feel that we have shown growers over the past three years, that although these new products are more expensive, they are also more effective and just as safe on the ginseng as the standards they have relied on for years.

V. Lessons Learned

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

IV. Additional Information

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

Ginseng Board Of Wisconsin Newsletter Articles:

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

Workshops/Tours:

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

Presentations:

'Program for Blight and Root Rot Protection' M.K. Hausbeck, Ginseng Spring Growers' Meeting, Wausaw, WI, Mar 2013.

'Fungicide Safety, Debudding, and Seed Testing and Treatments, M.K. Hausbeck and B. Harlan, Ginseng Spring Growers' Meeting, Wausaw, WI, Mar 2013.

'Know the Label and Know the Law' M.K. Hausbeck, J Heil, and B. Harlan. Ginseng Spring Growers' Meeting, Wausaw, WI, Mar 2013.

VII. Contact Info

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5) Grower-driven sustainability standards for cranberry production (11-005)

Report Date: September 18, 2013

I. Project Summary

A. While sustainability isn't a new topic, the interest in quantifying sustainable agriculture behind the farm gate is relatively new. Pressure to document sustainability has come from a variety of sources, ranging from international buyers to the general public. Until recently, these efforts have been largely driven by food buyers, processors and retailers that are interested in differentiating products in the marketplace based on "green" or "eco" perceptions, but without considering the raw product cost to do so. This project was designed to add cranberry producer economic and risk considerations to the sustainability discussion and to push toward a reasonable approach to quantify advances behind the farm gate.

B. This project worked very synergistically with an FY10 SCBG project with the same title. The previous project focused on practice-based survey tools that cranberry producers filled out to represent advances in sustainability behind the farm gate. The economic and risk management solutions that were developed in the FY11 block grant were then represented in the latest iteration of the cranberry producer sustainability surveys. Working together, these two projects have now formed a very cohesive, reasonable and streamlined approach to documenting sustainable practices and metrics. This foundational work has now been expanded to several other commodities, such as mint, soybean and processing vegetables.

II. Project Approach

In the FY11 project, we developed a data assimilation and analysis tool that allowed for composite analysis of several years and replicated field study data points into a single yield and risk management projection (cranberry yield deviation from percent of maximum yield). In particular, the tool focused on pest management and soil fertility inputs – likely the two most significant management topics when considering overall production sustainability. This approach was extremely unique in that it allowed us to demonstrate to producers any risk associated with changing production practices to those considered more sustainable. Working synergistically with the FY10 project and among colleagues, we then used this foundational practice and metric based information from the producers to develop a novel data sustainability analysis approach that we call the "Frontiers of Sustainability." This analysis not only graphically shows the distribution of producers across the spectrum of sustainability adoption, but it also allows us to identify the top improvements that would most greatly advance the producer community along the sustainability continuum.

All activities in our plan of work were completed successfully, many exceeding our expectations. Included were:

- Developed yield risk models based on existing production research data.
- Developed input- and survey-based sustainability assessment programs.
- Tested, modified, and finalized software with grower, handler, buyer input.
- Presented completed software to growers at events such as 2012 and 2013 Cranberry Schools and 2012 Cranberry Grower Marsh Clinics.
- Identified data gaps that can be addressed through production research, such as in water use monitoring practices.
- Communicated outcomes to broad communities of interest, including buyers, handlers and the general public.

The data assimilation and analysis tool has been published to the internet. The link is: http://www.aae.wisc.edu/fdong6/loginsustainability.aspx. Password: SustainabilityCB. The majority of the time was spent developing and testing the complex calculations behind the very large research data base that was compiled. Future work with additional funding sources will include web site refinement/presentation. The survey tool was done as a paper version as outlined in the report.

III. Goals and Outcomes Achieved

A. In the intermediate to longer-term, the cranberry sustainability efforts and overall program have greatly increased producer involvement in advancing production along the sustainability continuum, including consideration of production and risk management as represented by the work in this grant. Additionally, this work has been broadly recognized by public agencies and the supply chain as being at the forefront of national sustainability efforts. The methodology developed in this project has now been implemented in a variety of other sustainability efforts and with other commodities, such as mint, processing vegetables and soybean.

B. The sustainability documentation and risk management work has involved broad participation by the cranberry community as proposed. The outcomes of the pest and soil fertility risk management tool have been demonstrated in a participatory way to growers on numerous occasions.

Goal: The developed sustainability software will be implemented by processors and handlers in a manner that accounts for production economics and crop risk associated with sustainability practices.
Performance Measure: Industry adoption will be measured through a survey of the cranberry processors and handlers conducted by the Wisconsin State Cranberry Growers Association (WSCGA), and will be reported as the percentage of production acreage in Wisconsin involved in the developed program.
Benchmark: Given that such a sustainability software is not currently available, the benchmark is zero for industry adoption, and production costs of non-certified cranberries will be used as the economic benchmark.
Target: The target for software adoption rate will be 10% in the first year of the program and 15% participation by the second year.
The strength of this software development process relative to others is that it is not only grower-driven but also grower-reviewed during the process, thus feedback will be directly from growers and crop handlers/buyers as they test-run and react to metric parameters. This immediate

feedback loop will result in a very efficient use of time and resources as the standards can be tailored based on grower and industry review as the process takes place, as opposed to a review after project completion.

About 600 growers and handlers participated in the demonstration of the software with opportunity for feedback, and 70% of the cranberry acreage was represented by the sustainability practice survey responses. 25% of growers responded that they have or are in process of adopting use the software. 100% of handlers reported favorably to the use of the software.

IV. Beneficiaries

-Wisconsin's 223 Cranberry Growers representing over 60% of the nation's cranberry acreage, plus buyers and handlers that are being asked or required to participate in sustainability programs can now do so in a way that is reasonable and considers economic solvency.

V. Lessons Learned

Offer insights into the lessons learned by the project staff as a result of completing this project. This section is meant to illustrate the positive and negative results and conclusions for the project. Provide unexpected outcomes or results that were an effect of implementing this project. If goals or outcome measures were not achieved, identify and share the lessons learned to help others expedite problem-solving.

The data used in this project was much more complex and large than initially envisioned, and took many weeks to work through in the process of developing the risk management tool. While the outcomes of the tool are very simple and easy to demonstrate to the grower community in a way that they can adjust to more sustainable outcomes, the methodology behind the scenes was more cumbersome and challenging than initially anticipated. Additionally, we found that growers greatly favored paper surveys instead of electronic tools, and preferred interactive demonstrations of the risk management tool with UW personnel instead of being provided with a more traditional "software" package. In other words, the personal educational interaction was important to the project's success.

VI. Additional Information

Not applicable

VII. Contact Info

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6) Making SavorWisconsin.com Mobile Web Capable (11-006)

Report Date: 8/31/14

I. Project Summary

A. SavorWisconsin.com is a free online marketing tool that allows Wisconsin producers to promote specialty crops. The site houses over 1,800 producers, of which 90% are specialty crops producers; promotes over 200 farmers' markets across the state; and connects specialty crop producers to over 40,000 consumers each month. With the site's focus on helping consumers connect with Wisconsin specialty crops, by providing listings of events and non-specialty crops we garner more traffic because the site serves as a one-stop shop to find Wisconsin products.

The proposal was originally designed to help promote and increase the awareness of Wisconsin specialty crops and the producers through cutting-edge technology, by updating the site to be mobile web capable. After surveying businesses, farmers' markets and event holders listed on the website, it was deemed that the majority of site users have created their own online presence through websites and social media. As a result, Savor has evolved into a reference tool for consumers to locate specialty crops and products in their vicinity, and as an additional way for producers to advertise their products and locations.

Because the greatest concern from producers was promotion of the Savor website, we felt it was more important to focus on utilizing advertising/promotion tactics with successful track records. Several other DATCP Agricultural Development programs have found their greatest success in promoting on Public Radio, industry and consumer food and agriculture events such as trade shows, expos, festivals, conferences, etc., and in print in local product publications. Because of this, we changed the focus of this project to promoting the site to consumers via the above mentioned venues and monthly highlights of specific specialty crops rather than the mobile web capable technologies.

B. This project built on a series of Specialty Crop Block Grants, the most recent of which was in 2010. The purpose of that project was designed to help increase awareness of and sales for the Wisconsin Specialty Crop producers listed on the site. This project further advances those efforts through reaching new markets via additional marketing venues other than utilized in the past.

II. Project Approach

This project began in March 2013 with a survey to assess the benefits of www.SavorWisconsin.com to the producers listed on the site. Results showed that the main purpose www.SavorWisconsin.com fulfilled had changed. When the site was originally founded, it provided a web presence for producers who did not have their own website. Savor evolved into a reference tool for consumers to locate specialty crops and products in their vicinity, and as an additional way for producers to advertise their products and locations. SavorWisconsin.com

functioned as primary web presence for about 1/5 of the producers listed on the site. However, 80% of producers listed have their own websites.

The survey was sent to 1700 producers listed on the site. 221 producers 13% completed the survey.
Results are summarized below:

- 56% said they use social medial
- 83.3% signed up to gain more on-line exposure for their business
- 57% signed up to gain more sales leads for their business
- 80% of businesses have their own website
- 21% said sales increased due to savor
- 56% don't have a way to assess if savor brings in additional income
- 78% have less than 5 employees
- Most common theme was that site needed to be promoted to public/consumers more

We had planned to implement social networking, photo sharing, commenting tactics or other on-line and social networking tactics for visitors and listed profiles. However, with the focus being to drive traffic to SavorWisconsin.com, the reported increase in individual websites and individual business promotion through social media, we opted to focus on traditional marketing tactics to drive people to the website.

SavorWisconsin.com was promoted at the following industry events reaching over 20,000 attendees:

- Institutional Food Marketing Coalition Annual Meeting
- Isthmus Food & Wine Festival
- Local Food Means Business Workshop
- Midwest Foodservice Expo
- Midwest Organic Farming Conference
- Wisconsin Agri-Tourism Summit
- Wisconsin Agri-Tourism's 4 Regional Education Days
- Wisconsin Farm to School Summit
- Wisconsin Fresh Fruit & Vegetable Conference
- Wisconsin Local Food Summit

The following is the list of monthly promotions on the site – March 2013 through June 2014:

- March – CSA
- April – Green Industry
- May – Farmers' Markets
- June – Dairy
- July – Strawberries and Cherries
- August – Specialty Meats
- September – Agri-Tourism (apples, wineries)
- October – Pumpkins
- November – Cranberries
- December – Local Gifts

- January – Healthy Fruits and Vegetables
- February – Potatoes
- March – Direct Markets
- April – Trees and Shrubs
- May – Market Gardening
- June – Cheese

We utilized data from Google Analytics to analyze usage, site traffic and repeat visits. Results will be found in Section III of this report.

While SavorWisconsin.com did include 10% to 20% non-specialty crop producers listed on the site over the course of this grant, funds were used solely to enhance sales of specialty crops. To ensure this, 30% of each expense of this project was funded through other sources, enough for the non-specialty crop portion of each expense to more than adequately be funded by non-specialty crop money. The only activities related to non-specialty crops were the two June montly promotions in 2013 and 2014 that highlighted cheese and dairy. No specialty crop funds were used in creating or posting these promotions.

III. Goals and Outcomes Achieved

A. Outcome I

- Increase site traffic for specialty crop searches on mobile technolgy from <.05% to over 30% of total traffic within six months of technology implementation, to be measured by Google Analytics.

While we chose not to focus on implementing mobile technology, we did see an increase of 29% in accessing SavorWisconsin.com through this media type, showing that the site users were already gravitating towards accessing the site information through mobile devices without any special promotions or enhanced web tools. We felt this result emphasized the importance of our swith to traditional promotion of the site. People were using their mobile technology to reach the site perfectly fine without additional help. The importance factor was getting people to the site, how they got their did not require special focus.

Outcome II

- Increase the number of specialty crop producer listings from the current 1,650 to 1,750 in 2012 by recording the number of specialty crop producers listed on SavorWisconsin.com on a monthly basis and surveying to see how the site is opperating and how it can be improved to benefit them.

When the grant started in March of 2013 there were 1,800 profiles and ended with 1,884 in June of 2014. While the number of profiles increased, it's small in comparison to prior years, mirroring the data reported in the March 2013 survey that 80% of of those listed on the site now have their own online presence. The website function is now geared towards assisting consumers locate and purchase specialty crop products rather than providing an actual website for producers.

This project was funded initially with a Block Grant in 2001. It has had several rounds of SCBG funding in addition to other government and private sources and has been an extremely

successful project. However, as technology has developed, the function of the site has changed and its usefulness has diminished simply from the fact that most businesses have their own web and social media presence and several other websites have been introduced that have similar functions to SavorWisconsin.com and have had more publicity and marketing dollars used to promote them. This site is still valuable and used as evidenced by 1.4 million hits during the grant period, but emphasis on continued promotion is likely to diminish, maintaining it as a conduit to Wisconsin specialty crop producers and resalers rather than a source of new specialty crop features and producers.

B. See section A. for actual results

IV. Beneficiaries

The SavorWisconsin.com website has broad impact and supports producers in all Wisconsin Specialty Crop industries including 1884 producers listed on the site. Through features and offline promotional activities, emphasis has been placed on the following industries: Christmas trees, nursery growers, maple syrup, fresh market vegetables, cranberry, berry & fruit growers, and potatoes. While the site primarily benefits the listed producers, it's real benefit is to the tens of thousands of consumers who have visited the site in order to locate Wisconsin specialty crops in their areas.

Item	**Goal**	**Actual**
Increase Traffic	1.3 million	1.4 million
Producer Listings	1,700	1,884
Monthly Features	1 per month	16 implemented
Social Sharing Links	100 per month	On average 100/month

V. Lessons Learned

We began this project expecting to implement mobile technology in the form of an App to drive traffic to the site. Upon surveying those listed on the site the information gathered showed going in this direction would not be as impactful as originally projected. It is important to stay in touch with the audience your project serves, enabling you to make informed and beneficial decisions.

We are fortunate that the parameters of the Specialty Crop Block Grant Program allow us a great deal of flexibility in amending projects.

VI. Additional Information

None

VII. Contact Info

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7) Cultivating alternative apple pollinators (11-007)

Report Date: February 28, 2013

I. Project Summary

A. Apples are a pollinator-dependent, specialty crop grown throughout much of Wisconsin. Historically, apple growers have relied on honey bees to meet their pollination needs. However, as honey bees become more expensive and difficult to obtain, the relative importance of native, wild pollinators increases. While many growers would like to rely solely on wild bees, it is unknown if, or in what numbers, they can provide full pollination. The abundance and diversity of wild bees may also be impacted by pesticide use and the availability of floral resources, though little research has been conducted specific to apple production. This research project measured the pollination contributions of native, wild bees to apples, assessed how pesticide use in apple orchards affects native bees, and identified floral resources utilized by bees outside of apple blossom. Overall, the outcomes of this research will enable growers to make better decisions regarding their need for managed pollinators. An additional goal of this research is to enhance farmers' ability to take management actions that conserve wild bees for pollination. The sustainability of apple growing throughout Wisconsin will increase with a greater dependence on wild bee pollinators. Research has been disseminated at grower meetings and conferences, and through site-specific research reports to participating growers.

B. This project did not build on previously funded projects with SCBGP.

II. Project Approach

Objective 1: To determine the extent to which native, wild bees provide pollination services to apples and to assess whether full pollination can be achieved with wild bees alone.

Activities and tasks performed: Sixteen orchards were recruited to participate in this research including 7 orchards without honey bees and 9 orchards with honey bees. **Wisconsin Apple Growers Association** recruited orchards by advertising in grower magazines and on associated websites. Fruit set was measured at all 16 orchards. Wild bees were collected in bee bowl traps at all 16 orchards for two consecutive weeks during apple bloom and identified to species.
Significant results: Frost significantly, negatively affected fruit set at all orchards ($P<0.001$). However, we saw no significant effect of the number of honey bees on fruit set (Figure 1). The number of honey bees captured

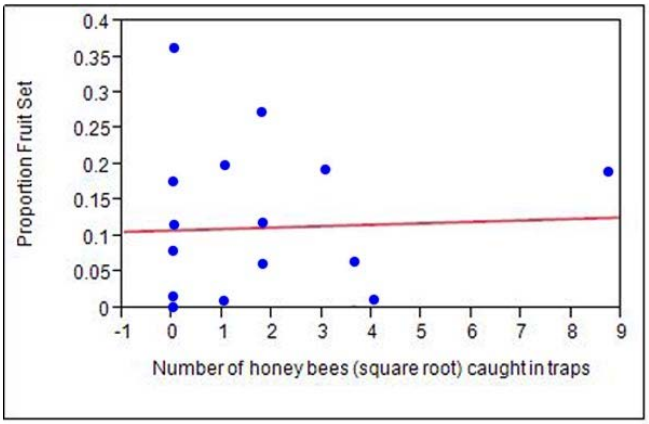

Figure 1. The relationship between proportion fruit set and the number of honey bees found within an orchard during bloom

in traps is significantly correlated to the number of hives a grower rents or manages, but also includes neighboring or feral honey bees. Alternatively, we did find a positive relationship between the species richness of wild bees and fruit set (Figure 2), but no significant relationship between the abundance of wild bees and fruit set (P=0.32).

Conclusions and recommendations: Fruit set at an orchard will depend on the diversity of wild bees within the farm, as well as on abiotic factors such as frost. Farms situated in diverse landscapes are more likely to have a high diversity of wild bees (see objective 3). The majority of growers can get adequate fruit set (10% or higher) from wild bees alone, and for these orchards, increasing honey bee hives does not improve yield. However, some orchards relying solely on wild bees have below adequate fruit set, in part due to a small wild bee community.

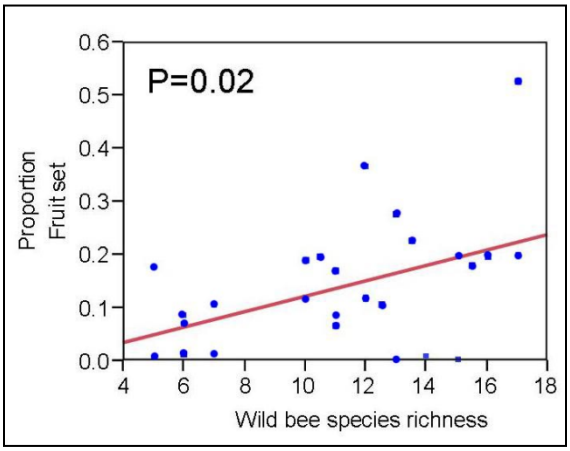

Figure 2. The relationship between proportion fruit set and the species richness of wild bees found within an orchard during bloom

Objective 2: To determine how agricultural management affects native, wild bees. Specifically, to examine the effects of pesticide use and apple blossom density on wild bees and levels of apple pollination.

Activities and tasks performed: Fourteen orchards were selected that vary in pest management practices including 7 certified organic or no-input orchards and 7 conventional orchards.

Project partner Wisconsin Apple Growers Association assisted in recruiting orchards by advertising in grower magazines and on associated websites.

Wild bees were collected at all 14 orchards using bee bowl traps. Thirty-six bumble bee colonies were distributed throughout the 14 orchards from April – July 2012. Bumble bee colonies were monitored throughout the growing season. Data from the bumble bee colonies, including colony weight, number of workers, queens and males have been collected. Additional data such as the size and fat content of bumble bees are currently being collected. Thirteen of fourteen orchards have turned in spray records for the 2012 growing season, and toxicity scores for the orchards are being developed.

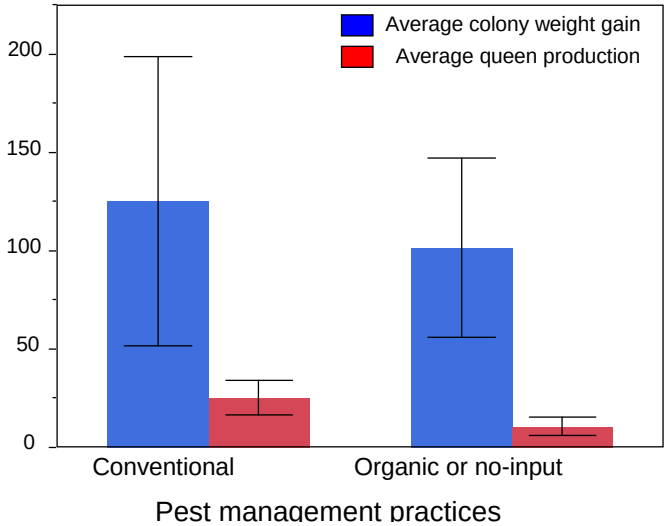

Figure 3. Average bumble bee queen production and colony weight gain over the course of the season at conventional and certified organic or no-input orchards

Wild and honey bee visitation rates were observed as a function of apple blossom density

at the orchard block and per-tree level.

Project partner Peninsular Agriculture Research Station provided use of apple trees and housing over the research period. A total of 7 observation periods were conducted within 5 different orchard blocks on 42 different trees. Wild bee abundance and richness at all 21 participating orchards was also related to the blossom density estimated at all orchards.

Significant results: There is no significant difference in the abundance or diversity of wild bees at certified organic or no-input orchards compared to more conventionally managed orchards (P=0.6, 0.8, respectively). There is also no significant difference in bumble bee colony weight gain or queen production at organic or no-input orchards compared to conventionally managed orchards (Figure 3).

Both wild bees and honey bees significantly preferred orchard blocks with a higher apple blossom density (P<0.001; P<0.001, respectively) and preferred individual trees with a higher blossom density (P=0.02, P<0.001, respectively). Wild bee abundance as collected in bee bowl traps was significantly, positively related to the density of apple blossoms within the orchard block (Figure 4).

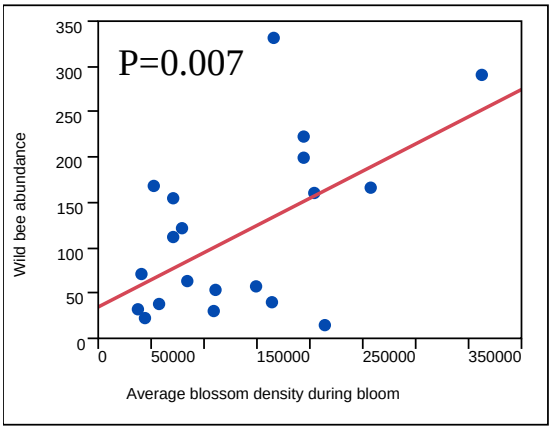

Figure 4. The relationship between the abundance of wild bees and the apple blossom density in an orchard

Conclusions and recommendations: Our experiment may not have detected a significant effect of pest management practices on wild bees because most apple growers follow guidelines to avoid pesticide poisoning of bees such as spraying early or late in the day and when the crop is not in bloom. Second, native bees, including wild bees and bumble bees, may be more sensitive to other factors such as land-use change or diseases than they are to the pesticides applied within the orchard. Likewise, pesticides applied in the surrounding landscape may be more influential compared to those applied within the apple orchard, as apple orchards occupy a relatively small portion of a bee's foraging area. We therefore conclude that apple growers' pest management practices have the potential to affect wild bees, but that at our study sites, other factors such as landscape (see objective 3) or bloom density (see below) are more influential.

Bees are attracted to dense floral displays. There will be more bees per flower in orchard blocks or on orchard trees that have a higher density of apple blossoms. Therefore, growers should maximize the density of flowers in the orchard during bloom in order to maximize the density of pollinators.

Objective 3: To characterize the floral resources used by the wild bees that pollinate apples.

Activities and tasks performed: The abundance and diversity of wild bees at all participating 21 orchards was related to the landscape characteristics surrounding the orchard. These results were compared to those from 2010, when wild bee populations were surveyed at 30 orchards varying in the surrounding landscape. Attempts were made to remove and analyze pollen from the

bumble bees placed at 15 orchards, but we were unable to collect and analyze a significant amount of data (see Lessons Learned).

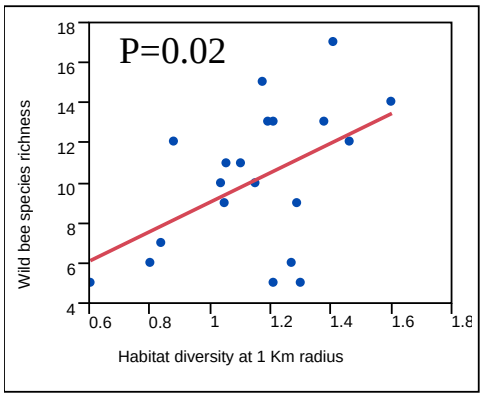

Figure 5. The relationship between the diversity of wild bees and the diversity of habitat types at a 1 Km radius surrounding the orchard

Significant results: Wild bee diversity was positively related to the diversity of land-cover types in the surrounding landscape (Figure 5). Wild bee abundance was marginally, negatively affected by the total amount of intensive agriculture in the surrounding landscape (P=0.16). Wild bee abundance and diversity were also relatively consistent across years, from 2010 to 2012, at the same study sites (P<0.001 for both abundance and diversity).

Conclusions and recommendations: Growers are encouraged to maintain a diverse landscape, including natural habitat, for the conservation of wild bees. A diverse landscape includes open grassland, woodland, home vegetable or flower gardens, dirt roads or paths, and mass-flowering crops, all of which support wild bees. The wild bee community of an orchard is likely to be relatively consistent across years, and dependent on the surrounding landscape. The wild bee abundance and diversity of an orchard is therefore a relatively stable characteristic of the site. Orchards situated in resource-poor landscapes, particularly those dominated by intensive agriculture, will have to supplement their pollinator population with managed bees.

III. Goals and Outcomes Achieved

A. The performance goals of this research were to 1) Help growers make more informed decisions about their need for managed honey bees by assessing the contribution of wild bees to the pollination of their trees, 2) Increase grower awareness and knowledge of how pest management practices affect native, wild bee pollinators, and 3) Provide growers with knowledge of what floral resources within their orchard are utilized by native bees, and what is the value of the off-crop habitat in providing resources for bees.

The activities described above have met, or made progress towards meeting, all three performance goals. Completed activities have informed the relative contribution of honey bees and wild bees to fruit set, and the factors determining whether a grower can rely solely on wild bees for pollination. Additionally, our results show the significant effects of bloom density and surrounding landscape structure on wild bee populations. Ongoing activities towards meeting performance goals number 2 and 3 include additional analyses of how pesticides affect the health of bees, and future experiments on how and when wild bees use the surrounding landscape.

B. Proposed work plan and actual accomplishments:

Objective 1:

1. Process all wild bees collected and identify the bees to species. I estimate 2,000 wild bees will be processed belonging to approximately 30-40 different species.
2. Statistically analyze data. Relate the abundance and diversity of wild bees to proportion fruit set at each orchard.

Both of these activities were completed during the reporting period. Over 1,500 bees were identified to species, and the abundance and diversity of wild bees has been related to fruit set at the 16 participating orchards (Figures 2 and 3).

Objective 2:

1. Process all wild bees collected and identify to species. I estimate 2,000 wild bees will be processed belonging to approximately 30-40 different species.
2. Continue processing and collecting data from the 36 bumble bee colonies. This includes recording the number of males, workers and queens, calculating the fat content of individual bumble bees, and recording the presence of parasites on bumble bees. I estimate that approximately 3,000 adult bumble bees will be processed from these colonies.
3. Continue collecting spray records from growers until all 14 orchards have submitted spray records
4. Develop toxicity scores from growers' spray records for all 14 orchards using the Environmental Impact Quotient for each active ingredient applied (Kovach et al 1992).
5. Conduct statistical analyses relating the abundance and diversity of wild bees to toxicity scores, and relating bumble bee data (fat content, number of queens, weight of colony) to the toxicity scores calculated at each orchard.

All wild bees were identified to species, and the abundance and diversity of wild bees was related to pest management practices (organic/no-input vs. conventional) (Figure 4). The total number of workers and queens per colony has been determined, and the weight gain of the colony over the course of the season has been calculated for 36 colonies. The fat content and size of individual bumble bees is still being determined for approximately 600 worker bees. Spray records have been received from 13 of the 14 participating orchards, and toxicity scores will be calculated from these spray records within the following month. Many statistical analyses have been conducted, including relating the bumble bee colonies' weight gain and queen production to orchard management (Figure 5), but further analyses need to be conducted pending the completion of the above described activities.

Objective 3:

1. Examine pollen on a subsample of bumble bees collected from bumble bee colonies, and on a subsample of wild bees collected in bee bowl traps. Identify pollen to plant family.

These activities were not conducted due to the difficulty in obtaining clean pollen samples from the bumble bees. The pollen was mixed with honey, nectar and debris from the colony, and this makes the pollen difficult or impossible to identify. Attempts were made to remove pollen from live bees flying in the field, but it proved difficult to catch and randomly sample these bees.

Additionally, the pollen obtained from a few bees was difficult to identify without a reference collection.

Alternatively, analyses were conducted relating wild bee abundance and diversity to landscape characteristics. These analyses showed wild bee resource use at the scale of land-cover or habitat type as opposed to individual flower species. Results were then compared to a study done in 2010 examining landscape effects on wild bees (Figure 7).

Other:

1. Research results will be disseminated to all 21 participating orchards in late December.
2. Research results will be presented at apple grower meetings and conferences in late fall/winter of 2012-2013.
3. Research results will be disseminated in *Fresh Magazine* to over 1,000 fruit growers with the help of **project partner Wisconsin Apple Growers Association**.

Research results have been distributed to all 21 participating growers, and overall results were presented at the 2013 Wisconsin Fruit and Vegetable Conference. We are currently in the process of writing a report for *Fresh Magazine*.

IV. Beneficiaries

Research results were disseminated to the **21 participating apple growers**, including overall results and results specific to each site. Results specific to each site can help growers make decisions on whether to rent honey bees, potentially saving growers with large wild bee communities up to $700 - $7,000 ($70/hive * 1 hive/acre * 10-100 acres). For orchards low in wild bee diversity, our results encourage supplementing wild bees with managed pollinators to increase fruit set up to 10%. Overall research results were also presented to **approximately 200 apple growers** at the 2013 Wisconsin Fruit and Vegetable Conference. Overall results have the potential to impact growers' management practices, encouraging practices such as preserving diverse and natural habitats for wild bee resources, or attracting wild bees with dense floral displays. Future activities include writing a research report for inclusion in *Fresh Magazine*, which is distributed to over **1,000 apple growers**, and writing scientific manuscripts for Entomology and Ecology journals. Furthermore, results from this research will inform a guide to wild bee pollinators that will be available online as a Mobile Site and available in hardcopy for approximately 200 apple growers in Wisconsin.

V. Lessons Learned

Warm temperatures followed by spring frosts hindered our ability to achieve our goals for objective 1. Specifically, it was difficult to measure the contribution of wild bees to fruit set when fruit set was largely determined by frost. While we fully intend to achieve all goals for objective 2, we have not yet finished conducting the laboratory research or statistical analyses. We learned that one year is a relatively short time period in which to conduct research, especially when such research involves field and laboratory components. Finally, it also proved difficult to achieve our overall goals for objective 3. It was difficult to non-lethally, and randomly, collect pollen from bees. It was also difficult to identify pollen without an extensive reference

collection of all plants within the area. It may be easier to determine the floral preferences of bees with observations, molecular techniques, or tracking.

VI. Additional Information

Not applicable

VII. Contact Info

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8) Improving nitrogen use efficiency in sweet corn production (FY11-008)

Report Date: February 28, 2013

I. Project Summary

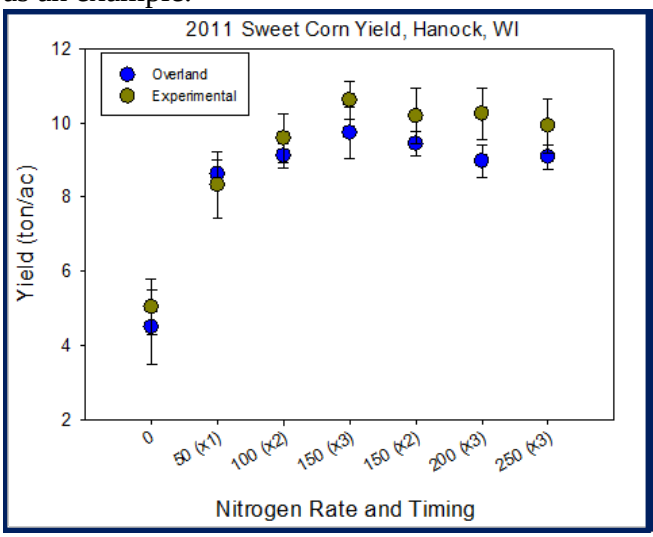
A. Corn (Zea mays L.) is grown on sandy soils in the Central Sands Area of Wisconsin, an area of irrigated vegetable production which has elevated levels of nitrate nitrogen (NO_3-N) concentrations in a the shallow groundwater. However, there is some concern that the current N rate recommendations for sweet corn are too low as newer varieties will need more N to obtain greater yields. Recent research has been done using controlled release fertilizers attempting to minimize the amount of NO_3-N leaching past the rooting zone. However analysis of leaching rates have been determined by porous cup samplers or lysimeters placed directly below the root zone. Few if any studies have directly assessed changes in groundwater nitrate concentration from different fertilizer treatments by directly sampling groundwater. The persistence of elevated groundwater nitrate concentrations requires investigation into novel management techniques and methods that verify new management methods impact on groundwater quality.
The objectives for this research were to: (1) determine the effect of hybrid, planting density, N rate and their interactions on sweet corn yield, (2) evaluate NUE components across improved management practices, and (3) evaluate nitrate concentrations in groundwater below conventional and alternative sweet corn management practices. Corn (Zea mays L.) is grown on sandy soils in the Central Sands Area of Wisconsin, an area of irrigated vegetable production which has elevated levels of nitrate nitrogen (NO_3-N) concentrations in a the shallow groundwater. Recent research has been done using controlled release fertilizers attempting to minimize the amount of NO_3-N leaching past the rooting zone. However analysis of leaching rates have been determined by porous cup samplers or lysimeters placed directly below the root zone. Few if any studies have directly assessed changes in groundwater nitrate concentration from different fertilizer treatments by directly sampling groundwater. The persistence of elevated groundwater nitrate concentrations requires investigation into novel management techniques and methods that verify new management methods impact on groundwater quality.

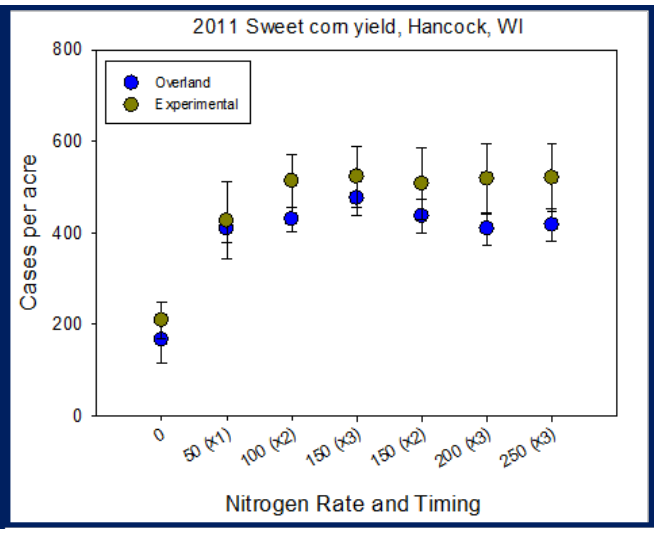
B. This project complimented a sweet corn project funded by the 2010 SCBG program utilized wells that had previously been established in fields planted to potato. This project complemented that work by affording the opportunity to assess agricultural systems and crop rotations rather than a single crop. Growers in the area often use a potato-corn-soybean rotation, and the continuation of the previous project into sweet corn more properly addresses how growers manage their land in the area.

II. Project Approach

Nitrogen rate by variety
Two sweet corn varieties were evaluated over seven nitrogen rates across three years at the Hancock ARS. All fertilizer was applied by hand and sweet corn was harvest by hand. Ten ears were collected per plot and analyzed for weight of cut kernels (which were converted to units of cases/ac). Across the three years of the study, optimal N rates varies from 100 to 200 lb./ac of N

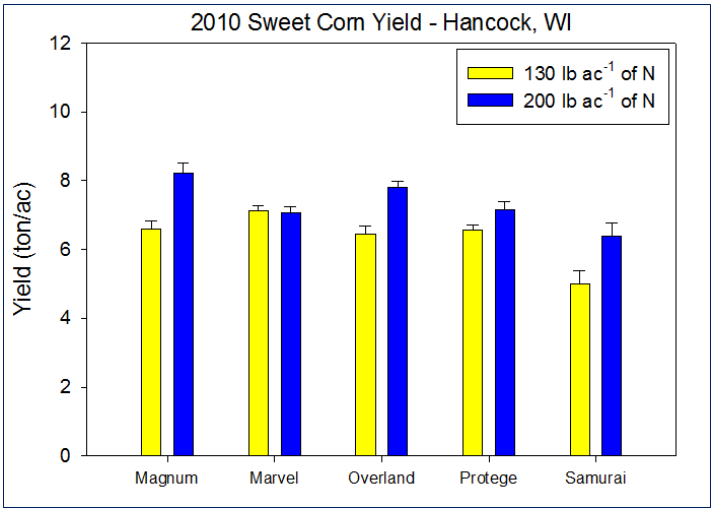
depending on the growing season. However, the optimal N rate for processor yield (cases/ac) was similar to slightly less than that of grower yield (ton/ac). Data from 2011 are reported here as an example.





Sweet corn variety by nitrogen rate

Ten sweet corn varieties were evaluated over two nitrogen rates (130 and 200 lb./ac of N). Trends were similar across years, with older varieties (i.e. named varieties) having lower yields than experimental varieties and with nearly all varieties having a yield increase between 130 and 200 lb./ac of N. Results from the 2010 growing season are provided as an example.



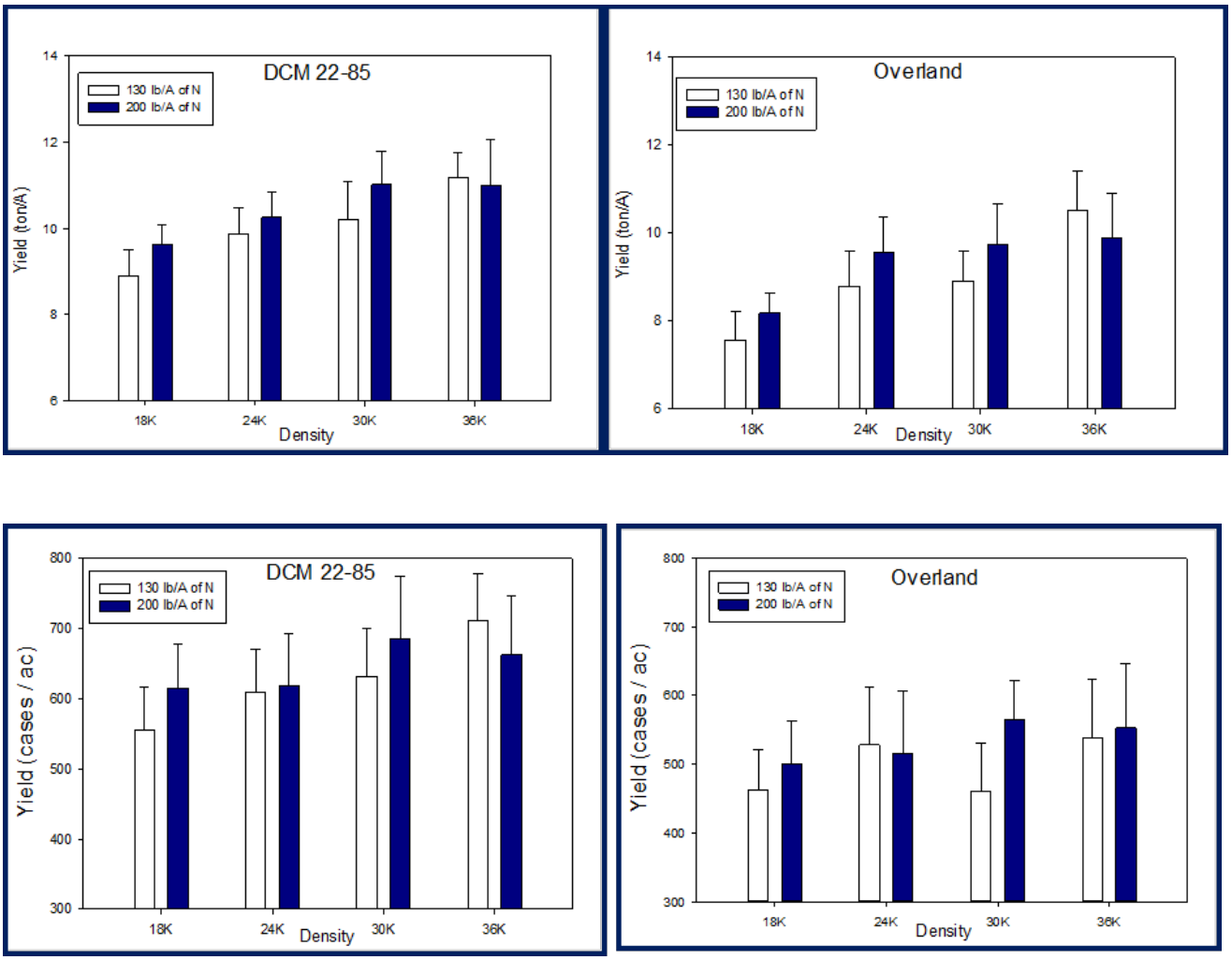
Density by nitrogen rate by variety

Two varieties were evaluated across

two nitrogen rates (130 and 200 lb./ac of N) and four planting densities. These results indicate that there was a slight yield increase up to 30,000 seeds/ac with newer, higher yielding varieties (DCM 22-85), while yields plateaued at 24,000 seeds/ac with older varieties

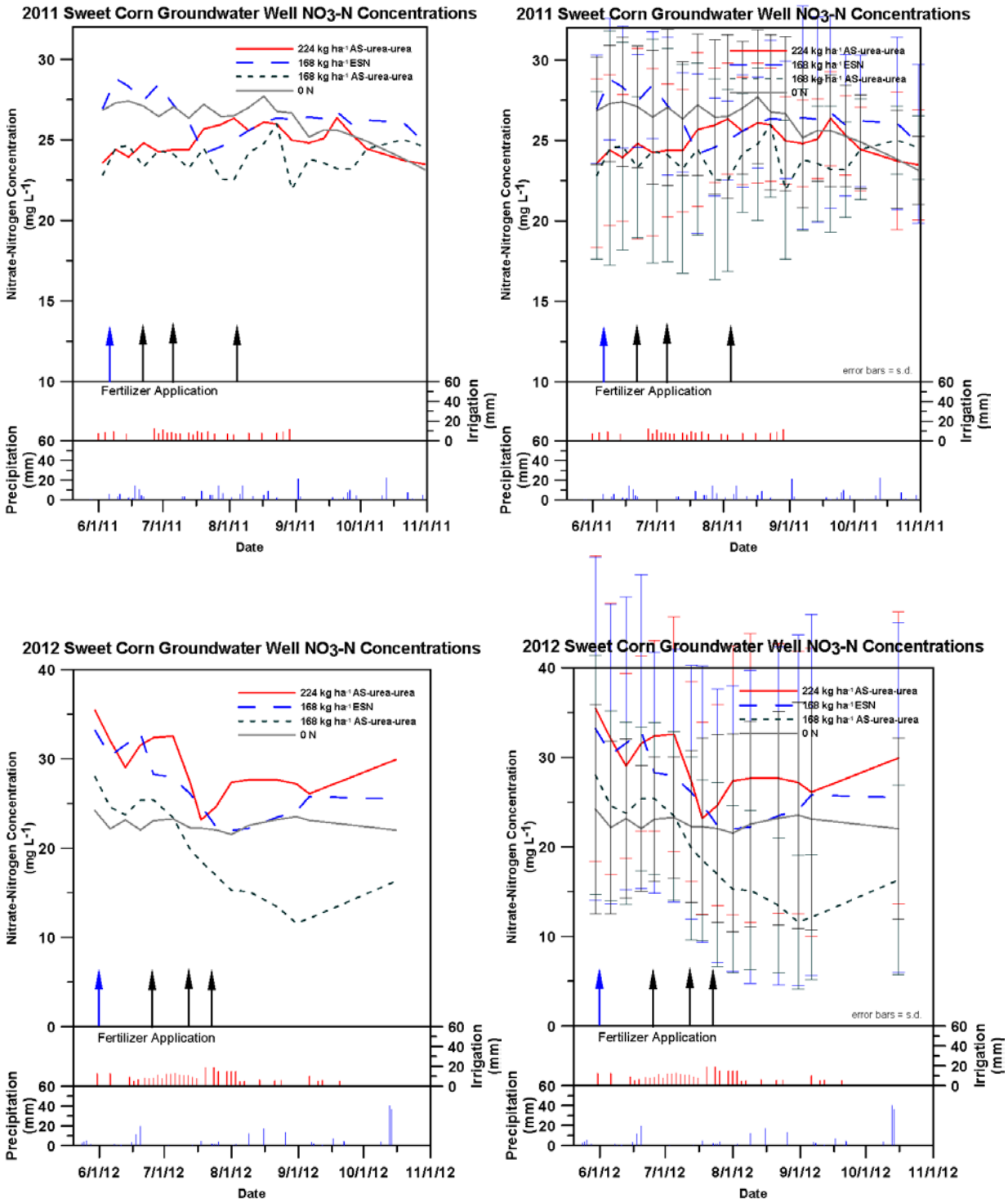
Density by nitrogen rate by variety

Two varieties were evaluated across two nitrogen rates (130 and 200 lb/ac of N) and four planting densities. These results indicate that there was a slight yield increase up to 30,000 seeds/ac with newer, higher yielding varieties (DCM 22-85), while yields platued at 24,000 seeds/ac with older varieties (Overland). It is also interesting to note that yields plateaued when N was applied at sufficient rates. At lower N rates, yields increased with an increase in seeding density. The effect on density was much more variable on processor yield (cases/ac). Statistically there no effect of density on kernel yield.



HGWN – This study evaluates conventional nitrogen management practices versus controlled release nitrogen and their impact on groundwater nitrate concentration. Four fertilizer rates 200 lb. ac^{-1} (224 kg ha^{-1}) as ammonium sulfate-urea-urea (HCONV), 150 lb. ac^{-1} (168 kg ha^{-1}) as ammonium sulfate-urea-urea (RCONV), 150 lb. ac^{-1} (168 kg ha^{-1}) as polymer coated urea (RPCU) and no applied N. Polymer coated urea (PCU) was applied at planting, and the conventional practice was split with applications at emergence, 4 weeks after planting and 6 weeks after planting. Plot sizes were 50 ft. ×50 ft. had 3 groundwater monitoring wells installed, which were established the prior year in potato. Wells were PVC pipes 3.2 cm in diameter with 2.3 m screens that had 0.5 mm slot width. Wells were sampled weekly throughout the growing season approx. 25 May – 1 September in 2011 and 2012. Samples were put on ice and are stored at 4 °C to be assessed for nitrate and ammonium concentration. Ear, kernel, and stalk samples were taken at harvest (25 August 2011 and 14 August 2012 and were assessed for total nitrogen uptake and total carbon concentration. Yields again in this year were lower in the PCU treatment in both years (16.3 Mg ha^{-1} or 7.3 tons ac^{-1} in 2011 and 16.7 Mg ha^{-1} or 7.4 tons ac^{-1} in 2012) as compared with the HCONV (20.0 Mg ha^{-1} or 8.9 tons ac^{-1} in 2011 and 18.8 Mg ha^{-1} or 8.4 tons ac^{-1} in 2012) or the RCONV (18.9 Mg ha^{-1} or 8.4 tons ac^{-1} in 2011 and 18.9 Mg ha^{-1} or 8.4 tons ac^{-1} in 2012). Nitrogen uptake was highest in the conventional treatments across ears, stalks, and kernels, as compared with the PCU treatment for the 2011 growing season. Nitrogen uptake

efficiency was highest in the RCONV treatment followed by the HCONV treatment. The RPCU treatment had the lowest nitrogen uptake efficiency among treatments. Nitrogen uptake and NUE will be calculated for the 2012 growing season after nitrate analysis by SPAL. Since the benefit from PCU comes from resisting leaching due to large rain events, and there were none of these events in either 2011 or 2012, the similarity in the data shows that in years that there is little nitrate leaching because of dry conditions the PCU does not perform as well as conventional split applied nitrogen management. Fertilizer treatment effects on groundwater nitrate concentration were inconclusive, as large variation in nitrate concentration masked any statistically significant differences between treatments.



III. Goals and Outcomes Achieved

A. Groundwater samples were collected from both years and assessed for nitrate concentrations. Sweet corn stalks, ears, and kernels were collected and assessed for nitrogen and carbon concentration for 2011. Sweet corn stalks, ears, and kernels were collected, and processed and

are awaiting analysis at the UW Soil and Plant analysis laboratory for total nitrogen and carbon concentration. Yield calculations from ear data was compiled for both years of the study. These samples helped us achieve the outcome of determining fertilizer effect on plant quality and groundwater nitrate concentration.

B. We accomplished the collection and assessment of groundwater nitrate concentrations for both years of the study. We accomplished the collection of plant samples for both years of the study. Assessment of nitrate and carbon concentrations has been completed for the 2011 samples, and the 2012 samples are prepared and will be assessed by SPAL in the near future, and nitrogen and carbon concentration and nitrogen uptake tables will be compiled to provide two years of fertilizer effect on plant quality to growers.

Table 1. Sweet Corn Yield

Treatment	2011	2012
	----------Mg ha^{-1}----------	
HCONV	20.00 a	18.8 a
RPCU	16.26 b	16.7 b
RCONV	18.95 a	18.9 a
0 N	2.33 c	7.8 c
P>F	<0.001	<0.001

Table 2. Plant Nitrogen and Carbon concentrations by sample type for 2011.

	Nitrogen			Carbon		
Treatme	Ears	Stalks	Kernels	Ears	Stalks	Kernels
	----------g kg^{-1} ----------					
HCONV	14.57 a	17.28 a	19.85 a	460.8 a	440.4 ab	456.6 a
RPCU	12.63 a	10.57 b	17.60 b	457.9 a	431.3 c	451.6 b
RCONV	14.40 a	16.46 a	19.31 ab	461.6 a	443.3 a	453.6 ab
0 N	12.11 a	6.30 c	18.30 ab	455.5 a	432.8 bc	452.4 ab
P>F	0.146	<0.001	0.038	0.320	0.022	0.058

Table 3. Plant nitrogen uptake by sample type for 2011.

Treatment	Ears	Stalks	Kernels	Total
	----------kg N ha^{-1}----------			
HCONV	67.1 a	107.9 a	48.4 a	175.0 a
RPCU	50.0 b	67.6 b	34.4 b	117.6 b
RCONV	64.6 a	104.2 a	41.7 ab	168.8 a
0 N	6.6 c	30.0 c	2.9 c	36.6 c
P>F	<0.001	<0.001	<0.001	<0.001

IV. Beneficiaries

Beneficiaries of our research are potato and vegetable growers on sandy soils. They are able to utilize our data to make better decisions regarding how they manage soil fertility in sands while addressing environmental concerns. Results of this study have been presented at the following events:

2013 Potato Grower Conference. “Improving nitrogen use efficiency in vegetable production systems.” Attendance: 106 (proceedings paper); Audience: sweet corn growers, industry.

2013 Wisconsin Crop Management Conference. “Measuring the impact of nitrogen management on groundwater quality in sandy soil under vegetable production.” Attendance for presentation: 55; Attendance total: 1525 (received proceedings paper); Audience: growers, crop consultants, industry.

2012 International Sweet Corn Development Association Meeting. “Sweet corn and nitrogen use efficiency.” Attendance: 65; Audience: Industry, researchers.

2012 Midwest Food Processor Meetings. “Controlled-release nitrogen on sweet corn for improved water quality.” Attendance: 65 (proceedings paper); Audience: Industry.

2012 American Water Resources Association Meeting (Wisconsin Chapter). “Controlled-release fertilizer effect on groundwater nitrate concentration in sandy soils under vegetative production.” (Attendance for presentation: 60; Total attendance: 200 (received proceedings paper); Audience: policy and governmental, researchers)

2011 North Central Industry and Extension Soil Fertility Conference. “Slow-release fertilizer effect on groundwater nitrogen.” (Attendance: 200 (proceedings paper); Audience: agricultural industry, researchers)

2011 Soil Science Society of America Conference. “Slow-release effect on groundwater nitrogen concentration.” (Attendance for presentation: 75; Total attendance: 3,000 (received abstract); Audience: researchers)

V. Lessons Learned

Offer insights into the lessons learned by the project staff as a result of completing this project. This section is meant to illustrate the positive and negative results and conclusions for the project. Provide unexpected outcomes or results that were an effect of implementing this project. If goals or outcome measures were not achieved, identify and share the lessons learned to help others expedite problem-solving.

This data offers insight into the difficulty in developing a single numeric N rate guideline for sweet corn. Optimum yields varied between years and was dependent on timing and intensity of rainfall. The current guideline of 150 lb./ac seems adequate, but with such variation, the true guideline is a range between 150 and 200 lb./ac. Supplemental N is necessary in some cases and future efforts will focus on developing guidelines for when supplemental N is appropriate.

Directly monitoring changes in groundwater quality is wrought with difficulty. Previous year's results have shown that variability in nitrate concentrations do not give a statistical difference between fertilizer types and strategies to directly monitor groundwater using groundwater monitoring wells to determine fertilizer effect may need be adjusted. Larger fields, monitored over time, may be a better strategy to determine a treatment effect on groundwater quality using wells. In addition, a water table drop has occurred and some wells did dry after the second growing season in 2012. This illustrates the difficulty in placing wells, as the elevation of the groundwater table has also been highly variable, changing over 2 m over the course of three summers of well sampling. The PCU we used underperformed the conventional fertilizer treatments, and this may have been because of when fertilizers were applied to the field and further research may be needed to address timing of fertilization when using a PCU.

VI. Additional Information

Three publications are in preparation: (1) Optimizing nitrogen fertilizer in sweet corn production (Agronomy Journal), (2) Fertilizer effects on sweet corn yield and groundwater quality (Journal of Environmental Quality), and (3) Surface to groundwater transport in sandy soils (Vadoze Zone Journal).

VII. Contact Info

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9) Retail Promotional Tools for "Wisconsin Potatoes" Buy Local Effort (FY11-009)

Report Date: November 16, 2012

I. Project Summary

A. The initial intent of this project is to sell more Wisconsin grown potatoes in Wisconsin. When surveying sales data in retail grocery stores it appears that 40 – 60% of the potatoes sold in Wisconsin stores are grown somewhere other than Wisconsin. We believe we should increase our presence locally, which would improve our food distribution systems and reduce carbon footprint by reducing food miles.

II. Project Approach

The WPVGA has developed a "Buy Local" retail sales bin. The bin carries the image of potato farmer Justin Isherwood with our Healthy Grown logo as well as the image of Susie Favor-Hamilton our spokesperson.

The bin functions as a container in which potatoes are shipped as well as a grocery store floor display. These bins are expected to be reused for up to a year in the retail setting. They can also be returned to shippers to be refilled and returned to the retail outlet.

The project is now complete. We worked with Volm Bag Company who assisted in the final phases of printing the images (skin) on the bin and worked with bin assembly. Over 1,500 bins were printed and constructed. These have been made available to our shippers, being rationed at 200 bins per shipper. Nearly half of these bins were requested by shippers within 24 hours of the announcement of their availability. Volm Bag has already placed an order for additional bins as these are instantly popular with our shippers.

This project carries a great "Buy Local" message that our shippers are using from Minneapolis to Chicago, across the state of Wisconsin. I expect this bin design to be used for 5-7 years into the future.

III. Goals and Outcomes Achieved

A. We met our goal of creating over 1,000 "Buy Local" retail sales bins and making them available to our shippers. The future and continued use of this bin is highly anticipated. Our duty in this project was to complete a bin that shippers and retails want to use, then turn this product over to private industry. We expect Volm Bag Company to continue the production of the bin and make them available to our shippers now and into the future.

B. Our initial plan was create 1,000 – 1,100 bins under this grant funding. We were able to create and make available to our shippers over 1,400 bins at no cost to the shipper. The bin has taken off and repeat orders are already underway.

IV. Beneficiaries

This project has allowed us to provide the first 200 bins to our shippers at no cost. The creation of the printing plates allows them to reorder additional bins without the cost of design and printing plates.

Volm Bag Co., one of our best Associate Members has partnered with us to cover a cost overrun of $6,000 as they will be able to profit from additional sales of these bins including future orders. This project has created a good partnership within our industry.

We have created something with value serving several business purposes.

Our consumers can now easily identify which potatoes in the grocery store were grown in Wisconsin. On a regular basis we are told that our customers cannot identify Wisconsin grown products with the large amount of store brand labeling. Potatoes sold in this bin will clearly be identified as Wisconsin grown.

V. Lessons Learned

All of our goals have been met with this project and its performance is exceeding our initial expectations. I would like to have tightened up the completion timeline, but I anticipate better staff member performance in the future.

The cost of the project was greater than expected. Our initial budget was $31,000. Our costs for design, printing plates, printing and bin construction exceeded $37,000. We were able to work with Volm Bag Company to pay the overrun costs as they will have the ability to sell any overrun production as well as make future sales of the bins.

VI. Additional Information

NA

VII. Contact Info

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10) Market expansion for Wisconsin grown grapes, Phase II (FY11-010)

Report Date: January 16, 2013

I. Project Summary

A All Wisconsin grape growers benefited from this project. WGGA represents over 150 grape grower members and there are an additional 150+ grape growers that have been identified as having vines in the state. These growers all benefited from the grape sales created by this project. All 90 of Wisconsin's bonded wineries also benefited from this project. Wineries having accredited wines benefited the most as this project promoted these wines for sale, but all wineries benefited from the increased awareness of Wisconsin's wine industry which encouraged consumers to tour the various wineries and purchase their products. Consumers who appreciate local wines benefited from this project. Currently wine produced and/or bottled in Wisconsin may contain “0” Wisconsin grown grapes. Just because a wine is sold at a Wisconsin winery or retail outlet does not mean that wine has any locally grown grapes as part of its makeup. Through this project, we promoted accredited wines so consumers know that the wine they are drinking has a minimum of 75% of Wisconsin grown grapes. This project aided consumers who wished to make conscious decisions to buy truly Wisconsin wines.

There continues to be a shortage of Wisconsin grown grapes. We helped growers establish relationships with Wisconsin wineries, and all Wisconsin grown grapes were sold. Prices for grapes have risen due to demand. This year many grape growers contacted us about planting larger commercial vineyards or expanding their current vineyards. Over the next couple of years the acreage in Wisconsin should continue to grow tremendously.

B. During Phase II: Market Expansion for Wisconsin Grown Grapes, we continued to build on the work accomplished during 2011 (funded through SCBG-2010). Phase II continued to build marketing relationships between Wisconsin grape growers and Wisconsin wineries and by so doing, expanding the number of wines made with Wisconsin grown grapes. In addition, this second year of funding focused on educating consumers about Wisconsin accredited wines, the cold-climate grapes they are made from, and the unique characteristics they possess. As consumers get more comfortable with cold-climate grape varieties, wineries will increase production of them, thus encouraging more people to plant commercial vineyards, which increases the amount of Wisconsin grapes going into wines and ultimately into the hands of the consumer.

The first year of the grant was primarily researching and developing contacts within the industry, identifying Wisconsin wineries and contacting and building relationships with each of them. The same was done for the grape growers. Thanks to this project, WGGA staff are contacted weekly by someone who is interested in growing grapes or starting a winery or who already has a vineyard but is not onWGGA’s contact list.

II. Project Approach

During 2012, I traveled to Wisconsin to attend the Wisconsin Fresh Fruit & Vegetable Conference in Wisconsin Dells from January 15-17, 2012. At the conference I presented at three different sessions: Building Grower & Winery Relationships, Overview of Wisconsin Grape and Wine Industry 2012—Grape Session and Overview of Wisconsin Grape and Wine Industry 2012—Winery Session. I also attended different sessions on grape and winery topics, the Wisconsin Food and Wine Pairing Dinner, and the annual meeting for the WGGA. I took photos at the conference and posted them on Facebook and the WGGA website. The conference had a record attendance of 701 attendees.

Other items I worked on during 2012 include WGGA Membership updates and renewals (Google group, lists, database, e-news), Wisconsin Wine Accreditation Program 2012, responding to emails, maintaining lists of grapes for sale by growers and grapes wanted to purchase from wineries and helping each party connect with each other. There was a shortage of grapes again this year and all grapes that were posted for sale were sold right away.

Throughout the year, I attended a few of the Northern Grapes webinars. I also attended the WGGA Board Meetings via Skype. I helped coordinate the WGGA Educational Survey to WGGA Members and finalized data report for the WGGA Board of Directors.

I flew back to Wisconsin to attend the WGGA Spring Vineyard School at Wollersheim Winery on the 29th of March. I took pictures and posted them and the PowerPoint Presentations on the WGGA website. Over 100 people attended and most were members.

I have maintained and continued to build up social media and marketing for WGGA. I updated and took over as an administrator for the WGGA LinkedIn account. I have continued to post articles, events and pictures to the WGGA Facebook page.

I have also updated the WGGA website as follows:

1) Created a map of all Wisconsin wineries by county
2) Created a list of all Wisconsin wineries
3) Created a Media Kit on the WGGA website which includes Wisconsin Grape & Wine History, WGGA marketing materials (grape poster, grape brochure), Report of Wisconsin Grape Growers 2011 and Report of Wisconsin Wineries 2011.
4) Posted press releases
5) Added PowerPoint presentations from events
6) Wrote and blasted out monthly
7) Posted media articles

This was my second year as the Coordinator for the Wisconsin State Fair Professional Wine Competition. The competition was a huge success as over 150 wines were entered this year compared to 100 entries last year. The competition grew 50%. More and more Wisconsin wineries are entering the competition and it is a great way to showcase Wisconsin wines. I attended and presented at the Wisconsin State Fair Foundation All-Star Blue Ribbon Tasting

event in June. We featured Wisconsin wineries and poured Wisconsin grown and produced grape wines to the attendees.

I continued to update the Wisconsin wineries database with the most current TTB and Wisconsin Wineries Permit listings. As mentioned previously, Wisconsin now has 90 bonded wineries. It is important to continue to track the growth of the industry as not all of these wineries are involved with the Wisconsin Grape Growers Association and/or the Wisconsin Winery Association.

The Wisconsin grape and wine industry was featured in many media outlets including Midwest Wine Press, Palate Press, Door County Advocate, Green Bay Press Gazette, Milwaukee Journal Sentinel, Wines & Vines, The Daily Meal. Wine Business, Good Day Wisconsin, Adunate Blog, Green Bay Press Gazette and Journal Democrat to name just a few. All Wisconsin grape and wine industry articles are posted to Facebook and to the WGGA website.

In 2011, I discovered that Wisconsin had 73 bonded wineries. That was 32% more than was originally estimated before I began my work as the WGGA Grape Marketing Coordinator. As of December 2012, there are now 90 bonded wineries in Wisconsin and another 11 currently going through the licensing process. That is 17 new wineries in 2012!

Wisconsin Bonded Wineries (As of September 2012)

AEppleTreow Winery & Distillery	Burlington	WI
All Sisters' Winery, Inc.	Bayfield	WI
Apple Barn Orchard & Winery	Elkhorn	WI
Armstrong Apples	Campbellsport	WI
Autumn Harvest Winery	Chippewa Falls	WI
Autumn Winery	Milltown	WI
Bauer-Kearns Winery	Platteville	WI
Bayfield Winery, LTD.	Bayfield	WI
Bos Meadery LLC	Madison	WI
Botham Vineyards & Winery	Barneveld	WI
Branches Winery LLC	Westby	WI
Brigadoon Winery	Tripoli	WI
Burr Oak Winery	New Lisbon	WI
Cap N Corks	Eau Claire	WI
Captain's Walk Winery	Green Bay	WI
Cedar Creek Winery	Cedarburg	WI
Chateau St. Croix Winery & Vineyard	St. Croix Falls	WI
Chiselled Grape Winery	Grafton	WI
Clover Meadow Winery	Shell Lake	WI
Cold Spring Vineyard	Hubertus	WI
Danzinger Vineyards	Alma	WI
DNA Vintners	La Crosse	WI
Door Peninsula Winery	Sturgeon Bay	WI
Elmaro Vineyard	Trempealeau	WI
Fawn Creek Vineyard & Winery	Wisconsin Dells	WI

Fermenting Cellars	Janesville	WI
Fisher King Winery	Mount Horeb	WI
Forgotten Fire Winery	Marinette	WI
Fresar, Inc.	Rosholt	WI
Grandpa Fro's Invention Farm & Country Winery	White Lake	WI
Harbor Ridge Winery	Egg Harbor	WI
HookStone Winery	Hayward	WI
Infinity Beverages	Eau Claire	WI
Island Orchard Cider	Ellison Bay	WI
Kerrigan Brothers Winery	Freedom	WI
LedgeStone Vineyards	Greenleaf	WI
Lewis Station (The Wine Vineyard LLC)	Lake Mills	WI
Lil' Ole Winemaker Shoppe	Wausau	WI
Lost Island Wine, LLC	Onalaska	WI
Maiden Rock Winery & Cidery	Stockholm	WI
Maiden Wines	Maiden Rock	WI
Mountain Bay Winery	Hatley	WI
Muller Wines	Lake Nebagamon	WI
Munson Bridge Winery	Withee	WI
New Glarus Primrose Winery	New Glarus	WI
Northleaf Winery	Milton	WI
O'Neil Creek Winery	Bloomer	WI
Orchard Country Winery	Fish Creek	WI
Parallel 44 Vineyard & Winery	Kewaunee	WI
Pieper Porch Winery & Vineyard	Waukesha	WI
Pine River Winery	Pine River	WI
Quinney Estate Winery	Chilton	WI
Red Oak Vineyard	Sturgeon Bay	WI
River Bend Vineyard & Winery	Chippewa Falls	WI
S&J Winery LLC	Warrens	WI
Sandstone Ridge Vineyard & Winery	Osseo	WI
Seven Hawks Vineyards	Fountain City	WI
Shepard's Hard Cyder Winery	Viola	WI
Simon Creek Vineyard & Winery	Sturgeon Bay	WI
Sinnipee Valley Vineyard	Kieler	WI
Spurgeon Vineyards & Winery	Highland	WI
Staller Estate Winery	Delavan	WI
Stone's Throw Winery	Baileys Harbor	WI
Studio Winery	Lake Geneva	WI
Tenba Ridge Winery	Blair	WI
The WineSitters	Holmen	WI
Three Lakes Winery	Three Lakes	WI
Trout Springs Winery	Greenleaf	WI
Two Brothers Wines LLC	Pewaukee	WI
Valley Vineyard	Prescott	WI
Van Price Innovations LLC (Lance's Winery)	Antigo	WI

Van Wychen Wines, INC.	Warrens	WI
Vernon Vineyards	Viroqua	WI
Vetro Winery, LLC	Concord	WI
Villa Bellezza Winery & Vineyards	Pepin	WI
Vines & Rushes Winery, LLC	Ripon	WI
Vines to Cellar	Port Washington	WI
Vino in the Valley	Maiden Rock	WI
Von Klaus Winery	Baraboo	WI
von Stiehl Winery	Algoma	WI
Water 2 Wine	Brookfield	WI
Weggy Winery	Muscoda	WI
Whispering Winds Winery LLC	Fennimore	WI
White Winter Winery	Iron River	WI
Wine Tyme Winery	Superior	WI
Wollersheim Winery	Prairie du Sac	WI
Woodland Trail Winery	Lakewood	WI

To date, 18 wineries are accredited through WGGA's Wisconsin Wine Accreditation Program 2012. This program accredits wineries that are producing wines using a minimum of 75% of Wisconsin grown grapes. These 18 wineries account for just 20% of Wisconsin's bonded wineries; however, there are wineries who produce Wisconsin grown grape wines and did not complete the WGGA Wisconsin Wine Accreditation Program 2012 Application. Thirty-seven wineries were accredited in 2011, compared to eighteen in 2012. Three new wineries completed an application and were accredited in 2012, fifteen were accredited in both 2011 and 2012, and twenty-two only in 2011. We estimate that over half of Wisconsin wineries produce at least one Wisconsin wine with 75% or more Wisconsin grown grapes.

WGGA Wisconsin Wine Accreditation Program 2012

2012	2011	Winery Name
2012	2011	AEppleTreow Winery & Distillery
2012	2011	Botham Vineyards & Winery
2012	2011	Captain's Walk Winery
2012	2011	Clover Meadow Winery
2012	2011	Danzinger Vineyards
2012	2011	Door Peninsula Winery
2012	2011	Elmaro Vineyard
2012	2011	LedgeStone Vineyards
2012	2011	Northleaf Winery
2012	2011	Orchard Country Winery
2012	2011	Parallel 44 Vineyard & Winery
2012	2011	River Bend Vineyard & Winery
2012	2011	Valley Vineyard
2012	2011	von Stiehl Winery
2012	2011	Weggy Winery
2012	-	Autumn Harvest Winery
2012	-	Red Oak Vineyard
2012	-	Sandstone Ridge Vineyard & Winery

	2011	Bauer-Kearns Winery
	2011	Brigadoon Winery
	2011	Burr Oak Winery
	2011	Cedar Creek Winery
	2011	Cold Spring Vineyard
	2011	Fermenting Cellars
	2011	Fisher King Winery
	2011	Maiden Rock Winery & Cidery
	2011	Muller Wines (White Winter)
	2011	Sinnipee Valley Vineyard
	2011	Spurgeon Vineyards & Winery
	2011	Staller Estate Winery
	2011	Trout Springs Winery
	2011	Two Brothers Wines LLC
	2011	Van Price Innovations LLC (Lance's Winery)
	2011	Vernon Vineyards
	2011	Vetro Winery, LLC
	2011	Villa Bellezza Vineyard & Winery
	2011	Vino in the Valley
	2011	Whispering Winds Winery LLC
	2011	Wollersheim Winery
	2011	Woodland Trail Winery

Therefore, the need to educate Wisconsin winery owners about grape cultivars grown in Wisconsin and their specific characteristics and traits is ongoing and necessary if we wish to increase the sale of Wisconsin wine grapes. It is also necessary to stress the importance of marketing locally grown and produced wines. Independent winery businesses are driven by their customer's wants and needs. For that reason, it is important to educate the wine-drinking public about Wisconsin grape varieties and the wines made from them. If consumers ask for wines made with Wisconsin grapes, more wineries will make wines with Wisconsin grapes. This will be a focus of WGGA in the future.

III. Goals and Outcomes Achieved

1. **In 2012, we expect to increase the availability of Wisconsin Accredited Wines by increasing the number of outlets by 100 locations where wines are available i.e. restaurants, grocery stores, wine shops and at consumer events.**

The availability of Wisconsin wines, other than at the winery, is limited and even more so for accredited wines. This project will increase by 100 locations where accredited wines are available for consumer purchase. Locations offering accredited wines for the first time will be documented and tracked by the Grape Marketing Coordinator. While placing wines, the Coordinator will note comments, concerns and ideas relative to consumer acceptance of accredited wines.

With only 18 wineries accredited this year, the expected measurable outcome to increase the number of outlets by 100 locations seemed impossible to reach. Between Parallel 44 Vineyard &

Winery and Weggy Winery, there were 200 and 96 retail and restaurant accounts respectively with Wisconsin Accredited wines in them! That is a total of 296 accounts for just two Wisconsin wineries. So it is fair to say that Wisconsin wines became more accepted at local restaurants, grocery stores, wine shops and at consumer events over the course of this project.

Over the course of this project, more consumers were introduced to Wisconsin grown and produced wines and visited local wineries. Wine trails have formed throughout the state (Wisconsin Winery Association lists five wine trails on their website). As more and more wineries open, consumers have the opportunity to visit multiple wineries in one area and make a vacation out of it.

2. **In 2012, we expect to increase consumer awareness of Wisconsin accredited wines by 15%.**

At events supported by this project, consumers will be asked to complete a survey in return for the opportunity to win an accredited wine-related prize. This survey will ask the consumers familiarity with Wisconsin wines in general and specifically accredited wines. 15% of those responding will be introduced to these new products through our efforts.

At each event, the survey will be handed to each individual (21 years and older) who would like to taste Wisconsin Accredited wines. This is their ticket to taste and experience Wisconsin grown and produced wines.

The survey will include questions such as, have you ever tasted a Wisconsin grown and produced wine, how many wineries to you think are in Wisconsin, have you ever visited a winery in Wisconsin and if so how many, have you ever purchased Wisconsin wine at a retail store, are you familiar with Wisconsin grape varieties, etc. Survey data will be compiled throughout the year by the Grape Marketing Coordinator.

While the consumers are tasting, the WGGA Volunteer will educate them on the difference of wines that are grown and produced in Wisconsin versus just produced, number of wineries and growers in the state and the different varieties that are grown in Wisconsin. Each consumer will receive a WGGA brochure with the different grape varieties. In addition, lists of wineries and wines that are accredited by the WGGA will be available for the consumer to take with them.

The WGGA attended the Wisconsin Garden Expo and Wisconsin Restaurant Expo in 2012. At these events the survey was available for consumers to take. At the Wisconsin Garden Expo 52 people participated in the survey, but at the Wisconsin Garden Expo no one participated in the survey. The survey and results are below.

WGGA also produced 3,500 Grape Variety Wheels, which provided descriptions of the cold-climate grapes grown in Wisconsin and what foods pair with these wines. The Grape Wheels were all distributed through accredited wineries.

Example of Consumer Survey

Thank you for participating in the Wisconsin Grape Growers Association Consumer Survey. Below are a few questions about the Wisconsin wine industry.

1. Have you ever tasted a Wisconsin grown and produced grape wine?

2. How many wineries do you think are in Wisconsin?

3. Have you ever visited a winery in Wisconsin? If so, which ones?

4. Have you ever purchased Wisconsin wine at a retail store (ie: Festival Foods, Woodman's)?

5. Are you familiar with Wisconsin grape varieties? Name one.

For your chance to win a Wisconsin Wine Enthusiast membership, please complete the information below.

Date of Birth: _____

Name:_____

City:_____State:_____

Email: _____

Phone:_____

Thank You! Winners will be contacted via email or phone.

WISCONSIN GARDEN EXPO SURVEY RESULTS
2012 SURVEY POPULATION: 52

SURVEY DEMOGRAPHICS:

STATE OF SURVEY PARTICIPANT

IL: 1
WI: 51
Total: 52

CITY OF SURVEY PARTICIPANT	**AGE OF SURVEY PARTICIPANT**
Brodhead: 1	**22**
Columbus: 2	**23**
Cuba City: 2	**27**
De Forest: 1	**28**
Elkhart Lake: 1	**30**
Elmwood: 1	**31**
Elroy: 1	**31**
Fitchburg: 2	**36**
Frederic: 1	**37**
Jefferson: 1	**38**
Lake Geneva: 1	**39**
Luxemburg: 1	**43**
Madison: 9	**44**
Milwaukee: 1	**46**
Nelcoosa: 1	**48**
New Glarus: 1	**48**
New London: 1	**49**
Oconomowoc: 1	**50**
Oconto: 1	**52**
Oregon: 4	**52**
Orfordville: 1	**53**
Oshkosh: 2	**53**
Pecatonica: 1	**53**
Platteville: 2	**53**
Poynette: 1	**55**
Reedsburg: 1	**56**
Rio: 1	**56**
Sturgeon Bay: 1	**57**
Sun Prairie: 3	**57**
Sussex: 1	**57**
Waunakee: 1	**57**
Wausau: 1	**58**
Wild Rose: 2	**58**
Total: 52	**58**

AGE OF SURVEY PARTICIPANT

QUESTION 1: HAVE YOU EVER TASTED A WISCONSIN GROWN AND PRODUCED GRAPE WINE?

No: 5
Yes: 47
Total: 52

QUESTION 2: HOW MANY WINERIES DO YOU THINK ARE IN WISCONSIN?

Range 2-242
4 wineries: 1
8 wineries: 1
10 wineries: 2
12 wineries: 3
15 wineries: 4
20 wineries: 5
22 wineries: 1
24 wineries: 1
25 wineries: 1
30 wineries: 1
32 wineries: 1
36 wineries: 1
40 wineries: 1
45 wineries: 1
50 wineries: 4
52 wineries: 1
60 wineries: 3
64 wineries: 1
78 wineries: 1
80 wineries: 1
90 wineries: 1
100 wineries: 3
108 wineries: 1
120 wineries: 1
125 wineries: 2
130 wineries: 1
134 wineries: 1
162 wineries: 1
200 wineries: 1
242 wineries: 1
A lot!: 2
Did not answer: 2
Total: 52

QUESTION 3: HAVE YOU EVER VISITED A WINERY IN WISCONSIN? IF SO, WHICH ONES?

Did not answer: 1
No: 6
Yes: 45
Total: 52

Botham Vineyards: 5
Cedar Creek Winery: 2
Door County Wineries: 2
Door Peninsula Winery: 6
Eagle: 1
Fisher King Winery: 1
Kerrigan Brothers Winery: 1
Lewis Station Winery: 1
N/A: 6
New Glarus Primrose Winery: 1
North Leaf Winery: 1
Parallel 44 Vineyard & Winery: 3
Simon Creek Winery: 1
Sinnipee Valley Vineyard: 1
Spurgeon Vineyards: 1
Stone's Throw Winery: 2
Tenba Ridge Winery: 1
Three Lakes Winery: 1
Vernon Vineyards: 1
Vetro Winery: 1
von Stiehl Winery: 4
Weggy Winery: 1
Wollersheim Winery: 26
Total Wineries Listed: 70

QUESTION 4: HAVE YOU EVER PURCHASED WISCONSIN WINE AT A RETAIL STORE (IE: FESTIVAL FOODS, WOODMAN'S)?

Did not answer: 2
No: 7
Yes: 43
Total: 52

Discount Liquor: 1
Willy St. Coop: 1
HyVee: 1
Sindik's: 1
Steve's Liquor: 1
Woodmans: 3
Pick & Save: 1
Festival Foods:1

QUESTION 5: ARE YOU FAMILIAR WITH WISCONSIN GRAPE VARIETIES? NAME ONE.

Did not answer: 6
No: 20
Yes: 26
Total: 52

Beta: 1
Black cap: 1
Concord: 5
Did not answer: 7
Edelweiss: 3
Foch: 4
Frontenac: 3
Frontenac gris: 1
Interlaken: 1
Marquette: 3
Millot: 1
N/A: 28
Native wild grape: 1
St. Croix: 2
St. Pepin: 2
Swenson Red: 1
Total: 64

B. ***Please see above.***

IV. Beneficiaries

All Wisconsin grape growers have the potential to benefit from this project. WGGA represents over 150 grape grower members and there are an additional 150+ grape growers that have been identified as having vines in the state. These growers will all benefit from the sales potential of their grape crop created by this project.

All 90 of Wisconsin's bonded wineries will have the potential of benefiting from this project. Those wineries having accredited wines will benefit the most as this project will specifically promote those wines for sale, but all wineries will benefit from the increased awareness of Wisconsin's wine industry and the opportunity to tour the various wineries and purchase their products.

Grape and wine industry partners also benefit from this project. For example, Midwest Wine Press has worked hand in hand with me from the beginning. I have helped them develop partnerships between vineyards, wineries and winemakers to add value to others in the industry.

Wisconsin Winery Association has benefited from this project as well. I have monitored growth of Wisconsin wineries over the past two years and reached out to new wineries to give them

information on both groups. Membership levels have increased with both organizations and there is a better awareness of what each organization offers.

V. Lessons Learned

The Wisconsin grape and wine industry has grown tremendously over the past two years. There are now 90 bonded wineries in the state as of December 2012. Wisconsin should hit 100 wineries in 2013! That puts us as one of the leaders for number of wineries in the Midwest. Some of the lessons I have learned is that even though I was working for the Wisconsin Grape Growers Association, I also worked with a lot of Wisconsin wineries since most of them either own a vineyard or purchase grapes from the grape growers in the state. It was challenging to work with the Wisconsin Winery Association. There was little communication between the two associations and both have separate goals and objectives. Hopefully in the future, the two associations can have a better partnership and work towards certain goals together as both are trying to promote and market the Wisconsin wine industry.

VI. Additional Information

The WGGA Facebook page has 174 likes. It keeps growing each day.
https://www.facebook.com/wigrapes

The WGGA Twitter page **@wigrapes** has 55 followers and is now linked up with Facebook updates.

WGGA website: **www.wigrapes.org**.

VII. Contact Info

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11) GAP/GHP Cost Share Program (FY11-011)

Report Date: March 25, 2013

I. Project Summary

A. The purpose of this project was to provide food safety assistance to Wisconsin-based specialty crop producers and processors, and to promote the Good Agricultural Practices / Good Handling Practices ("GAP/GHP") certification program. The DATCP Bureau of Business Trade Practices – Fruit & Vegetable Inspection Unit is authorized by USDA to certify farms and facilities under the GAP/GHP program. A key part of the certification process is an on-site audit. This grant provided funds to make these audits (and therefore, certification) financially accessible to more producers and processors, thereby creating new market opportunities for Wisconsin producers. Many large chain stores require food safety certification at the farm level. The GAP/GHP requirements are governed by USDA. USDA establishes the standards and trains the state inspectors who are certified to conduct the audits. USDA also mandates that the price of the audit is $92.00 per hour plus and overhead fee of $50.00. Under this grant agreement, the Fruit & Vegetable Inspection Unit's audit clients paid $23.00 per hour (25%) and the grant covered the remaining $69.00 per hour (75%).

In addition, this grant helped defray the cost of having Fruit & Vegetable Inspection unit auditors provide free workshops and training seminars for growers. These seminars were typically organized by trade organizations for their members or by processing facilities for their suppliers. They provided an opportunity for growers to learn about the GAP/GHP requirements before submitting to the audit and, therefore, more efficiently obtain certification.

Finally, this grant facilitated the Fruit & Vegetable Inspection Unit auditors maintaining their credentials to do this work. USDA requires each auditor to attend an eight hour, on-line class to review standards. This grant covered 75% of the salary & fringe expenses for the time that the three auditors spent in their continuing education training.

B. The Fruit and Vegetable Inspection Unit received a similar Specialty Crop Grant in 2010. This work builds off that project by increasing the outreach efforts to producers with new organizational contacts and new workshop partners to increase the number of cost shared GAP/GHP certifications.

II. Project Approach

The Fruit & Vegetable Inspection Unit conducted 75 GAP/GHP audits. Many of these audits would not have been possible without this grant. Most of the businesses audited were growers but there were also some packing & distribution facilities. The growers were from all over Wisconsin and the products included: acorn squash, apples, butternut squash, cabbage, cucumbers, eggplant, mustard greens, onions, peppers, potatoes, pumpkins, sweet corn, tomatoes, and zucchini.

This grant also provided support to The Fruit & Vegetable Inspection Unit by sharing in the unit's costs for which it does not bill customers. Over the grant period, the unit's auditors conducted 10 workshops or seminars to talk about GAP/GHP standards and the certification process. These workshops were typically arranged by grower trade organizations or businesses 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. 143 people attended the workshops in the following areas: Antigo (5 workshops, 25 people), Green Bay (1 workshop, 3 people), Wisconsin Dells (1 workshop, 15 people), Dalton (1 workshop, 70 people), La Farge (1 workshop, 25 people), and Jackson (1 workshop, 5 people).

This grant also covered part of the cost of having three Fruit & Vegetable Inspection Unit auditors maintain their credentials with USDA. Fruit & Vegetable Inspection Unit auditors dedicated eight hours each to USDA on-line training. This grant covered 75% of the employees' pay while they fulfilled this requirement.

III. Goals and Outcomes Achieved

A. The Fruit & Vegetable Inspection Unit performed 75 GAP/GHP Audits during this grant period. This is comparable to the 76 audits performed during FY 10 grant period. Previously, during the FY09 grant period, the Fruit & Vegetable Inspection Unit performed 55 of these audits. The Fruit & Vegetable Inspection Unit presented training seminars or workshops seven times this year. This is a decrease from the seventeen that were presented in the FY10 grant period and similar to the four that were presented during the FY09 grant period.

B. The goal of this project was to increase the number of growers who obtain USDA's GAP/GHP certification. We had established measurable outcomes of increasing the number of growers & packing houses that are GAP/GHP certified and increasing the number of free presentations and workshops by 20% each over the average of the previous three years.

Previous to this grant period, the three-year average for number of GAP/GHP certification audits was 56 per year. Therefore, the goal for this grant period was 68 audits (56 X 20% increase). The actual number conducted was 75.

Previous to this grant period, the three-year average for number of seminars and workshops was 12 per year. Therefore, the goal for this grant period was 15 seminars and workshops (12 X 20% increase). However, the actual number conducted was seven. More requests were made for individual or small group consultations rather than large seminars and workshops during this grant period.

IV. Beneficiaries

The purpose of this project was to make third-party food safety audits (GAP/GHP) available to small and medium-size Wisconsin growers, many of whom would not otherwise have the resources to pay for the audits. Specialty crop buyers are increasingly requiring growers and packing facilities to obtain third-party audits. Growers who are unable to comply may lose market share and find themselves at a competitive disadvantage.

V. Lessons Learned

The grant awarded was for $30,000. However, the total claimable expenses was only $25,681.72. There was less demand for workshops and seminars than we anticipated; therefore, our costs were lower than expected.

VI. Additional Information

Not applicable

VII. Contact Info

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12) Development of new commercial strawberry, plum/apricot and aronia cultivars (11-012)

Report Date: October 24, 2014

I. Project Summary

A. In the past ten years, there has been a resurgence of interest in diversified fresh market fruit production driven by the demand for more locally produced foods and consumer recognition that locally grown fruits are fresher, taste better, have more accountability for food safety and are more environmentally sustainable. Diversity also reduces weather- related risk for growers, expands direct marketing opportunities and provides consumers with access to fresh, locally-grown fruit over a longer period of time. Specialty crops such as strawberries and fresh dessert plums/apricots introduced into an area provide a particularly promising market niche that can be used to great advantage for increased farm profitability. The demand for more diverse and locally-adapted fruit crops cannot be sustained without the continued introduction of new cultivars that meet changing consumer demands and environmental conditions. The urgency that supported this proposal was highlighted by fact that many other breeding programs for fruit crops have been eliminated across the country, just when they are needed most.

Cultivars of new value-added fruit crops will contribute to greater social, economic, and environmental sustainability in Wisconsin. This proposal included initiation of the **first domestic** Aronia-breeding program dedicated to improved cultivars for commercial fruit production. Aronia, also known as chokeberry, is a highly adapted native shrub that was taken to Europe and Asia about 100 years ago. Its fruit, which resembles that of blueberries and juneberries, has multiple health attributes. Modern analytical tests have shown Aronia to be a “super fruit” with exceptionally high levels of phyto-nutrients. It tops the chart for antioxidant content with Oxygen Radical Absorbance Capacity (ORAC) nearly three times that of blueberries and Anthocynanid content (which gives cranberries their reputation for urinary tract health) levels 5-10 times higher than cranberries. Aronia also contains other nutraceuticals associated with cardiac health, anti-cancer activity, and the suppression of chronic diseases and effects of aging. In addition to health benefits, flavorful Aronia products include wine and pastries to juice blends and ice cream.

There is need for an Aronia-breeding program in this country to introduce new genetics for cultivar diversity in selections suitable for both fresh commercial fruit production and value-added, processed products. Cultivars have been selected primarily for their ornamental characteristics in this country and those selected for fruit production in Europe represent a very limited gene pool. Variability existing in native wild Aronia populations would allow for significant improvement via controlled hybridization to improve yield, nutraceutical levels, fruit chemistry, climatic adaptation and plant architecture. Diversity will be critical to the continued development of a rapidly expanding Aronia grower/processing network in the Midwest. Infrastructure for handling, processing, marketing and distribution of Aronia has much in common with cranberries, which makes it well-suited to become a major value-added crop in Wisconsin.

Social and environmental necessity will make perennial fruit crops a key component of a sustainable future. Perennial fruit crops have far more economic growth potential than any other segment of the agricultural economy in Wisconsin. They contribute to environmental sustainability in contrast to annual cropping systems. They reduce soil erosion, contribute to diverse and stable microbial soil communities, require little fertility from fossil fuel sources, and reduce food miles when incorporated into a regional food supply system. They also contribute to the health and well-being of society by providing a balance between caloric intake and nutraceutical components for health and longevity. However, none of this can be sustained without an innovative fruit-breeding program.

Therefore, funding for this project was used to accelerate commercial fruit cultivar development and initiate an Aronia-breeding program. Growers need a dedicated plant breeding program that incorporates more genetic variability, thereby enhancing consumer appeal and grower sustainability.

B. This project does not build on a previously funded Specialty Crop Block Grant.

II. Project Approach

We used our established work plan timetable, using a check-off list to ensure all activities were completed. See the plan of work time tables below for activities accomplished. All research was conducted at the UWRF Fruit Research Facility (28 acres, irrigated, w/ deer fence).

"Objectives" in Table I and Table II below will be referred to as numbers (1-3) from the objectives listed in the Outcomes Section. (1= initiate Aronia breeding program, collect germplasm, establish hybridization protocols. 2=release one strawberry cultivar and continue development and release of more strawberry cultivars; 3=release 2nd plum-apricot hybrid cultivar and continue development and release of more plum/apricot cultivars)

Table I
Work Plan Activities/Responsibilities 2011/2012

Task	Activities Necessary	Personnel/ Duties	Timeline
2, 3	Prepare morphological and horticultural descriptions of one strawberry selection + plumcot; summarize all data pertaining	P1 & P3	Dec. 2011-March 2012
2, 3	Submit patent applications	P1	March 2012
2, 3	Contact strawberry and tree fruit nurseries to license for propagation and sale of plants to commercial growers	P1	Dec. 2011-Jan. 2012
2, 3	Germinate and grow 20 strawberry and 30 apricot/plum seed progenies, to yield of 1,500 and 500 seedlings, respectively;	P1, P1W, P3	Jan.-May 2012
2,3	Conduct greenhouse hybridization on forced potted stock (target of 30 hybrid crosses each and 6,500 and 400 seed, respectively, strawberries, plums/apricots	P1, P1W, P3	Feb. 2012-May 2012
2, 3	Establish seedling field planting of 1,500 and 300 of strawberries, plums/apricots, respectively; grow through summer and fall, herbicide applications, irrigation	P1, P3	June 2012-Nov.2012
2,3	Evaluate field-planted 2011 seedlings and selections from past years. Advance sels. through eval. levels	P1, P3	June-Sept. 2012
2	Evaluate elite selections already established in replicated trials at other universities	P5, P6	June-July 2012
1, 2, 3	Maintain parental potted plum/apricot, Aronia plants in outdoor nursery; overwinter in walk-in cooler	P1W, P1, P3	May 2012-Oct. 2012
2, 3	Evaluate elite selections under commercial field conditions	P7, P8	Jun-Sep '12
2	Propagate all important selections in tissue culture	P2, P1W	On-going, Dec.'11-'12
2, 3	Propagate new selections by runner plants/budding in greenhouse	P3	Jun-Dec'12
1 ,2, 3	Collect, statistically analyze, summarize data from evaluation trials; prepare progress report	P1, P3	November-Dec. 2012
1, 2, 3	Disseminate information to growers and public	P1	Dec. 11/'12 Jan. 12/'13.
3	Send budwood to International Plant Management for distribution to commercial grower/testers + budwood to Willow Drive Nursery for selection tree number ramp-up	P3	Aug. 2012
1	Acquire 2 gal. plants (20 each) of 'Viking' and 'Nero' and any other cultivars available as larger potted stock, and/or dig larger dormant plants in field for pot establishment	P1, P8	Spring 2011
1	Contact University of Connecticut, USDA-ARS North Central Regional Plant Introduction Station, USDA/OSU-Dr.Bernadine Strik and Dr. Chad Finn; Stephen McKay, Cornell Extension	P3, P1	Dec. 2011-Feb. 2012
1	Establish Aronia collection germplasm base for breeding program. Goal of 30 accessions from USDA/other universities	P1, P3, P8	Dec. 2011-Dec. 2012
1	Determine interested growers/collaborators(goal of 10). Collect wild germplasm-fruit, softwood cuttings. Goal: Collect fruit from 100 wild *Aronia melanocarpa* genotypes and 5 cuttings each of 20 wild superior selections	P8, P3, P1	Summer 2012
1	Extract seed/stratify; grow plants from cuttings sourced from wild plants and repositories	P3	Summer-fall 2012
1	Establish hybridization protocols; scheduling of parental plant forcing/dormancy, using stock acquired in Spring 2011	P1, P3	Jan. – May 2012

Table II
Revised Work Plan Activities/Responsibilities for 2013-2014

Task	Activities Necessary	Personnel/ Duties	Timeline
2, 3	Prepare morphological and horticultural descriptions of plumcot summarize all data pertaining	P1 & P3	Dec. 2013-July 2014
2, 3	Submit patent applications	P1	March 2014
2, 3	Contact tree fruit nurseries to license for propagation and sale of plants to commercial growers	P1	Dec. 2013-Jan. 2014
2, 3	Germinate and grow 20 strawberry and 15 apricot/plum seed progenies, to yield of 1,500 and 200 seedlings, respectively;	P1, P1W, P3	Jan.-May 2014
2,3	Conduct greenhouse hybridization on forced potted stock (target of 20 hybrid crosses each and 5,000 and 300 seed, respectively, strawberries, plums/apricots	P1, P1W, P3	Feb. 2013-May 2013
2, 3	Establish seedling field planting of 1,500 and 300 of strawberries, plums/apricots, respectively; grow through summer and fall, herbicide applications, irrigation	P1, P3	June 2014-July.2014
2,3	Evaluate field-planted 2013 seedlings and selections from past years. Advance sels. through eval. levels	P1, P3	June-July 2014
2	Evaluate elite selections already established in replicated trials at other universities	P5, P6	June-July 2014
1, 2, 3	Maintain parental potted plum/apricot, Aronia plants in outdoor nursery; overwinter in walk-in cooler	P1W, P1, P3	May 2014-July 2014
2, 3	Evaluate elite selections under commercial field conditions	P7, P8	Jun-July '14
2	Propagate all important selections in tissue culture	P2, P1W	On-going, Dec.'13-'14
2, 3	Propagate new selections by runner plants/budding in greenhouse	P3	Jun-July'14
1 ,2, 3	Collect, statistically analyze, summarize data from evaluation trials; prepare progress report	P1, P3	September 2014
1, 2, 3	Disseminate information to growers and public	P1	Dec.'13-July '14
3	Send budwood to International Plant Management for distribution to commercial grower/testers + budwood to Willow Drive Nursery for selection tree number ramp-up	P3	N/A
1	Acquire 2 gal. plants (20 each) of 'Viking' and 'Nero' and any other cultivars available as larger potted stock, and/or dig larger dormant plants in field for pot establishment	P1, P8	N/A
1	Contact University of Connecticut, USDA-ARS North Central Regional Plant Introduction Station, USDA/OSU-Dr.Bernadine Strik and Dr. Chad Finn; Stephen McKay, Cornell Extension	P3, P1	N/A
1	Continue establishing Aronia collection germplasm base for breeding program. Goal of 30 accessions from USDA/other universities	P1, P3, P8	Dec. 2013-July 2014
1	Determine interested growers/collaborators (goal of 10). Collect wild germplasm-fruit, softwood cuttings. Goal: Collect fruit from 100 wild *Aronia melanocarpa* genotypes and 5 cuttings each of 20 wild superior selections	P8, P3, P1	N/A
1	Extract seed/stratify; grow plants from cuttings sourced from wild plants and repositories	P3	N/A
1	Establish hybridization protocols; scheduling of parental plant forcing/dormancy, using stock acquired in Spring 2011	P1, P3	N/A

III. Goals and Outcomes Achieved

A. This grant terminated 7/31/14. Any work discussed for future/beyond the termination date is funded by other sources which this grant helped us leverage. Also any work discussed about crops not originally in the proposal were also funded through another source but are listed in this report as they fit the project and we felt it beneficial to mention them.

Goal 1: Initiate a new Aronia breeding program; collect and evaluate germplasm, establish compatible hybridization protocols-

Performance Measures: Collection of distinct number of germplasm accessions, development of an evaluation critieria sheet, evaluation of germplasm under field conditions, compatible hybridization protocols written.

Benchmark: New project, using existing breeding program infrastructure.

Easily Measurable Targets:

1. Acquire 2 gal. plants (20 each) of 'Viking' and 'Nero' and any other cultivars available as larger potted stock, and/or dig larger dormant plants in field for pot establishment. 2. Establish Aronia collection germplasm base for breeding program. Goal of 30 accessions from USDA/other universities. 3.Determine interested growers/collaborators (goal of 10).
4. Collect wild germplasm-fruit, softwood cuttings. Collect fruit from 100 wild Aronia genotypes and 5 cuttings each of 20 wild superior selections.

Goals 2 & 3: Release the first new strawberry and plumcot cultivar within the next year; continue to develop and release a series of new strawberry and plum/apricot cultivars-

Performance Measures: Application for patents-submitting a complete description and justification of each strawberry and plum/apricot invention to the U.S. Plant Patents Office. 2. Submit tissue culture samples of new selections to Agdia for virus screening. 3. Locating and licensing at least one major nursery to propagate and offer plants for sale to Wisconsin commercial growers. 4. Obtain additional data from network of universities and growers regarding performance of our strawberry selections in different environments 5. Conduct hybridization and seedling growing procedures to keep new selections moving through the process of evaluation and release –number of crosses and number of seedlings.

Benchmark: Strawberry and plum/apricot breeding programs have been on-going for 21 and 19 years, respectively. We have tested many selections from our breeding program and many cultivars from other parts of the world for adaptation to Wisconsin. Now we are poised to release our own adapted cultivar for each crop type for Wisconsin commercial growers.

Easily Measurable Targets

1. The official release of a new strawberry and plumcot cultivar will allow Wisconsin growers to remain competitive and improve profitability;
2. Germinate and grow 20 strawberry and 30 apricot/plum seed progenies, to yield of 1,500 and 500 seedlings, respectively;
3. Conduct greenhouse hybridization on forced potted stock (target of 30 hybrid crosses each and 6,500 and 400 seed, respectively, strawberries, plums/apricots
4. Establish seedling field planting of 1,500 and 300 of strawberries, plums/apricots, respectively; grow through summer and fall, herbicide applications, irrigation

Aronia Progress and Achievements-

We acquired 22 different genotypes (goal 30) which included black, purple and red Aronia from 7 sources. We have partnered with several nurseries, including Reeseville, McKay and Raintree. These nurseries have collected fruit and plants out in the wild and are more than willing to share germplasm. We believe that partnering with these nurseries is much more cost-effective than conducting our own collection expeditions considering time involved and no travel budget. Although we did collect some wild fruit this fall and also received some from other sources, we will be making much faster progress with the nurseries as they have agreed to send us 100's of seedlings already-grown field-transplant size next spring for a minimal charge. We received nice potted plants of 'Viking','Nero' and several other cultivars and clones from Carandale Farms, Larry Turner, a grower in Iowa and from several nurseries. With these larger potted plants, we were able to conduct hybridization protocol experiments in April 2012 and feel that we have developed techniques that are compatible with our labor availability, equipment and facilities,

All potted plants used in hybridization set fruit from controlled. We were able to achieve 20 different cross combinations. This means that we are making faster progress in breeding than was proposed in the original grant application. In spring 2013 we were able to refine protocols for germination of seed from our 2012 hybridizations. We tested germination under fluorescent lights (as per strawberry germination/early growth) and also germination in cell packs in the greenhouse in late spring. We concluded although greenhouse germination was easier and within mortality and growth parameters, that germination and early growth under fluorescent lights in an isolated environment to be superior. The greatest effects on mortality for greenhouse production was the endemic pest levels of shore flies, fungus gnats and aphids. Both sets of seedlings needed to be acclimated to outdoor conditions before they could be field-established. We successfully started 354 total seedlings in plug trays from both methods. These seedlings represent thirteen parental cross combinations. In July, we transplanted these plug-grown seedlings into field plots at a 2 X 12' spacing. These are now successfully established and are growing rapidly with supplemental irrigation. Concurrently, we received 100 dormant, bareroot seedlings from a commercial nursery in southern Wisconsin and are growing these alongside the above seedlings in the field for future comparative purposes. We also added to our replicated performance trial that was established last fall. Five more genotypes were added under replication, including a newer Polish cultivar. We will be evaluating these genotypes over the years for fruit size and quality, plant habit and vigor, yield potential, pest tolerance and suitability for commercial production in the Midwest. As of 2014, seedling Aronia are estimated to be within one year of fruiting at this point and approximately 50% of replicated trial fruited for the first time in summer 2014. Fruiting data on this trial was not taken due to variability in initial genotype size differences. We estimate there will be very few differences amongst cultivars due to this variable within the next year, thereby producing minimal influence on 2016 harvest data.

Although overall, we were not able to achieve our original goal of acquiring 30 Aronia accessions, we feel very successful in that we started a new breeding program, a new replicated performance trial and have potential new cultivars growing in the field. Our outreach efforts were very effective in developing new grower interest in Aronia production and assisting existing growers with developing more effective cultural marketing strategies. A summary of outreach activities is as follows:

1. **"Planning an Aronia Business"-** Midwest Aronia Association Annual Convention, Des Moines, IA. March 30, 2012.
2. **"Fruit Breeding Program at University of Wisconsin-River Falls" -** MN State Horticulture Society Presentation, St. Paul, MN. April 5, 2012.
3. **"Basics of Planning and Diversification in Fruit Crops " –** Local grower meeting Roberts, WI. February 14, 2013.
4. **"Aronia Production Considerations" –** Keynote Opening Presentation for Annual Midwest Aronia Growers Association Convention. Des Moines, IA. April 4, 2013.
5. **"Aronia: A Potential New Crop for Commercial Small Fruit Growers" -** Annual Statewide Wisconsin Fresh Fruit and Vegetable Growers Association (WFFVGA) Conference. Wisconsin Dells, WI. January 21, 2014.
6. **"Starting a Viable Commercial Aronia Enterprise" –** Regional Field Day, Fairbank, IA. September 6, 2014.
7. Smith, B.R. 2013. *Aronia: The Stress-free Crop? Or is it?*- Midwest Aronia Association Newsletter 1(4):7-8.
8. Smith, B.R. 2013. *Aronia pollination, fruit set and fruit abortion* – Midwest Aronia Association Newsletter 2(2):8

Strawberry Progress and Achievements

We were able to collect and analyze 2011 data from our replicated strawberry performance trial in order to evaluate our premier advanced strawberry selections even more fully to prove their importance for commercial release. This data is available upon request. We also received data from commercial growers (observational) and controlled replicated trial data on our selections from University of Minnesota and Iowa State University. We are not as far as we would have liked regarding our release of the strawberry cultivar because of a total failure of our older replicated yield trials due to massive frost and were therefore unable to use fruit samples to complete our descriptors to be submitted with our plant patent application.

We were initially unsuccessful in our efforts to fully establish a new performance trial (65 total genotypes replicated four times, with 20 of our breeding selections included) in summer 2012 due to the high heat levels, but by summer/fall 2013, we determined that the planting was sufficiently established to be able to harvest and take a full range of data for summer. We harvested all the way into mid-July and will be analyzing the data in late 2014 (grant ended 7/31/14) and reporting on the results to commercial strawberry growers at both the annual Wisconsin Fresh Fruit and Vegetable Growers Conference in January 2015 and as an invited speaker at the 2015 North American Strawberry Growers Association Annual Conference/8th North American Strawberry Symposium in Ventura, CA, February 3-6. Data collected include winter hardiness, vigor, leaf spot, leaf scorch Phomopsis leaf blight (all numerical ratings); fruit firmness, size, flavor, shape and color and harvest season and total yield. This data will help commercial growers immensely in choosing adapted cultivars to plant by saving money not wasted on time and space devoted to inferior cultivars. Improving profitability with superior fruit and yields from identified adapted cultivars is a primary goal and secondarily, helps us identify which of the UW-River Falls selections are superior and sufficiently competitive to justify release and patenting. By the end of our project, we have successfully identified a total of 90 superior genotypes out of the seedling strawberry fields over the 2013 and 2014 seasons. These were dug and replanted into selection evaluation blocks and we continue to evaluate and identify

potential cultivar candidates. The 2013 elite selections (top 10/37) are identified as follows: 13-73-4, 13-75-6, 13-77-2, 13-85-27, 13-86-12, 13-88-1, 13-92-15, 13-92-92, 13-92-94, and 13-107-127. We plan to dig multiple bare-root plants of these superior selections this fall in anticipation of fast-tracking them into a new replicated performance trial for spring 2015. We identified, dug, and established 53 selections this past summer 2014 originating from the 2013-planted seedlings. The 2012-2014 hybridization years yielded 328 total hybridization combinations and approximately 22,700 seed. Which totals significantly more than the 3- year stated goal total of 80 cross combinations and 18,000 seed. Over the three year span, we planted 11,497 seedlings as compared to the stated goal of 4,500 seedlings.

In fall 2013, we dug bare-root plants of the elite clones of 10-71-73(180 plants), 10-72-42(54 plants), 11-25-12(40 plants), 11-60-118(50 plants), 11-68-158(34 plants) and 11-70-115(53 plants) in anticipation of establishing a small replicated performance trial in spring 2014. These were dug so that we would have vigorous, healthy plants for spring. They were placed in the potted fruit tree cooler on campus for overwintering. Unfortunately, this cooler failed in mid-winter. Facilities Management personnel had not properly hooked up the alarm system, so we were unaware until about 2 weeks after the failure. All plants were dead after being in plastic bags exposed to room temperature for that length of time. We are set back two years because of this for these clones as we had dug just about every plant we could find out in the field that fall. On some clones, we only had 2-3 potted plants left to use to start regenerating enough plants for trials. Between cooler failures, lack of guidance/support for patenting and weather, we did not meet our goals but felt under the circumstances that we made good progress. Our outreach efforts were very successful and are summarized as follows:

1. **”Beginning Commercial Strawberry Growing” -** Annual Statewide Wisconsin Fresh Fruit and Vegetable Growers Association (WFFVGA) Conference. Wisconsin Dells, WI. January 15, 2012.
2. **“What’s Your Berry IQ?” -** Annual Statewide Wisconsin Fresh Fruit and Vegetable Growers Association (WFFVGA) Conference. Wisconsin Dells, WI. January 16, 2012.
3. **“Small Fruit Research Update: UW-River Falls ” -** Annual Statewide Wisconsin Fresh Fruit and Vegetable Growers Association (WFFVGA) Conference. Wisconsin Dells, WI. January 17, 2012.
4. **“Berry Delightful Possibilities” –** Community Fruit Growers Presentation, Ladysmith, WI. April 3, 2012.
5. **“Fruit Breeding Program at University of Wisconsin-River Falls” -** MN State Horticulture Society Presentation, St. Paul, MN. April 5, 2012.
6. **“Berry Culture and Cultivars” –** Area Gardener’s Spring Expo, WITC, Rice Lake, WI. April 14, 2012.
7. **“Fruit Cultivar Development at UW-River Falls:Challenges and Rewards” – C**ommunity Fruit Grower’s Forum, Redwing, MN. August 15, 2011.
8. **“Home Vegetable and Fruit Production” –** Annual Twilight Tour, Spooner Research Station/Demonstration Garden, Spooner, WI. August 23, 2011
9. **“Intelligent Integration and Culture of Small Fruits” –** Amery Area Growers. Amery, WI. October 6, 2011.
10. **”Small Fruit Research Results for University of Wisconsin-River Falls** – USDA NCCC-212 Meeting. Fayetteville, AR. October 26,2011.
11. **“Fruit Production Techniques for the Beginning Grower” –** Master Gardener

Training Session.Chippewa Falls, WI. November 29, 2011.

Extension and Research Publications

1. Bordelon, B., M. Ellis, and C. Welty, eds. (multiple contributors, including B. Smith). 2012. *Midwest small fruit & grape spray guide 2012*.
2. Smith, B. 2012. *The importance of strawberry performance trials.* Fresh(publication representing the Wisconsin Produce Industry). 2(1):16-17.
2. Smith, B.R. 2012. *Recommended and trial strawberry cultivars for Wisconsin* – 2012. 4p.
3. Smith, B.R. 2012. *UW-River Falls small fruit research report* - 2012. 14p.
4. Smith, B.R., 2012. *Winter Injury in Strawberry: Causes, Diagnosis, Early Winter Prevention..* Fresh 2(4):16-20.

Attendance At Professional Meetings

1. Wisconsin Fresh Fruit and Vegetable Growers Conference, Jan 2-4, 2012.
2. Midwest Aronia Research and Growers Convention, Des Moines, IA, Mar. 31-April 1, 2012.
3. Great Lakes Fruit Research and Grower Meetings, Grand Rapids, MI, Dec 8-10, 2012.

2013 Outreach/Presentations:

Multi-state strawberry germplasm testing. UW-River Falls evaluates University of Minnesota elite strawberry selections for performance in Wisconsin replicated trials; University of Minnesota researcher, Dr. Jim Luby, tests UW-River Falls elite strawberry selections in replicated performance trials at Grand Rapids, Excelsior and Morris, MN. Iowa State University researcher, Dr. Gail Nonnecke, tests UW-River Falls elite selections in replicated performance trials at Ames, IA.

1.“Extension Outreach and Research Activities at UW-River Falls” – District Meeting of Ag/Hort Agents. UW-River Falls Campus. December 19, 2012.

2. ”Strawberry Research Across North America” - Annual Statewide Wisconsin Fresh Fruit and Vegetable Growers Association (WFFVGA) Conference. Wisconsin Dells, WI. January 14, 2013.

3. “Small Fruit Research Results” - Annual Statewide Wisconsin Fresh Fruit and Vegetable Growers Association (WFFVGA) Conference. Wisconsin Dells, WI. January 15, 2013.

4. “Basics of Planning and Diversification in Fruit Crops ” – Local grower meeting . Roberts, WI. February 14, 2013.

6. “It’s the Berries” – Living Well Workshop, Alma, WI. March 9, 2013.

8. “Contemplating Commercial Strawberry Production?” – Evening Mini-Clinic, Chippewa Falls, WI. March 28, 2013.

10. “Fruit Production Stats and Topics of Importance for Ag and Hort Agents” – Call-in Guest Speaker on WHU(Wisconsin Hort Update)**.** August 16, 2013.

11. ”Marketing an Promotional Efforts on a Small Fruit Farm” – Guest Panelist Presentation, 3rd Annual North Central Wisconsin Small Farm Conference. Athens, WI. October 19, 2013.

12. “Considerations on Starting a Small Fruit Enterprise” –3rd Annual North Central Wisconsin Small Farm Conference. Athens, WI. October 19, 2013.

13. **"Strawberry Production Tips for Commercial Growers"** –3rd Annual North Central Wisconsin Small Farm Conference. Athens, WI. October 19, 2013.
14. **" Fruit Growing Concepts for Advanced Home Gardeners"** – Master Gardener Presentation, Chippewa Falls, WI. November 5, 2013.

Publications

Extension and Research Publications

1. Bordelon, B., M. Ellis, and C. Welty, eds. (multiple contributors, including B. Smith). 2013. *Midwest small fruit & grape spray guide 2013*.
2. Smith, B.R. 2013. *UW-River Falls small fruit research report - 2013*. 11p.
3. Smith, B.R. 2013. *Recommended and trial strawberry cultivars for Wisconsin* – 2013. 4p.
4. Smith, B. R. 2013. *The development of new winter-hardy commercial strawberry cultivars and hybridization germplasm for eastern North America.*
5. Smith, B. R. 2013. *Strawberry Breeding Program and Variety Trials in Wisconsin*- Great Lakes Expo, Grand Rapids, MI Proceedings. 9p.
6. Smith, B.R., 2013. *Development of new commercial strawberry,plum/apricot and aronia cultivars*.6p. (Grant Contract Number 11-012 Annual Progress Report-USDA Specialty Crop Block Grant)

Attendance At Professional Meetings

1. Wisconsin Fresh Fruit and Vegetable Growers Conference, Jan 13-15, 2013.
2. ANRE Conference Fruit Team Meeting. Chula Vista Resort, Wisconsin Dells, WI. October 11, 2013.

Special Activities for 2013:

1. **Consultant -** Eco-Village Fruit Project headed by Peter Morsch in City of River Falls, WI.
2. **Developed** Fruit and Vegetable judging classes for MACHS(Mid-America ColHorticulture Society) Annual Convention Hosted by UW-River Falls.

2014 Presentations/Outreach:

1. **"Where Will New Strawberry and Raspberry Cultivars Come From?"-** Upper Midwest Regional Fruit and Vegetable Growers Conference. St. Cloud, MN. January 17, 2014.
2. **"Commercial Fruit Production and Business Set-Up: Strawberries and Raspberries" –** 4th Annual Farming For Profit Workshop Series-Commercial Fruit Production. Spooner, WI February 17, 2014.
3. "**Integrating Edible Landscapes in to Your Home Yard or Commercial Enterprise" –** Area Winter Conference, Green Bay, WI. March 1, 2014.
4. **"Which Fruit Cultivars For Specific Locations?"** – Regional Spring Seminar Series, Shroeder's Nursery, Green Bay, WI. May 3, 2014.
5. **"Small Fruit Culture:Weed, Insect, Disease Control Strategies for Sustainability" –** Small Fruit Area Workshop, Roberts, WI. July 22, 2014.
6. **"Home Fruit and Vegetable Production Techniques"** – Annual Twilight Tour, Spooner Research Station/Demonstration Garden, Spooner, WI. August 19, 2014.

Plum/apricot Breeding Progress and Achievements-

Plum breeding has progressed very well overall but not the release of the new plumcot because of a climatic delay due to the massive frost in spring 2012 which precluded any fruit harvest for use in patent descriptions. In summer 2013, we collected fruit and vegetation of the plumcot for patent descriptions and release. We have gotten minimal input from other testers that are growing this clone and therefore, we have delayed submitting a patent application. Our replicated plum/apricot trial (4 replicates/entrant) was established in 2012 with 5 of our breeding program plum selections along with BlackIce, Toka and Alderman plums. One of our older selections (98-95-17-11) was tested for several years in southern Wisconsin by a commercial grower. He has urged us to release this selection, so we decided to retest it in our new trial. We made over 89 hybrid crosses of plums and apricots in the two spring seasons of 2012 and 2013, which resulted in 935 seed and 355 seedlings eventually established in the field as of summer 2014. We were able to make several selections in the field in 2013, including a superior apricot that had been planted originally in 1995 (98-95-25-21). A yellow plum selection with a rose blush and yellow flesh was also identified (02-98-19-1). In spring 2013 we had established a rootstock nursery that grew well and we were able to T-bud propagate 10-15 trees each of these two selections. We also were able to identify five superior genotypes in *P. besseyi* plots (two are yellow) and made 14 selections in our plots of *P. maritima*. Not only will selections from these two species be used in breeding but they also have potential to be used in further research oriented towards developing them as new crops for the Upper Midwest. Both species have extreme drought tolerance and late bloom, making them ideal candidates for survival in global warming scenario mesoclimates. *P. maritima* is already grown on the east coast and growers have developed a cottage industry around processed products from this species.

We were unable to meet our goals of 20 hybrid crosses and 300 seed for spring 2014 due to the potted parental tree winter storage cooler failure in mid-winter. Facilities Management personnel had not properly hooked up the alarm system, so we were unaware until about 2 weeks after the failure. At room temperature for two weeks, all the fruit trees had budded out in the darkness of the cooler. About 20% were dead already at the time of discovery. In mid-February, we moved all of the trees in to two greenhouses to try to save them. With everything packed so tightly, proper light interception, watering and pest control were impossible. Another 20% died by June. A heavy spider mite infestation started in April, and without any spray equipment to use in such tight spots, the spider mite populations started to build. We purchased predatory mites twice to try to combat these pests but control was only minimal. Some of the trees defoliated in the greenhouse and others defoliated when they were moved to the summer growing area in the outdoor nursery area. To help offset the devastating parental potted tree losses, we ordered 40 trees, consisting of as many cultivars as we could; to allow us to grow some healthy trees to have something to use in crossing for spring 2015. Since many of the potted plants that were in the cooler were genetically unique from the breeding program and cannot be purchased at nurseries, they are permanently lost; and cannot be replaced even with further breeding within the next 20 years (note-this is a good reason to rely on old-fashioned subterranean storage, common 100 years ago, characterized by no refrigeration. At a 10' depth, temperatures remain stable in the winter between an ideal 29-50^{0}F). We are not sure how many have survived, since many have been defoliated since July. Further losses occurred regarding advanced evaluation and release of two selections. We had budded (propagated) both our new yellow plum selection (02-98-19-1) and advanced apricot selection (98-95-25-21) last fall and had stored them in the cooler. All 30

of these younger trees died due to cooler failure. We hope that we can repropagate the yellow plum selection this fall in the greenhouse. Thus far, we have budded 10 trees. The apricot elite selection may be lost forever since construction of the new $63 million Health and Human Performance Facility on campus necessitated cutting down the only surviving tree of that unique selection. We had propagated about 10 trees before this but we are unsure as to whether they will survive winter and grow next spring.

On a much more positive note, we were able to establish a very large field planting of 426 unique plum, apricot, cherry, pear and peach seedlings from the UW-River Falls hybridization program in June 2014. Due to good growing conditions, some of the seedlings have made exceptional growth and could even fruit some next year.

Our outreach efforts over the three years resulted in considerable education of the public and generating a relatively large group of interested commercial growers. Our efforts are summarized as follows:

2012Presentations :

1. **"Fruit Breeding Program at University of Wisconsin-River Falls" -** MN State Horticulture Society Presentation, St. Paul, MN. April 5, 2012.
2. "**Stone Fruit Breeding at the University of Wisconsin-River Falls:Improving Commercial Viability"-** 2012 Great Lakes Expo, Grand Rapids, MI. December 9, 2012.

Extension and Research Publications

3. Smith, B.R. 2012. *Breeding Black Ice™ and Other New Winter Hardy Plums and Plumcots*- 2012 Great Lakes Expo, Grand Rapids, MI Proceedings. 6p.

Attendance at Professional Meetings

1. Wisconsin Fresh Fruit and Vegetable Growers Conference, Jan 2-4, 2012.
3. Great Lakes Fruit Research and Grower Meetings, Grand Rapids, MI, Dec 8-10, 2012.

2013 Outreach/Presentations:

Collaborator – USDA-ARS(Appalachian Fruit Research Station) Dr. Ralph Scorza and Douglas Raines -Plum Pox Resistance project. *UW-River Falls Role* –Introgress Transgenic Plum Pox resistance from 'Honey Sweet' hexaploid European plum(*P. domestica)* into diploid Japanese(*P. salicina*) and American (*P. americana* and *P. besseyi*) germplasm via UW-River Falls unique dipoloid/hexaploid hybrid backcrossed to European 'Honey Sweet' 6X.

1. **"Basics of Planning and Diversification in Fruit Crops " –** Local grower meeting . Roberts, WI. February 14, 2013.
2. **"Fruit Production Stats and Topics of Importance for Ag and Hort Agents" –** Call-in Guest Speaker on WHU(Wisconsin Hort Update)**.** August 16, 2013.
3. **" Fruit Growing Concepts for Advanced Home Gardeners"** – Master Gardener Presentation, Chippewa Falls, WI. November 5, 2013.

Attendance At Professional Meetings

1. Wisconsin Fresh Fruit and Vegetable Growers Conference, Jan 13-15, 2013.
2. Midwest Aronia Research and Growers Convention, Des Moines, IA, April 4-6, 2013.
3. ANRE Conference Fruit Team Meeting. Chula Vista Resort, Wisconsin Dells, WI. October 11, 2013.

Special Activities for 2013:

1. **Contributor/Reviewer** for Stone Fruit/*Prunus* section on new small fruit farms website through CIAS(Center for Integrated Ag Systems). http://uncommonfruit.cias.wisc.edu/
2. **Consultant –** Development of Stone Fruit Planting at Chicago Botanic Garden, Glencoe, IL.
3. **Consultant -** Eco-Village Fruit Project headed by Peter Morsch in City of River Falls, WI.
4. **Collaborator** – USDA-ARS(Appalachian Fruit Research Station) Dr. Ralph Scorza and Douglas Raines -Plum Pox Resistance project. *UW-River Falls Role* –Introgress Transgenic Plum Pox resistance from 'Honey Sweet' hexaploid European plum (*P. domestica)* into diploid Japanese(*P. salicina*) and American (*P. americana* and *P. besseyi*) germplasm via UW-River Falls unique dipoloid/hexaploid hybrid backcrossed to European 'Honey sweet' 6X.
5. **Developed** Fruit and Vegetable judging classes for MACHS(Mid-America ColHorticulture Society) Annual Convention Hosted by UW-River Falls.

2014 Presentations/Outreach:

1. **"Fruit Tree Winter Protection and Training Session" –** Area Growers Workshop, Chippewa Falls, WI. January 3, 2014.
2. **"Commercial Fruit Production and Business Set-Up: Apples, Tart Cherries and Plums" –** 4th Annual Farming For Profit Workshop Series-Commercial Fruit Production., Government Center, Balsam Lake, WI. February 3, 2014.
3. "**Integrating Edible Landscapes in to Your Home Yard or Commercial Enterprise" –** Area Winter Conference, Green Bay, WI. March 1, 2014.
4. **"Orchard Business Record-Keeping and High Density Efficiency" –** Commercial Fruit Tree Workshop, Spring Valley, WI. March 6, 2014.
5. **"Orchard Pruning and Training Techniques" –** Commercial Fruit Tree Workshop, Maple Leaf Orchard, Spring Valley, WI. March 6, 2014.
6. **"Orchard Pruning and Training Basics-Demonstration and Hands-On"** – Colfax, WI. April 3, 2014.
7. **"Fruit Tree Grafting and Budding Techniques for the Beginner to Advanced"** – Rice Lake, WI. April 15, 2014.
8. **"Which Fruit Cultivars For Specific Locations?"** – Regional Spring Seminar Series, Shroeder's Nursery, Green Bay, WI. May 3, 2014.
9. **"Home Fruit and Vegetable Production Techniques"** – Annual Twilight Tour, Spooner Research Station/Demonstration Garden, Spooner, WI. August 19, 2014.
10. **"Fruit Tree Cultivars, Training and Identification"** – Master Gardener Training, Alpha, WI. October 14, 2014.

**Several beneficiaries not originally anticipated, became major components of this project. A new program, the 2014 ANRE Internship was announced in spring 2014. This was intended to not only serve as official credit for required internships for Bachelors degree candidates in the state but also identify potential new ANRE Extension personnel. The PI of this SCBG teamed with a county agent and because of this SCBG project, we were able to obtain a grant to pay for a student intern to work part time on the county level and part-time on this SCBG project. In turn, the student(from the UW-River Falls Horticulture Program) was able to gain experience in the breeding projects and outreach related to Aronia, strawberries and plums/apricot and we were able to achieve much more than anticipated for the final year of this project. This student now is actively interested in eventually obtaining employment through ANRE and could easily be working with fruit growers in Wisconsin within the next few years.

B. See Section A

IV. Beneficiaries

Primary beneficiaries are: 1. growers already raising strawberries, plums/apricots and Aronia; 2. growers desiring to expand their operations with these crops (Wisconsin has approximately 465 farms currently growing strawberries and approximately 1600 fresh market vegetable growers who already grow or are prime candidates to grow some fruit crops) 3. farmers contemplating starting or adding fruit growing to diversify an existing agricultural enterprise. This project is also creating opportunities for new and underserved farmers. Initiating an Aronia-breeding program benefits an entirely new group of processors, small and large, and indirectly increases sales of other fruit (and vegetable) crops that are grown to take advantage of newly created and augmented infrastructure. Consumers are the ultimate beneficiaries of an ever-increasing supply of safe, nutritious, locally-grown (and processed) fruits as a result of the economic stimulus provided by the introduction of higher yielding, locally-adapted, disease and insect resistant cultivars. The ultimate beneficiary will be the environment, as perennial fruit crops become a larger part of our regional food supply system. This project has three plant breeding components. These include a start-up for Aronia plant breeding (a woody shrub), an on-going strawberry breeding program with some cultivars on the verge of release (a non-woody perennial) and a plum/apricot breeding program (tree fruits) that has had one successful release and several more selections nearing release. This combination adds efficiency and maximizes use of resources. It also impacts a wide range of beneficiaries. The following discussion will address each component separately concerning who the beneficiaries will be, how they will be impacted and what the potential economic impact will be to the extent that it can be determined.

Impacts of beginning an Aronia plant breeding program

There is no Aronia-breeding program in North America dedicated to plant improvement for fruit production. However, there is a rapidly growing industry that will need diverse, adapted, improved cultivars that foster industry growth. Superior cultivars cannot be created without the incorporation of a wider range of genetic material selected from both native North American plant populations and domestic cultivars currently used for landscaping purposes. No crop industry has survived without this critical type of systematic new cultivar development.

The Aronia industry is expanding quickly across the U.S. There are commercial Aronia growers in the Pacific Northwest, Midwest and Northeast. Iowa Cooperative Extension estimates that their Aronia industry is valued at $23 million. There have been five field days in Wisconsin with over 170 people in attendance, and at least 10 growers that have substantial acreage. Aronia can grow with very few inputs; it is drought, pest and cold tolerant. The late-blooming tendency of Aronia allows this crop to escape late spring frosts and therefore renders it a reliable annual producer. Aronia can be mechanically harvested, which greatly improves profitability by significantly reducing labor costs. It is estimated that at least 125 acres (400 acres are already planted in Iowa) of Aronia have been planted in Wisconsin as of summer 2014. With 5th year yields of 14,000 lbs/A and prices of $1.30/lb. annual net returnsare around $12,000/A wholesale. The industry could conservatively be valued at $3.5 million farm gate; with total benefits to the state economyexceed $5-7 million annually by 2020 when value-added processing is included. Aronia is one of the most promising new fruit crops for the Midwest. Since this project was funded, we have seen Wisconsin become a major hub for Aronia production/research as new cultivars are released. New cultivars could be available within 6 years by identifying elite, adapted germplasm. The outreach Extension efforts outlined in this project have had an immediate short-term impact by spurring on new growers and more acreage. The extension outreach efforts has increased new grower confidence and increased the number of growers starting Aronia in the state. Wisconsin is now known nationwide as a source for Aronia information and research. Over the next 5 years, the outreach and research efforts of UW-River Falls are expected to reach and influence at least 100 new growers and have an economic impact (including multipliers) from new acreage planted (130 acres) of approximately $5million by 2020. Our first cultivars released by 2021 (125 acres of production with new cultivars) should economically impact the industry and state by 2025 in the range of $10 million annually.

Even though Aronia is an emerging fruit crop, Aronia markets are becoming much more well-established over the last three years, with national quality standards and prices being developed by grower coops. Aronia is a significant commercial success in Europe. The nutritional profile, adaptability for mechanical harvesting and handling characteristics along with its many uses as an ingredient in value-added products makes Aronia well-positioned to rival cranberries for economic dominance in Wisconsin over the long-term. Small-scale processors are already beneficiaries. As they have been contracting out with some of our growers for small-batch processing (5-10 tons at a time). It will attract many new growers to provide the critical mass required to sustain a value-added industry, thus providing significant opportunity for underserved members of the agricultural community. Aronia is also one of the most environmentally friendly and, perhaps, the best-suited fruit crop for organic production.

Impacts of the strawberry breeding program

Growers and consumers are the primary beneficiaries of the strawberry breeding component. The existing strawberry industry in Wisconsin encompasses over 600 acres with a market value estimated to be $10 million annually. Over 320 Wisconsin farm families benefit from this high value cash crop either as a sole source of income or as supplemental income to reduce risk. Strawberry acreage in Wisconsin has declined by 30% in the past 15 years. One factor is the lack of locally adapted, high yielding cultivars with high quality needed to replace older, less-adapted varieties that no longer meet customer preferences or have experienced genetic decline.

Although we have not officially released cultivars as a result of this project, we have come much closer to that point due to the support. The setbacks we have experienced will ultimately improve the long-term sustainability of the breeding program, making it move closer to self-supporting status and clarifying the roles of the PI in legal release and patenting procedures. We fully believe that with these variables addressed, that we can move forward and release newer selections that are now in the advanced pipeline and have a major impact soon on commercial strawberry production in Wisconsin.

Development and identification of superior cultivars that Wisconsin commercial strawberry growers can plant has multiple benefits. Reduced costs of production and greater profitability increases efficiency and will help encourage business expansion. New cultivars will exhibit superior climatic adaptation, which helps counter the progressively negative effects of global warming/drying climatic changes already documented in Wisconsin. New cultivars with greater pest tolerance will require fewer crop protectants, which leads to greater sustainability and a safer environment. Wisconsin product quality will improve health-wise due to fewer pesticide residues and aesthetically, because of better fruit size, flavor, firmness and appearance. Estimates of new cultivar direct economic benefits are primarily based on variables such as increased yield, pest and stress tolerance for greater environmental adaptation, higher fruit quality and market season extension due to earlier and later maturing cultivars than the current norm (earlier and later cultivars benefit growers significantly by allowing growers to command premium prices and take advantage of market window niches). The collective impact of these factors can easily increase profitability by $3,000/A. Taking into account a modest increase in acreage planted and a conversion of 20% of existing acreage over to these new cultivars, total economic benefits to growers and the state is estimated to be $1.6 million annually in a few years' time.

The processing industry could also become a beneficiary. Currently there are a few growers conducting very limited value-added processing of strawberries into products such as jams and baked items that are sold directly to the public on-farm or at farmers' markets. However, there is no longer any commercial scale value-added processing of strawberries as there was in the 1950's. This could change when regional value-added infrastructure becomes economically justified with the introduction of Aronia and other value-added processing crops like plums, apricots, black currant, Saskatoon (juneberry) and elderberry. Higher yields of locally-adapted strawberries from this breeding program, along with scale-appropriate infrastructure for processing, could make growing strawberries for processing, in addition to retail sales, a viable option. This would allow products made from locally-grown strawberries available year-round and significantly increase economic impact. Processed, value-added strawberry products could conservatively, add another $1.0 million annually, to the state economy.

Impacts of the plum/apricot breeding program

Growers will benefit from new plum and apricot cultivars (including hybrids between plums and apricots) incorporating many of the same attributes as new strawberries and Aronia released by this breeding program. The primary improvement to increase commercial viability is centered around developing late spring bloom (later bloom leads to less late frost damage) higher fruit quality and climatic adaptation. These cultivars will help growers maintain a competitive edge over imported products from states such as California, Washington, Michigan and New York.

Currently, there are over 70 commercial growers and 100 acres of plums/apricots in Wisconsin. The first plum/apricot acreages planted with these new cultivars will help create new jobs, expand existing produce markets and create added interest in fresh fruit.

A realistic price and marketable yield production goal in Wisconsin for plums/apricots sold as fresh fruit at retail (direct market) is $1.75/lb, and 4,000 lb/A, respectively. New, adapted cultivars from this breeding program could easily encourage growers to plant an additional 50 acres of plums and apricots, and replace 25 acres of less-adapted cultivars. The economic benefits to growers and the state economy is estimated to be $630,000 annually within 5 to 8 years, the time that it takes for these stone fruits to reach maturity. It is estimated that 75 farm families could benefit. Plums, especially highly pigmented ones, have some of the highest nutraceutical content of all tree fruits, which is an added bonus for consumers. Plums and apricots can also be used for value-added products such as jams, bakery items, wines, juices and multiple dried-fruit products and nut mixes. These locally-produced, premium products could add another $250,000 annually to the state economy.

V. Lessons Learned

Most important lesson learned that needs to be communicated to federal, state and university officials in charge of oversight and funding for agriculture: Plant breeding (especially fruit breeding) requires many years of consistent funding and support. Without long-term funding and acknowledgement of the importance, results will not be forthcoming. This type of research has the potential to provide solutions for improving sustainability, farm profitability and minimizing global climate change effects on commercial fruit production. The cost-effectiveness of fruit breeding has been proven over the past 120 years. Short-term grants help but there needs to be line-item funds available that can be ear-marked for fruit breeding. Only then can we revisit the profound effects that were achieved by universities in the 1900's that resulted in the rapid growth of the fruit industry in the Midwest.

VI. Additional Information

Please see photographs of the ms, apricots and strawberries developed during this project:

Yellow plum selection from UWRF breeding program, SCBG project

UW-RF Apricot selection (98-95-25-21) from SCBG project

VII. Contact Info

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13) Bayfield fruit crop diversification (FY11-013)

Report Date: October 31, 2014

I. Project Summary

A. Geographically, Bayfield Wisconsin has the potential to be a premier fruit-growing region of Wisconsin. The moderating effect of Lake Superior on the climate reduces the chance for frost damage to flowers and lengthens the ripening season in the fall. The topography and well-drained soils support excellent production of a wide range of fruit crops including blueberries, raspberries, tart cherries, strawberries, and apples. At one point, total fruit acreage exceeded 3000 acres and is now down to less than 300 acres. Unlike other fruit growing regions, such as Door County, there is very little research and development support for the Bayfield fruit industry. As such, the industry remains small and underdeveloped. Targeted research and development efforts could help the region achieve its potential.

Needs assessment work conducted by UW-Extension led to development of the Bayfield Fruit Growers Initiative. Fruit crop diversification was listed as one of the action items in the Initiative primarily to diversify the offerings to pick-your-own customers and to support value-added processing. To that end, we proposed to establish a series of fruit crop production trials to generate research-based information in support of diversification. Specifically, we proposed to establish trials with wine grapes, black raspberries, fall-bearing raspberries, machine-harvest raspberries, sweet cherries, and currants. In addition, we proposed to collaborate with a private grape breeder to help advance his development of grape varieties for the Bayfield fruit-growing region.

B. This work has not previously been funded through the SCBGP.

II. Project Approach

Wine Grape Trials

The Bayfield Wine Grape Trial was established on private land near Bayfield, WI and included 24 varieties of cold-hardy grapes as recommended and supplied by Mark Hart, the private grape breeder and collaborator on this project. Of the varieties tested a handful were more vigorous and productive than the others including: Marquette, Baltica, Lacrescent, and MN 1200. A field day was held in 2012 at the trial and individual consultations with interested growers have been held since the trial was established.

Black Raspberry Trials

A black raspberry trial was established in 2010 and 2011 at two locations in the Bayfield region. Each trial had five plants each of Bristol, Blackhawk, Huron, Jewel, MacBlack, and Munger. Establishment was successful and the first fruiting year provided excellent taste and productivity data. Of the varieties tested, Jewel was rated as the best tasting and proved most-productive. As a result, a grower in Bayfield added 1000’ of Jewel in 2012. The winter of 2012/2013 killed most of the plants at one of the two locations with the exception of Jewel and the trial was

discontinued in 2013. The trial did show that consumer preference for black raspberries is strong and Jewel appears to be the better variety.

White, Pink, and Red Currants
A full description of the white, pink, and red currant trial can be found in the attached Research Bulletin. The data and lessons learned from the trial were presented at the 2013 WI Fresh Fruit and Vegetable Conference by Jason Fischbach of UW-Extension and Jon Hamilton of White Winter Winery.

Machine-Harvested Red Raspberries
Two machine-harvest trials were established as part of this project. The first was completed in 2012 and involved determining the harvest efficiency of machine-harvest using a blueberry picker and narrow row pruning strategy. The second harvest was established in 2013 with data collection to begin in 2015. The attached Research Bulletin provide more information on the trials and lessons learned. This information will be presented at the Bayfield Fruit Growers Clinic in December 2014.

Sweet Cherries

Two sweet cherry trials were implemented as part of this project. The upright fruiting offshoot (UFO) trial was established prior to this project, but was maintained throughout. The goal of the project was to demonstrate the training system to growers and determine which cultivar would be most suitable for the system. The trial was established at three locations and included three replications each of Skeena, Lapin, Benton, Regina, Schneider, and Blackgold. There was considerable mortality at all three locations and growth was too slow to effectively manage for the UFO system. The photo shows one example of a successful plant. The system does not look to be a viable option for the Bayfield region at this time and has not been recommended.

The second sweet cherry trial was established at a private farm in the middle of the Bayfield fruit growing region. The trial was a formal hardiness variety trial and the full details and results to-date can be seen in the attached Research Bulletin.

Fall-Bearing Raspberries
Due to the growing problem of spotted wing drosophila the fall-bearing raspberry trials were never established.

Grape Breeding and Cultivar Development
One goal of this project was to conduct wine trials with advanced selections of grapes developed by Mark Hart to provide him with data for making breeding decisions. Due to pest problems and

two abnormally slow and cold summers, wine from only one grape variety was made and tasted. Without enough ripe fruit of all the advanced selections to make the test batches of wine, the decision was made to make test batches of wine using the currants as reported on in the Research Bulletin.

Another aspect of the project was to validate the use of molecular markers for rapid screening of grape seedlings for desirable traits including perfect flowers and resistance to phylloxera. This work was never started and no funds were spent on this aspect of the project.

Fall-Planted Strawberry Trial
A fall planting of day neutral strawberries has never been attempted in Bayfield and may provide an opportunity for more efficient strawberry production and a longer season, particularly for the processing markets. Three replications each of Albion and Seascape were established at Bayfield Apple Company in Augst/September 2014. The plants were planted in a spaced-plant system on black landscape fabric with drip irrigation. Survival and yield data will be collected in 2015.

III. Goals and Outcomes Achieved

A. The primary goal of generating relevant and research-based information on a range of potential new fruit crops for the Bayfield region has been achieved. The on-farm trials, as described above or in Research Bulletins, are an effective tool in providing information to growers. In particular, the black raspberry, currant, and wine grape trials have been used to make go or no-go decisions by the growers. In the coming years, the machine-harvest and sweet cherry trials will likely have the most impact as these crops have the most interest from growers and consumers.

The grape breeding project was not as successful as we had hoped. Bird predation resulted in lost fruit in 2012 and the growing seasons in 2013 and 2014 started nearly two weeks late and were abnormally cold such that the advanced selections ripened with abnormally high acids and low sugars. Between the cold summers and record cold winter of 2013/2014, MAVO gained valuable information about the hardiness and ripening window of the advanced selections, which is important for the breeding program, but did limit what we could do in this project.

B. Goal: A total of five fruit trials will be established and/or expanded in cooperation with nine fruit-related businesses in Bayfield County.
Performance Measure, Target, Benchmark: Data will be collected in 2012 from the wine grape, currant, and black raspberry trials. The sweet cherry trial will be expanded and the red raspberry trials will be established.

Outcome: During this project we have established and/or maintained six primary trials (red raspberry, wine grape, sweet cherry hardiness, sweet cherry UFO, currant, black raspberry) involving direct contributions from eight fruit producers and one wine maker.

Goal: Fruit and wine quality data will be provided to MAVO for 10 advanced wine grape selections leading to release of wine grape cultivars locally-adapted to the Bayfield region.
Performance Measure, Target, Benchmark: White Winter Winery will create the wines in the fall of 2012 from the harvested grapes in addition to providing basic fruit quality components. The number of selections put into propagation and release will be the primary measure of the success of this component of the project.

Outcome: Fruit and wine quality data for only one advanced MAVO selection was collected during this project due to damage to vines from birds or extreme weather. The variety that did produce enough fruit did not fully ripened and the juice had acid of 1.9 and brix of 14.2, which are not ideal for making wine. However, fruit quality data was generated from 10 currant cultivars and wine quality data was generated from 3 cultivars as reported in the currant Research Bulletin. It is unclear when or how many new grape varieties will be put into propagation as a result of this project.

Goal: Phenology, fruit quality, and plant performance data will be provided for black raspberry, primo-cane bearing red raspberry, wine grape, sweet cherry, and fresh-eating currants.
Performance Measure, Target, Benchmark: Data will be collected for the 2012 season. A measure of the use of this data will be how many growers put in new plantings. This data will be collected by Jason Fischbach

Outcome: Data from the black raspberry trial was collected and communicated to growers at the 2012/2013 Bayfield Fruit Growers Clinic. Data from the wine-grape trials has been subjective in nature and based on visual and taste observations by project staff, and more importantly, by growers at field days and individual consultations. Data from the sweet cherry, currant, and raspberry trials have been collected and communicated to growers at the Fruit Growers Clinics and via the attached Research Bulletins. To date, growers have installed new black raspberry plantings and are considering new sweet cherry plantings pending the results of the hardiness trial.

Goal: Feasibility and enterprise budget data will be provided for machine harvest of primocane-bearing red raspberries.
Performance Measure, Target, Benchmark: Performance data from the primocane bearing trials will be collected in 2012. A measure of the success of the trial will be the number of new primocane plantings by the Bayfield growers.

Outcome: The primocane bearing trial was never established due to concerns about spotted wing drosophila. However, the machine-harvest red raspberry trials are providing valuable data in support of expanded raspberry production for processing markets.

IV. Beneficiaries

Beneficiaries of this project include all collaborating growers providing direct contributions including:

Jim Hauser, Hauser's Superior View Farm
Eric Carlson, Blue Vista Orchard

Bruce Derauf, Star Route Vineyard
Guy Folsum, Bono Creek Orchard
Chris and Jon Dale, Highland Valley Farm
Dave Kositzke, Bayfield Apple Company
Bill Ferraro, Apple Hill Orchard
Renate and Scott Hauser, Bayfield Winery
Jon Hamilton, White Winter Winery

In addition, 15 people attended the 2012/2013 Bayfield Fruit Growers Clinic, 10 people attended the wine-grape field day in 2012, 25 people attended the currant presentation at the 2013 Fresh Fruit and Vegetable Growers Conference.

The project also directly benefited Mark Hart with Mount Ashwabay Vineyard and Orchard in advancing his grape-breeding work.

The results of this project have the potential to benefit all current fruit growers in the Bayfield area as well as fresh market growers and other farmers in the region looking to diversify their crops with high-value fruit. The Bayfield region is a huge tourist area and results of this project can also attract more tourism as fruit is already a popular attraction in the region. The project also has environmental benefits because the crops used in this project were all perennial which help reduce soil erosion and have other positive environmental attributes compared to other agriculture crops and practices, including being able to grow on marginal land.

V. Lessons Learned

Black Raspberries

Black raspberries have excellent market potential as an additional offering to pick-your-own or ready picked fresh markets. Jewel has excellent flavor and his vigorous and hardy enough to produce a dependable crop. Pruning and trellising is a burden as the vines are vigorous and have thorns.

Fresh-Eating Currants

Pink Champagne, Rovada, and Blanka appear to be the most viable currant cultivars for the Bayfield region, however, due to short strings and presentation of the fruit, Pink Champagne is difficult to hand pick. Fruit quality is good and there is potential with wine making, particularly for Blanka which can be picked much like grapes and could be priced right for the processing market. The crop has potential, but will depend on additional market development work. We have learned that most of the white currant varieties are simply too small and poorly presented on the plants for cost-effective harvest. Likewise, customers do not show a preference taste or appearance wise for the white varieties, other than blanka.

Wine-Grapes

Marquette, Lacrescent, and Baltica are likely three viable cultivars for Bayfield grape production.

Sweet Cherries
Sweet cherries have enormous market potential in the Bayfield market, but growers are hesitant to plant with expectations of good yields only 1 out of 3 years. Preliminary data from the hardiness trials indicate there may be varieties suitable for the Bayfield climate, but more work is needed. Additionally, it looks like the UFO cherry system developed in the Pacific northwest is not viable for Bayfield growers likely due to hardiness problems and too short of a growing season.

Machine-Harvest Red Raspberries
The stage is set for collection of a robust data set in 2015 as to the feasibility of machine harvest of Chemainus, Royalty, Saanich, or Cascade Bounty. All four cultivars survived the brutal winter of 2013/2014.

Wine From Advanced Selections of Grapes from the Mavo Breeding Program
The goal is to have a grape variety that will fully ripen in at least 9 out of 10 years in the challenging Bayfield climate where heat units are slow to accumulate. During this project the summers of 2013 and 2014 were abnormally cool and the single advanced selection that produced enough fruit for making test batches of wine ripened at 1.9 acid and 14.2 brix. This is poor chemistry for making wine. However, it is important to know how to make decent wine out of grapes that don't fully ripen. This makes the variety more viable and improves the profitability of growers by avoiding lost years.

White Winter Winery made a series of wines from this variety with fermentation processes designed to reduce acidity. The best wine had some residual sugar, but the acid reducing fermentation masked the otherwise fruity overtones of the grape variety resulting in a tart apple taste with butterscotch undertones. The tasters thought the best use of the under-ripe fruit from this selection would be a sparkling sweet wine with plenty of residual sugar.

VI. Additional Information
The attached Research Bulletins provide additional information and photos about the raspberry, cherry, and currant trials. This project has provided valuable information and on-farm research experience for Bayfield fruit growers that helps set the stage for expanded fruit production and consideration of new crops and new production systems.

VII. Contact Info

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14) Integrated systems to improve mint persistence in Wisconsin (FY11-014)

Report Date: June 24, 2014

I. Project Summary

A. Mint is a perennial crop that can survive more than 5 years, but stand survivability has shortened over the past decade. Stand persistence reductions have been linked to the mint bud mite, Verticillium wilt, injury from herbicides, and selection of mint lines with reduced persistence. A means to reduce input costs would be to improve mint persistence and reduce high costs of field establishment. This project focused on development of integrated management systems that improve the persistence of spearmint and peppermint in WI. Field research and demonstration projects were utilized to evaluate new germplasm and pest management systems for improved stand persistence in mint. The proposed project utilized current understanding of best management approaches for bud mite and weeds in combination with new germplasm to develop new systems targeted at improving mint persistence and productivity.

B. This project was a continuation of a 2010 funded project. The first year of the project was extended until December 31, 2012. This project repeated 2010 funded activities to validate with additional seasons of data as well as other accomplishments listed below.

II. Project Approach

1) Evaluate Verticillium resistance of new peppermint and spearmint lines and demonstrate impact on persistence and productivity over time.
   None of the lines evaluated will have commercial production potential. Crop rotation is the best strategy for managing Verticillium wilt. Nematodes have been found to have a substantial impact on mint health; the efficacy of nematicides in mint is being investigated in the future with other funding sources.

2) Demonstrate enhanced persistence of SH spearmint line across multiple locations and soil types in Wisconsin.
   This has been completed on commercial farms in WI and IN. While this line continues to perform, growers are securing alternative sources of mint.

3) Quantify interaction of mint bud mite best management systems and Verticillium resistant mints and SH spearmint on persistence and productivity.
   This has been completed. Registered and experimental reduced risk miticides are effective in suppressing but fail to adequately control bud mite. Efficacy and residue data to register the reduced risk miticide Oberon (spiromesifen) for use on mint has been compiled by IR-4 Project but the manufacturer has withdrawn registration request due to bee labeling issues. However, growers are concerned with pesticide residues in mint oil and now primarily rely on crop rotation to manage mint bud mite as well as Verticillium wilt.

4) Evaluate interactions between weed best management strategies and Verticillium resistant mints and SH spearmint on persistence and productivity.
The two-year project investigating the influence of weed best management practices on SH and standard spearmint was completed at the end of 2013. This research was carried out at the Gumz Muck Farm in Endeavor, WI. The study compared herbicides registered for use and commonly applied in Wisconsin spearmint in an additive model, ranging from a program consisting of 2 herbicide applications per season to a season-long program consisting of 4 herbicide active ingredients, on both a standard spearmint variety acquired from the grower as well as the SH spearmint observed to be more persistent in other fields. In summary, the SH mint was much more persistent than the standard spearmint. In fact, the standard spearmint did not persist into year 2 in any herbicide programs except that with only 2 herbicides, and the plant stand in that treatment was weak. The SH spearmint withstood the range of herbicide programs for the duration of the 2-year study. These results suggest that standard spearmint is quite susceptible to normal plant stresses, such as that occasionally caused by herbicides normally tolerated, which may limit the harvestable lifespan. Persistent SH plants isolated from the research field had been maintained in a greenhouse and have been planted at the Arlington Horticulture Research Farm for future research and grower use.

5) Develop revised nutrient management strategies for Wisconsin grown mint and evaluate impacts on yield and persistence.
Nitrogen content of peppermint grown on muck and mineral soils was evaluated over a 2 year period (third and fourth year of production). Nitrogen content of mint grown on muck and mineral soils was comparable during the third year of production but was initially higher in muck-grown mint during the fourth year of production. To better understand the mineral nutrition of mint grown on muck and mineral soils, mint production and mineral uptake should be studied in plots that are established in nitrogen-depleted soils and then treated with different rates of applied nitrogen. Emergence in spring has been related to the health of stolons in fall. Additional research might determine if timely late season fertilizer applications will improve stolon health and persistence.

6) Communicate integrated management systems that improve persistence and productivity to the Wisconsin mint industry.
Research results were communicated to growers at the February 2014 Midwest Mint Meeting. Moreover, results of a 2011 survey have been summarized in a pamphlet being prepared for publication. A draft copy of "WI Sustainable Mint Oil Production - A story of progress" is attached.

III. Goals and Outcomes Achieved

A. New spearmint and peppermint breeding lines evaluated for resistance to Verticillium wilt do not have any potential production value. However, these studies found that nematodes have significant impact on mint root health.

The SH spearmint line has greater persistence than the standard line but growers are securing other lines that may have enhanced persistence.

New "reduced risk" miticides may suppress but will not control mint bud mite damage. However, the potential harm to bee populations and concerns over pesticide residues in mint oil has reduced the demand/ability for chemical control.

The SH spearmint line was more persistent than the standard line in all treatments of a 2 year herbicide study.

The nitrogen content of mint grown on muck and mineral soils were compared but additional research would be needed to develop revised nutrient management strategies. As suspected, spring emergence is related to plant health in fall. Strategies to improve fall health should be investigated.

Research results have been presented to growers and a pamphlet summarizing results of a 2011 survey has been prepared.

B. All goals were accomplished with the exception that additional work is needed to develop revised nutrient management strategies. We did learn that after 3 years plant nitrogen content is greater in mint grown on muck than in mint grown on mineral soils and persistence is related to the health of stolons in fall. Timely (late summer/fall) fertilizer applications could improve persistence, especially in mint grown on mineral soils.

IV. Beneficiaries

This project will directly benefit multiple sectors of the Wisconsin mint industry. Increasing the efficiency and productivity of the Wisconsin mint production through improved crop persistence will improve competitiveness and secure future viability of the industry. Wisconsin mint growers will be direct beneficiaries. Many mint farms have multiple employees that support crop production and mint distillation. In addition to growers, multiple flavor houses are based in Wisconsin including Labeemint, I.P. Callison, and J.M. Todd who employee buyers, blenders, product managers, and others.

Nearly all Wisconsin mint farms will benefit. Several mint farms swap acres or subcontract mint with other farms. As a result, 40 to 50 farms may benefit from this project. Assuming each mint farms has at least one field and distillation manager, the total number of individuals that benefit may reach 120 to 150. Finally, all three flavor houses will benefit from supply of oil in Wisconsin with 40 to 50 different employees.

With current trends in the mint industry, the likelihood for increased acreage or expanded production seems limited. However, maintenance of the mint industry at its current acreage and production with a value of several million dollars impacts the farm gate value of Wisconsin agriculture. Spearmint production in particular is at risk due to the continual challenge in maintaining stands for more than even 1 or 2 years and the economic losses of failed stands.

This project was essential for the financial stability of the spearmint industry in Wisconsin with an estimated farm gate value of $500,000. Peppermint had a farm gate value of just over $3 million during 2008 and this project aims to improve the long term stability of peppermint industry as well.

V. Lessons Learned

Crop rotation after 3-4 years is the primary strategy for management of Verticillium wilt and mint bud mite. New potentially disease resistant mint lines are not commercially acceptable and new miticides, although able to suppress mint bud mite, are not acceptable due to potential threat to bee populations and residues in mint oil.

The SH spearmint line is more persistent than the standard line, especially when standard herbicides are used. This line currently is being maintained at the UW-Madison Arlington Horticulture Research Farm.

A better understanding of the mineral nutrition of mint grown on muck and mineral soils in Wisconsin is needed to revise nutrient management strategies. Mint production and mineral uptake should be studied over several years in plots treated with different rates of nitrogen.

VI. Additional Information

The following abstract summarizes graduate research supported with this grant.

Bolssen, Katie. 2014. Characterization of vegetative and reproductive growth and development and persistence improvement strategies of Wisconsin peppermint (*Mentha x piperita* L.) and spearmint (*Mentha spicata* L.). M.Sc. Thesis. University of Wisconsin-Madison.

Peppermint (*Mentha x piperita* L.) and spearmint (*Mentha spicata*) have been grown commercially in Wisconsin since 1943 and while production has increased over time, mint stand persistence has been on the decline over the last decade. Decreasing mint stand persistence causes economic losses via fewer production years and lower oil yield potential. Persistence has been shown to decline even in disease free soils, when using disease-free and hardy rootstock for planting, and using cultural controls for other pests and diseases.

This study characterizes growth and development by observing belowground biomass, the reproductive organs of mint, and aboveground biomass, the vegetative portion that is harvested for essential oil yield. Growth was measured over accumulated growing degree days (AGDD) to account for varying seasonal weather. A mowing trial was conducted to measure oil yield over AGDD and track regeneration of the mint stand at those specified harvest dates. Stolon health was visually characterized and planted to observe persistence directly.

Peppermint and spearmint biomass was measured biweekly *in situ* on both muck and mineral soils over AGDD, which was calculated by averaging daily high and low temperatures and subtracting by 4°C base temperature. ANOVA analysis was used to find significance of AGDD on aboveground, belowground, and total biomass. Tukey's HSD was used as a complement to ANOVA to find significant areas of rapid biomass accumulation or decline. Three mowing trials were conducted on each field and contained 9 plots each to be harvested biweekly for oil yield and then observed the following year for regrowth (percent canopy cover). Tukey's HSD was used to find significance between oil yields and canopy cover means. Peppermint and spearmint rootstock was characterized into three levels of health (viable, moderately viable, and non-

viable) and planted in fall for observing emergence rates in the following year. The trial tested if stolon health was independent of emergence rate using Fisher's Exact Test.

ANOVA analysis showed significance of AGDD on total biomass and aboveground biomass, but not on belowground biomass. Tukey's HSD pairwise comparisons provided significance for several AGDD ranges to indicate when aboveground biomass accumulates most rapidly. Tukey's HSD found that AGDD may predict oil yield accurately, which differs from how harvest time is currently dictated. Observations of canopy cover after various harvest dates suggest that harvest time does not impact persistence. Fisher's Exact Test confirmed that stolon health is directly related to emergence rates. These findings suggest that persistence is directly affected by characterized stolon health.

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15) Evaluating soil moisture probes for water use efficiency in cranberry beds (FY11-015)

Report Date: May 14, 2014

I. Project Summary

A. This project was a follow-up study to a previous Specialty Crops Block Grant evaluating the use of soil moisture probes to optimize irrigation of cranberry. During the course of this project we partnered with researchers from Laval University in Quebec and William Bland at UW-Madison and have been able to leverage these funds to accomplish much more than we had hoped with this project.

Goal #1 – Confirm results from 2010 SCBG research on soil moisture probe placement in the soil and evaluate impact of seasonal variability on soil moisture monitoring techniques and the impact on water use.

- Modifications: The original target and benchmark was to install probes in numerous sites, however, it became clear when we began this project that we needed to do a more comprehensive analysis on the primary research site in order to collect the data needed to understand how the different types of soil moisture probes performed. We did not have the capacity to install several types of probes in each cranberry bed; therefore we kept all the equipment in the primary research site to ensure adequate data was collected.
- Data collected confirmed previous findings that irrigation can be reduced without significant impact on plant health or plant productivity
- Preliminary results showing a reduction in water use of over 50% were shared with 300 growers at the two field days and many growers were interested and indicated would consider installing soil moisture monitoring systems

Goal #2– Determine feasibility of an on-line resource to provide daily evapotranspiration rates for cranberry growing regions to aid in irrigation scheduling.

- Partner: Bill Bland, UW-Madison, Dept. of Soil Science
- Developed ET calculator for cranberry growers to use, this was based on an existing program available to other crops
- Can be viewed at: http://www.soils.wisc.edu/uwex_agwx/cranberry
- The use of evapotranspiration for irrigation scheduling remains a question and we will continue to track the use of this tool and follow up with growers to determine if the use of ET tool influenced irrigation rates.

B. This project was a follow-up study to a previous Specialty Crops Block Grant evaluating the use of soil moisture probes to optimize irrigation of cranberry. During the course of this project we partnered with researchers from Laval University in Quebec and William Bland at UW-Madison and have been able to leverage these funds to accomplish much more than we had hoped with this project. This project allowed us to confirm the results of the preliminary work in the previous grant and also allowed us to provide more outreach opportunities to share the results

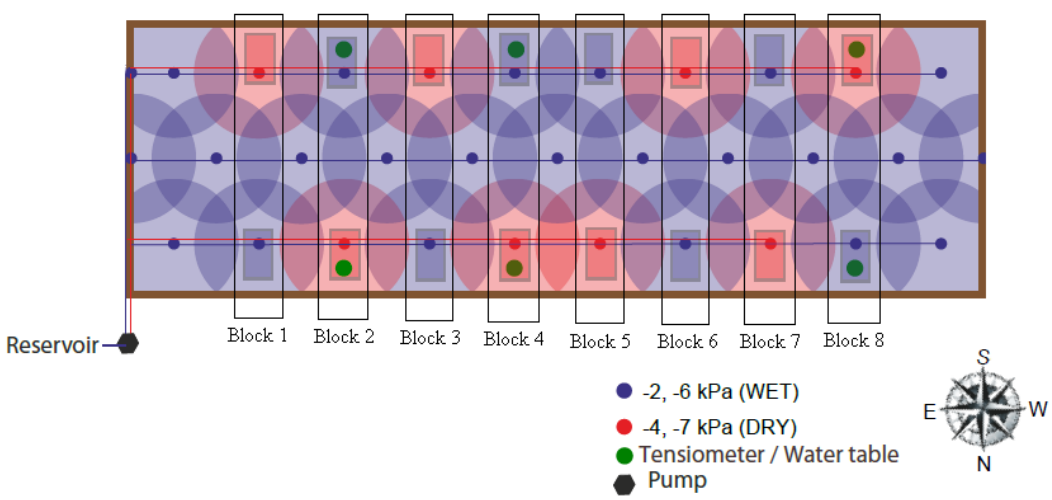
of both of the projects with growers. We were also able to provide an additional resource with the online ET calculator for growers that are not able to purchase soil moisture probes. These two projects have provided a robust analysis of the potential of soil moisture probes to improve water use efficiency in cranberry production.

II. Project Approach

Treatments and irrigation

The two irrigation treatments were predetermined at the start of the experiment with the producer and applied to one cranberry bed. The matric potential of the soil at a depth of 2.5" below ground was to be maintained between values of -2 and -6 kPa for the wet treatment and between values of -4 and -7.5 kPa for the dry treatment. The wet treatment broadly corresponds to what is normally targeted by the producers. In total, eight blocks were established, from east to west (Figure 1). Each treatment had four repetitions (experimental unit) on the northern side and four on the southern side of the culture bed. The two irrigation treatments were applied through two independent pipe systems and the water came from the same reservoir. The water pressure at the exit of the sprinkler head was the same when water went through both pipe system (57 PSI) and very similar when both systems were activated independently (56 PSI for the wet treatment and 58 PSI for the dry treatment).

The spatial distribution of water from the two irrigation treatment was evaluated at the beginning of each growth season to assess if the water provided by the sprinklers went principally to the targeted treatment. To do so, over 200 glasses were homogeneously placed in the culture bed and the accumulated water in the glasses was measured after a period of one hour for each treatment. The obtained data were then interpolated by kriging and plotted to interpret the spatial distribution of the applied water. Both irrigation treatment clearly applied water to the targeted area under slight wind conditions. Water was mostly applied to the areas of the wet treatment when that irrigation system was activated and *vice versa* for the dry treatment. Moreover, the glasses were placed in line and on the inside of the external irrigation lines while the sprinklers in the studied experimental units were on the inside (towards the middle of the culture bed). Thus, we can visually extrapolate the results not computerized to further confirm that water was applied correctly as was planned in the experimental design.



The same set up that was used in 2011 was again used in 2012. The measured pressures coming from each sprinkler increased to 60 PSI when both sprinklers were running. Also, when the individual treatments were running, the pressures coming out of the sprinkler head were 62 PSI for the wet treatment and 60 PSI for the dry treatment.
In 2012, the monitoring period was the 1st of June through the 7th of September (99 days), again there is a reduction in irrigation water applied in the dry treatment (54.5% difference). There is an overall increase in irrigation water applied which can be explained by the longer monitoring period (35.6 % longer than 2011) and also the occurrences of rainfall events in 2012 vs. 2011 (Figures 5 and 6). In 2011, there were regular rainfall events throughout the monitoring period, in contrast to 2012 when there fewer, larger irrigation events. This difference results in the bed needing more irrigation events to maintain the specified tensions.

Soil physical and chemical properties
Data collected for the research field included: bulk density, soil porosity, organic matter content, water content and matric potentials, absorbtion and desorption curves, texture and chemical analysis.

Plant Properties
Data collected included plant photosynthetic rates, xylem potential, yield and berry analysis.

Impact of irrigation treatment on cranberry yield, marketable berry number and weight and unmarketable berry number:

Year	Treatment	Yield (lb/A)	Marketable Berrty #/sqft	Marketable Berry Wt (g)	Unmarketable Berry #/sqft
2011	Wet	33,751	231	1.5	17.2
	Dry	34,382	240	1.5	21.7
2012	Wet	25,853	190	1.44	6.2
	Dry	27,673	200	1.45	6.8

Significant results, accomplishments, conclusions and recommendations:

The most important result of this project was the successful demonstration of the potential to reduce the amount of water used by cranberry growers for irrigation through the use of soil moisture probes. The significant results that were demonstrated in this study provide growers with evidence that although there is a cost associated with the purchase and installation of this equipment, the economic gains resulting from reduced use of irrigation pumps as well as the environmental benefit of reduced water use provides strong incentive to pursue this technology.

Distribution of received water for the wet and dry treatment

Year	Treatment	Rain		Heat Protection		Irrigation		Other[1]		Total
		Inches	%	Inches	%	Inches	%	Inches	%	Inches
2011	Wet	7.44	36	0.08	0	12.72	62	0.20	1	20.43
	Dry	7.44	66	0.08	1	3.46	31	0.28	2	11.26
2012	Wet	8.87	25	0.0	0	26.09	75	0	0	35.0
	Dry	8.87	42	0.20	1	11.88	57	0	0	20.9

[1]Other: Water received while testing the irrigation system or while spraying pesticides or providing mineral nutrients

Significant contributions and role of project partners in the project

This project would not have been possible with the significant contributions of our grower collaborator and partner scientists at UW-Madison and Laval University. Dr. Jean Caron and his research team at Laval University. Dr. Caron contributed to the project through funding received from the Natural Science and Engineering Research Council of Canada and industry partner for this research, Hortau inc.. He contributed both funds and expertise to this project. Dr. Bland and his research lab at UW-Madison contributed by the development of the web-based ET calculator based on previous work he had done both on cranberry ET and the development of ET calculators for other crops in WI. The PI is extremely grateful for the contributions and collaboration provided by these partners. Carl Salzwedle is a cranberry grower in Wisconsin that hosted the research site for 2 years and provided invaluable time, financial resources and input into this project.

III. Goals and Outcomes Achieved

1. Established optimum soil moisture thresholds for cranberry crop based on soil tension.

- The most significant outcome of this project has been the demonstration of the use of soil moisture probes to schedule irrigation can result in up to 50% reduction in irrigation water applied with no impact on yield.
- Over the course of two seasons, we monitored plant health, water use and crop yield of two different irrigation regimes. The reduced water use had no significant impacts on the plant physiological characteristics or yield over the time of the study.
- Results indicate that use of soil moisture probes to maintain moisture levels between -4 and -7KPa led to up to 50% reduction in water use with no negative impacts on crop health or production during the course of the study**.**

2. Held two field day trainings on use and placement of soil moisture probes

- Cranberry growers were invited to two different field days, one at the research site and another at the WI State Cranberry Growers Association field day to learn about how to use soil moisture probes, proper placement and impacts on irrigation use
- During these training sessions, growers were informed about the different types of soil moisture probes, how to calibrate volumetric probes
- How to test the efficiency of your irrigation system (partnered with NRCS staff for demonstration and provided information about NRCS-EQIP opportunities)
- Growers were taught how to test the uniformity of soil moisture (drainage) in their cranberry beds

- Growers were able to discuss the results of the trial with the growers that collaborated on the project and hosted the field trial, allowing growers to hear from both researchers and a grower that was able to provide information about the practical aspects of utilizing the equipment in a commercial cranberry production system.

3. Development of online evapotranspiration tool

- Tool available to growers to get access to daily ET rates for the area that they are in and use this data to inform irrigation scheduling.

B. This project was very successful in achieving the outlined goals of providing research based information to growers regarding the potential use of soil moisture probes to reduce the amount of water used for irrigation in cranberry production. The most demonstrative data is the water use data and yield data. This set of data clearly shows that there is great potential in continuing to pursue the use of soil moisture probes to improve water use efficiency.

Distribution of received water for the wet and dry treatment

Year	Treatment	Rain		Heat Protection		Irrigation		Other[1]		Total
		Inches	%	Inches	%	Inches	%	Inches	%	Inches
2011	Wet	7.44	36	0.08	0	12.72	62	0.20	1	20.43
	Dry	7.44	66	0.08	1	3.46	31	0.28	2	11.26
2012	Wet	8.87	25	0.0	0	26.09	75	0	0	35.0
	Dry	8.87	42	0.20	1	11.88	57	0	0	20.9

[1]Other: Water received while testing the irrigation system or while spraying pesticides or providing mineral nutrients

Impact of irrigation treatment on cranberry yield, marketable berry number and weight and unmarketable berry number:

Year	Treatment	Yield (lb/A)	Marketable Berrty #/sqft	Marketable Berry Wt (g)	Unmarketable Berry #/sqft
2011	Wet	33,751	231	1.5	17.2
	Dry	34,382	240	1.5	21.7
2012	Wet	25,853	190	1.44	6.2
	Dry	27,673	200	1.45	6.8

IV. Beneficiaries

The primary beneficiaries of this work are the approximately 250 WI cranberry growers, many of whom were directly communicated with during the course of this project. This project provides research-based recommendations for refining irrigation practices through the use of available technologies. Growers can use the data provided to conduct an economic analysis for their own operation which would allow them to make an informed decision about investing in

soil moisture monitoring equipment. The purchase of this equipment does represent a significant investment both initial and ongoing and therefore this data is extremely valuable to help growers make an informed decision.

The citizens of WI and surrounding areas are also beneficiaries of this project as the implementation of the recommendations could result in reduced pressure on water resources in the great lakes region, an issue which is being addressed by multiple groups.

V. Lessons Learned

The value of collaborating was wonderfully demonstrated in this project.

The more practical lessons learned are focused on the challenges associated with using equipment to collect data. Due to the number of sensors used and the several different data logging systems used, there were challenges associated with collecting consistent data formats. For example, the sensitivity of the equipment, while a great strength, was a challenge until we were able to adequately ensure all of the probes used in the study were providing a standardized output. The time taken to calibrate the probes both in the lab and in the field was well spent as it allowed us to avoid the arduous task of analyzing data that needed to be corrected for calibration offsets.

VI. Additional Information

None

VII. Contact Info

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16) Promotion of Wisconsin farm-grown Christmas trees (FY11-016)

Report Date: February 28, 2013

I. Project Summary

A. Sales of farm grown Christmas trees in recent years has seen very little growth, and sometimes experienced a decline. Growers need to keep current customers and continue to get new customers in order to be sustainable in the future. We address this by promoting real trees whenever we have an opportunity.

B. This project complimented previously funded projects by utilizing material that was developed including an educational video emphasizing environmental benefits of real Christmas trees, getting more copies of the activity booklets and brochures, and continued updates on the educational pages of our website, www.christmastrees-wi.org.

II. Project Approach

We have re-designed and printed our Go Green, Get Real brochure and the children's activity flyer. We set up, monitored and updated a Facebook page, updated our website, www.christmastrees-wi.org, and worked with the contracted firm to do media outreach and Facebook advertising. In 2011 and 2012, we coordinated the donation of trees for and participated in promotion of the Trees for Troops program, had an educational exhibit at Farm Technology Days and the Wisconsin State Fair and in Dec. 2012, at Milwaukee Winterfest. One of our members' farms was part of an educational agriculture tour, sponsored by Ag in the Classroom. ** It should be noted that no Specialty Crop Block Grant funds were used to fund any aspect of the Trees for Troops program. The Trees for Troops program is not a fundraising activity. It is a program where growers donate trees to military families, volunteers do the coordination, and the shipping is also donated. All trees were donated and all other activities were funded through organizational and individual donations and Wisconsin Christmas Tree Producers Association operating funds. Because we are proud of this program and consider it an additional promotion of live Christmas trees, we have included it in our report, even though activities to make it a success were not funded through this grant.

Publications: A quick response (QR) code was placed on the new designs to entice smartphone users to scan the code, which will take them to our website. The code will help in tracking the website visitors. We printed 5,000 copies of the activity flyer and 50,000 copies of the brochure. These are being distributed around the state at Chamber of Commerce sites, tourism bureaus, and visitor centers. They were distributed by Ag in the Classroom and Wis. Agribusiness Council to teachers and volunteers, and can be downloaded from our website. They were handed out at Farm Technology Days, State Fair, Winterfest and other events.

Media Outreach and Facebook Advertising: During November and December 2011, Stephan & Brady (S&B) assisted the Wisconsin Christmas Tree Producers Association with a Public

Relations and Social Media Advertising Campaign to help increase awareness for the importance of buying Real, Wisconsin Christmas Trees. The campaign included media outreach to print, online and broadcast media outlets, as well as Facebook advertising. The campaign messaging reached nearly 5 million consumers with an advertising equivalency of $38,000, resulting in a 350% return on investment.

Broadcast Television Outreach: S&B secured television segments for WCTPA in two major media markets: Madison and Milwaukee. The segments highlighted local tree farms and focused on the importance of buying real, Wisconsin Christmas Trees. In the Madison market, WCTPA was the focus of a "Tim's Travels" segment on the NBC 15 morning show. Tim Elliot, the producer, came out to Summers Tree Farm and followed a local family as they selected their tree. The Summers and the local family touched on key benefits for buying a real tree. The TV segment reached an audience of 29,400 people, with an advertising equivalency of $1,500. In Milwaukee, WCTPA was featured on Fox 6. The producer visited Noffke Tree Farm and did three live segments focusing on different aspects of real trees, resulting in more than 10 minutes of air time. The TV segment reached an estimated audience of 36,250 people, with an advertising equivalency of $2,125.

WCTPA members contributed money to air a TV commercial, which ran in 246 spots in Nov./Dec. 2012 throughout Wisconsin. As a non-profit, we received free airings equal to the number of paid ones. The 30-second commercial was professionally produced. At our Jan. member meeting, the response from the members concerning the effectiveness of the commercial was generally favorable; they thought it was a good investment. We acquired another website address, www.RealTree4me.com, which was used in the commercial and online ad to make it easy for the audience to remember. At our Jan. member meeting, the response from the members concerning the effectiveness of the commercial was generally favorable; they thought it was a good investment. Seasonal Media Releases: Four media releases were developed for 2011 to communicate the buy real messaging to Wisconsin daily and weekly newspapers and local shoppers. Each seasonal release was also distributed as a social media release – an interactive press release designed to target digital publications and websites. Coverage resulting from the seasonal media releases and social media releases resulted in more than 2.1 million consumer impressions across Wisconsin media outlets, and an advertising equivalency of $32,650.

Release Topics:
• Why You Should Buy Real
• Tips for Picking the Perfect Real Tree
• Real Tree Care
• Recycling Real Trees in Wisconsin
Facebook Advertising Campaign: Our Facebook page, "Real WI Christmas Trees," was created on www.facebook.com. Both of our website addresses are listed on the page and people are encouraged to go to our website for more information on real trees. A link to the Facebook page, in the form of a "like" button, was put on our website. A Facebook banner ad was developed in 2011 to help drive traffic and "likes" for the WCTPA Facebook page. The ad targeted Wisconsin residents, ages 25+. The ads performed extremely well during the busy holiday time period. "Likes" for the Facebook page increased by more than 2000% during the campaign – from about

20 “likes” initially to the current number of 486 “likes.” Engagement (comments, shares, etc.) on the page also increased.

The ads resulted in more than 2.8 million consumer impressions (the number of people who viewed the ads during the campaign), 994 clicks to the WCTPA Facebook page and 412 “likes.” Photos and comments were added to the Facebook page periodically. We gained 18 new likes since the 2011 campaign; advertising was definitely beneficial, as it is hard to get new people just by posting on the page.

Website: We have been working on improving the website. The Google tracking code was added. Documents were uploaded. We acquired another website address, www.RealTree4me.com, which was used in the commercial and online ad to make it easy for the audience to remember. We set up a home page at this location as a framed site, pulling content and links from our primary website.

Web Stats: Our website statistics showed that we had a 60% increase in traffic on our website in 2011 but a small decrease in 2012. Unique visitors in 2012 was 49,741; 34.7% were from a direct address, 58% were from a search engine, 7.1% from an external page including realtree4me.com. 53,187 unique visitors in 2011 compared with 32,964 in 2010. In 2011 when people came to our page from a link on another page, 22.5% of those came from a link on facebook.com. In 2012, 1,494 people viewed the TV ad which was posted on our site. 72 unique documents were downloaded (29 in 2011, 16 in 2012), average time on site was 126 seconds- compared with 143 seconds in 2011, and 157 seconds in 2010 (high speed internet shortens the time). Google analytics of the realtree4me.com web address showed: 663 people visited the site, approx. 73% attributable to the TV commercial, 27% attributable to the online ad. The online ad had a click-thru rate of .047%. This was not as high as we hoped it would be.
S&B Online Outreach: Outreach was done to top Wisconsin-based family websites and blogs. Editors and bloggers were offered a gift certificate for a free tree to give away to their readers in the context of a post or article about the importance of buying real, Wisconsin Christmas Trees. Three sites participated in the outreach including Milwaukee Moms (website), Haute Apple Pie (blog) and Volume One (website). Collectively, the three placements resulted in more than 43,000 consumer impressions and an advertising equivalency of $2,350.

WCTPA purchased an online ad in 2012 which ran across local media sites and "Mom" sites for five weeks. The ad linked to realtree4me.com. Google analytics of the realtree4me.com web address showed: 663 people visited the site, approx. 73% attributable to the TV commercial, 27% attributable to the online ad. The online ad had a click-thru rate of .047%. This was not as high as we hoped it would be.

Partners: The Wisconsin Agribusiness Council (WAC) mailed a packet of "This Business Called Agriculture" booklets to 1,480 schools for their 4th grade programs. The booklets include a page dedicated to Christmas tree farming. In each mailing there was also a teacher packet that included contact information, additional agricultural resources, a Christmas tree DVD, and at least one "Go Green, Get Real" brochure. The DVDs had a label which directed them to our website. In addition, in May 2013, each school will receive a packet from the WAC asking them

to evaluate the educational materials they received, and asking teachers and students to write thank yous to the sponsors.

Ag in the Classroom continues to distribute Christmas tree brochures and booklets at their events and trainings. Alice in Dairyland was given a supply of brochures to distribute at schools and other events. She spearheaded the Official Christmas Tree Cutting event in Waldo and promoted real trees during the Something Special From Wisconsin media campaign in Nov./Dec.

III. Goals and Outcomes Achieved

A. We completed all of our activities. We have brochures and booklets in stock to distribute by request. All DVDs were distributed.

B. Through our activities, we achieved a positive outcome for 2011 but a lesser positive one for 2012. Goal 1: Our website statistics showed that we had a 60% increase in traffic on our website in 2011 but a small decrease in 2012. Unique visitors in 2012 was 49,741; 34.7% were from a direct address, 58% were from a search engine, 7.1% from an external page including realtree4me.com. 53,187 unique visitors in 2011 compared with 32,964 in 2010. When people came to our page from a link on another page, 22.5% of those came from a link on facebook.com. Photos and comments have been added to the Facebook page periodically. We gained 18 new likes since the 2011 campaign; advertising was definitely beneficial, as it is hard to get new people just by posting on the page.

In 2012, 1,494 people viewed the TV ad which was posted on our site. 72 unique documents were downloaded (29 in 2011, 16 in 2012), average time on site was 126 seconds- compared with 143 seconds in 2011, and 157 seconds in 2010 (high speed internet shortens the time). Google analytics of the realtree4me.com web address showed: 663 people visited the site, approx. 73% attributable to the TV commercial, 27% attributable to the online ad. After landing on this site, all the links took them to our primary website. The online ad had a click-thru rate of .047%. This was not as high as we hoped it would be.

Goal 2: We surveyed the members to determine if their sales have increased. 242 were sent out, 103 returned. Sales increased for 39 of them, remained the same for 41 of them, decreased for 21 of them. For those with an increase, most didn't indicate a percentage. For those who indicated, one increased by 100%, and the mean of the rest increased by 9.4%

IV. Beneficiaries

Christmas tree growers across Wisconsin benefitted from our promotional efforts. We promoted farm grown trees, not just tree sales locations. If the public has a realistic knowledge of the benefits of farm grown Christmas trees, they can make an educated decision when choosing a tree. Those who placed an advertisement on our website got more benefit because the public could find their sales location through our website.

V. Lessons Learned

Promotion and advertising is expensive and many times very hard to track. You can never be sure that your campaign was effective unless all growers track every customer, which is very unlikely to be done.

VI. Additional Information

Not applicable

VII. Contact Info

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17) Control of powdery mildew and leaf spot disease using low-risk pesticides (FY11-017)

Report Date: December 31, 2012

I. Project Summary

There were two studies addressed in this grant. One study was the potential control of powdery mildew using low-risk bio fungicides on high value cut-flower crops, which is in its second year of trialing. This report will review the results from the 2012 season as well as a comparison with the 2011 season results. The second study looked at the effectiveness of cranberry leaves as mulch, which was in its first year in the trial.

The fungicide trial addressed the effectiveness of two certified organic, bio-fungicides on powdery mildew and foliar leaf spot, which reduce yields, quality and value in the cut-flower industry. Since these are common diseases that make the crop unsalable, conventional fungicides are often used for control, posing risk to workers, consumers and the environment. In order to minimize these risks, this trial tested and evaluated two fungicides, Cease and Regalia, to a synthetic fungicide, Heritage, and a non-treated control, on three high value cut-flower crops, purple coneflower (*Echinacea spp.),* Black-eyed Susan (*Rudbeckia spp.)* and sunflower (*Helianthus Annus).*

Wisconsin is the largest producer of cranberries in the United States. The U.S. Department of Agriculture National Agriculture Statistics Service estimated Wisconsin yielded 4.5 million barrels of cranberries this 2012 fall season. With all this production, there are many leaves that fall off during the season and even more are removed during harvest. For years, growers have been accumulating these leaves and have been giving them away to home gardeners who have reported a significant measure of weed suppression. These leaves are small, light-weight, retain soil moisture, and are attractive. Having cranberry leaves on the market as mulch would benefit both the cranberry growers by providing them an additional product as a source of income, as well as gardeners by providing them a quality, local product.

B. The project was originally funded by a 2010 SCBG to research the effectiveness of two organic fungicides during the 2011 growing season. The first year data documented that one of the organic fungicides provided control of powdery mildew as well as the conventional fungicide. The weather impacted some data points and development of powdery mildew in 2011. The fungal disease did not develop until late in the summer on the control plants due to the low humidity and rain indices. The 2012 project provided the opportunity to collect data that showed the same results as the 2011 study. The two years of research document the effectiveness of Cease as a control for powdery mildew in cut flower production.

II. Project Approach

Activities and Tasks Performed

For the fungicide trials, the study design included three fungicides: one conventional and two certified organic. Cease and Regalia were the two certified organic, fungicides chosen, and Heritage was the non-certified organic or synthetic fungicide. The two certified organic, fungicides were chosen to compare their different modes of action. Cease contains a bacterium (*Bacillus subtilis* strain QST 713) strain, which produces active compounds that disrupt cell membranes, thus inhibiting the germination and growth of plant pathogens on a leaf surface. Regalia contains an extract of giant knotweed (*Reynoutria sachalinensis*) which induces the plants defense systems by producing cell strengtheners, antioxidants, phenolics, and pathogenesis-related proteins which inhibit plant pathogens internally. Heritage contains Azoxystrobin, a commonly used conventional fungicide in the industry that is a broad spectrum, preventive fungicide with systemic and curative properties. The long-term use of Heritage has resulted in the development of resistant strains of fungal organisms. Powdery Mildew resistance has been documented. Heritage was selected after talking with the grower of W. & E. Radtke Inc., who uses this on his cut-flower crops. In addition to the three fungicide treatments, non-treated control plots were included in the study.

The three fungicides were tested on two separate species of coneflower: purple coneflower, (*Echinacea purpurea)* and *Echinacea* 'Rubinstern', two cultivars of Black Eyed Susan, 'Goldstrum' (*Rudbeckia fulgida*) and 'Summer Blaze ('*Rudbeckia fulgida*) and three cultivars of sunflower (Helianthus), 'Valentine', 'Ikarus' and 'Sonja' (*Helianthus annuus).* Individual rows with the following replications were established for each fungicide treatment and the non-treatment control. Rows were separated by a 5-foot wide strip. A 20-foot boarder was established around the total plot. All borders around and between the treated and non-treated plots were mulched to control weed development. Each row of the two organic fungicides and the control had six repetitions of sunflowers. Each repetition contained a selection of each sunflower cultivar, for a total of six plants of each cultivar in every treatment and non-treatment plot strip. There were five repetitions for *Rudbeckia* and *Echinacea*, with each repetition consisting of two to three plants of each cultivar. It is to be taken into consideration that the conventional fungicide was not included in the original grant. It was added later in order to create a full spectrum study and compare how certified organic fungicides perform against the non-treatment control, and a product used by cut-flower producers. Fewer replications of each plant species were used in each repetition. The *Rudbeckia* and *Echinacea* were replicated twice and the sunflowers were replicated three times.

The annual *Helianthus* were seeded in the greenhouse on May 14, 2012 and planted in the field, alongside the *Rudbeckia* and *Echinacea*, on June 8, 2012. The first spray application occurred on June 25, 2012 with subsequent sprays occurring on July 19th, August 14th, August 28th, and September 11th. As of September 11th, there was only powdery mildew present on the sunflowers and no powdery mildew or leaf spot on the *Rudbeckia* and *Echinacea*. The first signs of powdery mildew were seen on August 20th and the first sets of evaluations were taken on August 21, with subsequent evaluations taken on August 24th, 29th, and September 4th. On September 6th and 17th a new method of data collection was used. The data was based on the criteria of the images in Section VI: Additional Information. The method of data taking was adopted in order to obtain more representative data. The sunflowers were visually sectioned into a lower and upper section.

The overall percent coverage of powdery mildew that impacted the bottom half of the plant had one data point and the overall percent coverage of powdery mildew that impact the upper half of the plant had a separate data point. This method was adopted to determine disease indices for the upper and lower leaves. The bottom half of the plants developed significantly more powdery mildew compared to the upper half. The lower section does not have a significant impact on the economic value of a cut flower and thus the reason for the data adoption method.

The cranberry leaf mulch was obtained from Cranberry Creek Cranberries, Finely, WI. The leaves were stored on-site at the Agricultural Research Station. All leaves were turned during the winter and spring using a windrow compost turner. Two depths, 2" and 4", were tested within the three rows of *Rudbeckia*, *Echinacea*, and *Helianthus* of the fungicide study; the conventional treatment row of the fungicide study was not included in the mulch study. Before the mulch was applied, the rows were weeded thoroughly and tilling was completed around all plants to break up the crusted soil. Each of the three rows was divided into three sections with each row having one section of a 4" depth, one section of a 2" depth and one section with a control that had no application of cranberry leaves.

Weed counts on the cranberry leaf mulch study were taken four times this season on July 6th, July 20th, July 27th and August 3rd by separately counting the number of dicot weeds (broadleaved weeds) and the number of monocot weeds (grass-like weeds). Data separation of the broadleaf and monocot was established in order to observe if a difference exist in the types of weeds the cranberry leaves suppress. At the end of July, the tallest weeds in the control treatments were pulled out from around the base of the *Echinacea*, *Rudbeckia* and *Helianthus* and on August 1st, the weeds in the control treatment were cut to approximately 8" above the ground to ensure that weed pressure did not result in the suppression of the growth plant subjects in the study. By cutting them to 8", this retained the base of the weeds in the ground in order to continue taking weed counts and also did not compromise the fungicide study.

For this grant we have worked with the Commercial Flower Growers of Wisconsin in discussing the parameters of these two studies. They, along with private sector flower growers, helped determine which varieties of cut flowers were used. Their own experiences in mildew and leaf spot disease outbreak or development lead to the selection of purple coneflower (*Echinacea* spp.), black-eyed Susan (*Rudbeckia* spp.) and sunflower (*Helianthus annuus*) 'Valentine', 'Ikarus' and 'Sonja'.

The same private sector growers suggested that the conventional fungicide Heritage be adopted as part of the spray program. Heritage is the most commonly used cut flower fungicide in the industry. Seeds and plant material were generously donated by W. & E. Radtke Inc. and Benary Seed Company. Cranberry Creek Cranberries donated the cranberry leaves for the leaf mulch study. UW-Extension plant pathologist and Director of the Plant Disease Diagnostic Clinic, Brian Hudelson, assisted with disease identification by observing the plants in the field, as well as collecting plant material and performing test on the plant material in the laboratory. Test showed that no leaf spot disease was found to have infected any of the plants in the test plots.

Environmental and Infection Conditions

According to the University of California, powdery mildew is “white, powdery mycelia and spore growth” that develops on the surface of leaves, shoots, flowers and fruits. Wind is the primary source of spores spreading to new hosts. Germination occurs in the absence of water and is inhibited when there is a prolonged presence of water. Cloudy or shady conditions with temperatures between 60-80°F is ideal while extreme sunlight and heat with leaf temperatures above 95°F can kill the fungus. The Colorado State University Extension lists methods of cultural control.

These cultural controls include several options. Using varieties that have resistance to powdery mildew is the first choice a grower can use as part of an integrated pest management program. In the absence of resistant varieties a grower should limit nitrogen applications. Limiting nitrogen fertilizer in the late summer will decrease the chance of infection. Excessive plant growth, due to high nitrogen applications can trap moist air that produces a more conducive environment for powdery mildew. Reduction of relative humidity by avoiding overhead watering, removal of infected plant parts and increased spacing to prevent overcrowding also results in less disease indices. Clean up and remove all the infected plant debris in the fall, are all practices that can improve control of powdery mildew.

According to Purdue University Extension, foliar leaf spot symptoms are small dark brown lesions that are one-eighth to one-fourth inches in diameter. Spores overwinter in infected plant material and are spread by splashing water from rainfall or irrigation. Lower leaves are infected first and infection on the lower leaves continued to infect upper leaves throughout the season. Unlike powdery mildew, leaf spot spores require moisture to germinate. Overhead irrigation can lead to outbreaks of disease due to moisture retention on the leaves after irrigation.

The weather conditions at the West Madison Agricultural Research Station were recorded using Davis Vantage Pro Weather Station. Reviewing the monthly climatological summaries, the weather conditions of this season were very hot, dry and sunny. In June the average temperature for the month was 82°F. The total amount of rain received was 0.87” and the average wind speed was 3.4 mph. In July, the average temperature was 88°F with a total rainfall of 3.90” and an average wind speed of 2.7 mph. June and July also had many consecutive days with clear, sunny skies. August had an average temperature of 80°F with a total rainfall of 1.80” and an average wind speed of 1.8 mph. This information shows that the months of June and July had temperatures that were too high for the growth of powdery mildew and July had the most rainfall, which is less conducive to powdery mildew development. August had the most favorable conditions with lower temperatures and lower rainfall. The first document powdery mildew infection occurred in August. Leaf spot was not detected throughout the season. Weather conditions again were not conducive for the growth and development of leaf spot infection.

Quantitative Analysis

Fungicide Data:

Figure 1

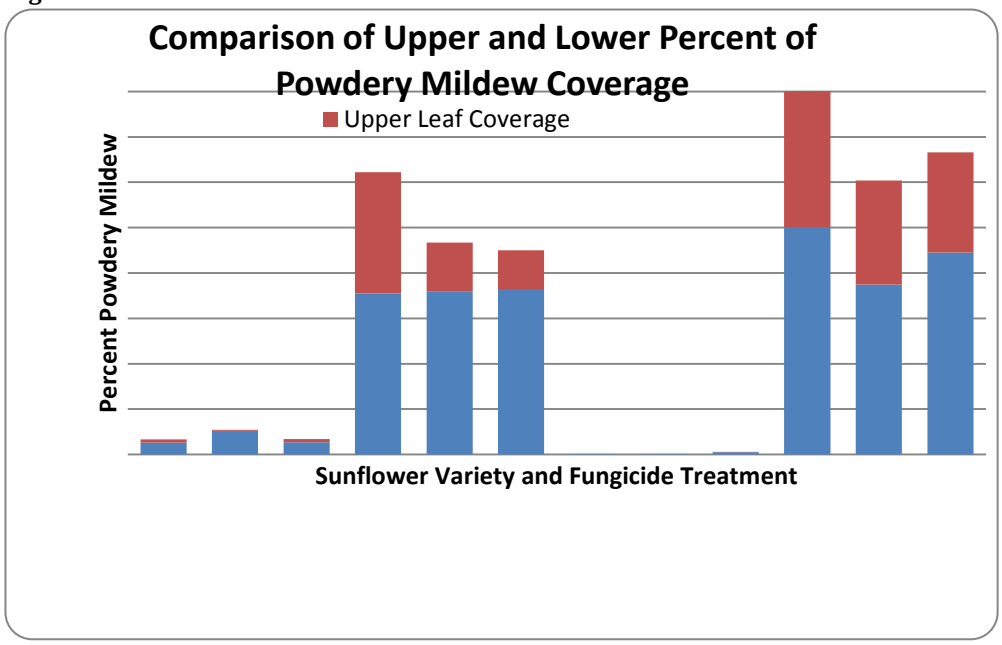
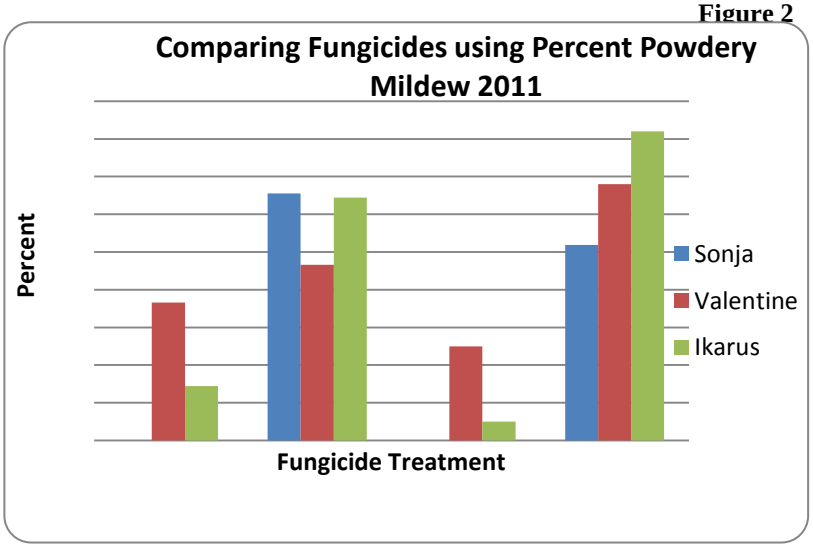


Figure 1- shows the total percent coverage of powdery mildew for the lower halves (in blue on graph) and upper halves (in red on graph) of the sunflower cultivars

'Sonja', 'Valentine' and 'Ikarus' for the three fungicides and the control as of the last data set on September 17th. Over the three month period, sunflowers in the Heritage treatment did not develop powdery mildew on the upper half of 'Sonja' and 'Valentine' and had an average of 0.03% and 0.05% on the lower halves respectively. 'Ikarus' developed an average of 0.03% powdery mildew on the upper half and 1.03% on its lower half. Of the two organic fungicides, Regalia performed better than Cease.Regalia developed an average of 1.3% and 5.3% powdery mildew on the upper and lower halves of 'Sonja' respectively. 'Valentine' developed an average of 0.35% on the upper leaves and 10.5% on the lower leaves and 'Ikarus' development of an average of 1.42% and 5.4% on the upper and lower leaves respectively. Cease developed an average of 53.37% on the upper leaves and 7% on the lower leaves of 'Sonja'. 'Valentine' developed an average of 21.44% on its upper half and 72% on its lower half. The upper leaves of 'Ikarus' developed an average of 17.5% and the lower leaves developed an average of 72.5%. The control developed the most powdery mildew with 'Sonja' developing 63.02% and 100% on its upper and lower leaves, 'Valentine' developed 45.83% and 75% on its upper and lower leaves and 'Ikarus' developed 44.17% of powdery mildew on its upper leaves and 89% on its lower leaves.

Figure 2



When comparing data from 2011 in Figure 2, the results are equivalent to the 2012 data in the amount of control each fungicide provided, showing Heritage and Regalia performing better than Cease and the control.

Cranberry Mulch Data:

Figure 3

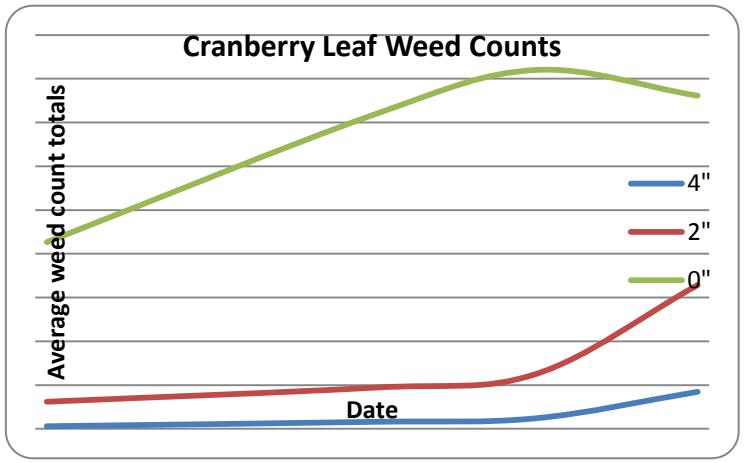


Figure 3 shows the total number of monocot and dicot weeds for a 4" depth, 2" depth and a 0" (no-treatment control) depth of cranberry leaves over a month period. Data shows that the 4" depth resulted in the best control with an average of 3 weeds, 8 weeds, 12 weeds, and 42.33 weeds over the data colleciton period. The 2" depth did not perform as well as the 4" depth. The 2" treatment had 31 weeds on July 6th, 47 weeds on July 20th, 62.33 weeds on July 27th and 164.33 weeds on August 3rd. Both the 4" and the 2" depths performed better than the no-treatement control. The control treatment had an average of 213.33 weeds on July 6th, 358.33 weeds on September 20th, 410 weeds on July 27th and 380.66 weeds on September 3rd.

Figure 4

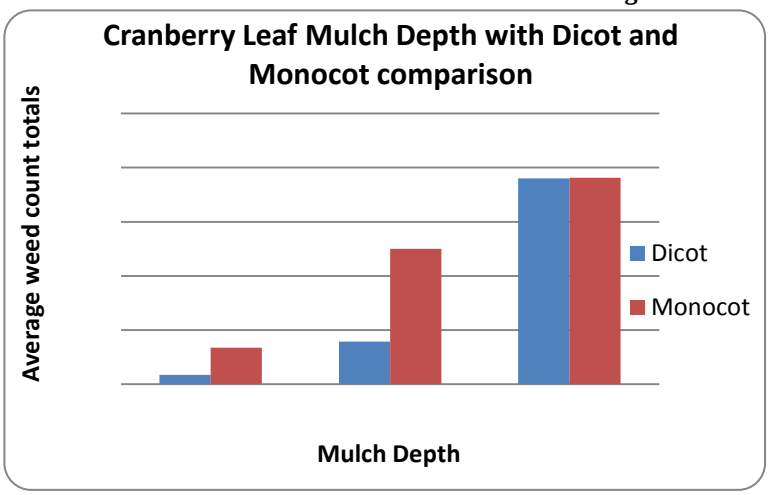


Figure 4 shows different depths of mulch and the affect of mulch depth on the growth of monocot weeds compared to dicot weeds. This graph shows the total number of weeds that were established for the last data set on September 3rd. In the 4" treatment there were fewer dicot weeds than monocot weeds with an average of 8.66 and 33.6 respectively. Fewer dicot weeds than monocot weeds emerged in the 2" treatment with an average of 39.33 dicots and 125 monocots. The control had an average of 190 dicots and 190.66 monocots develop.

Table 4

Summary of Cranberry Leaf Mulch outcomes					
	Average # monocots	Average # dicots	Average Total weed count	Average % coverage	% reduction from control
0”	190.66	190	380.66	93.75%	
2”	125	39.33	164.33	37.75%	56%
4”	33.66	8.66	42.33	6.25%	90%

Qualitative Analysis

Throughout the study, powdery mildew only developed on the three cultivars of sunflowers and not on the *Echinacea* or *Rudbeckia* and leaf spot was not detected on any of the three genera. Looking at Figures 1 and 2 from 2011 and 2012, they show consistent results with the conventional fungicide Heritage providing the most control of powdery mildew which was comparable to the organic fungicide Regalia. Cease provided less control than Regalia and performed comparably to the control, which gave the least control. It also can be noticed ‘Sonja’ contracted more powdery mildew in 2012 than in 2011 and ‘Valentine’ and ‘Ikarus’ did not show a trend in one contracting more powdery mildew than the other, showing the difference in effectiveness of each fungicide is not based on cultivar selection.

The photo below includes the control section in the top left corner, 4” sections in the top right corner and bottom left corner and a 2” section in the bottom right corner.

Figure 5

The cranberry mulch treatments showed significant differences in the number of weeds that were suppressed. Figure 5 shows a visual difference in the percent coverage of the three trial depths. The 4" depth had the best weed suppression abilities. The 4" treatment had 75% fewer weeds develop compared to the 2" treatment. When comparing the 2" treatment to the control, the 2" treatment had a 56% reduction of weeds. Figure 4 shows there was better control of dicot weeds than monocot weeds in both the 4" and 2" depths and there were an equal number of monocot and dicot weeds that grew in the control sections. This is presumed to be because the grass-like blades are better able to penetrate through the small spaces between the cranberry leaves than leaves of dicot weeds can. The decrease in the number of total weeds in the control shown in Figure 3 is due to pulling out weeds from the base of the plants in the fungicide study on August 1st.

III. Goals and Outcomes Achieved

In the fungicide study the perennial *Echinacea* and *Rudbeckia* had established growth and overwinter from the 2011 project. The annual *Helianthus* seeds were grown in the greenhouse and seedlings transplanted in the field after the threat of any late spring frost had passed. Timing was also correlated to insure strong growth establishment before powdery mildew and leaf spot growth infection period would develop. Five spray applications of the two organic fungicides and conventional fungicide were completed. The fungicide application was applied at the time humidity and temperatures levels were conducive to growth of the disease organisms. Sprays were set at 14 days increments. Data was taken on six occasions starting August 21st, when powdery mildew first developed, through September 17th.

This study was implemented in 2011. With each season, different extreme weather conditions influenced the results of the study. The 2011 and 2012 data, documented a trend in the effectiveness of each fungicide even under severe heat, fluctuating humidity levels and windy conditions.

The cranberry leaf mulch was composted for one year on-site at the station, and a compost turner was used to "turn" the leaf pile four times. The leaves were applied to the rows of the *Echinacea*, *Rudbeckia* and *Helianthus* after a thorough weeding and tilling of the ground around the plant species in the trial. The cranberry leaves were applied at the rates of 2" and 4" depths along with a non-treatment control. Data was taken on four occasions from July 6th to August 3rd. The numbers of monocot and dicot weeds were recorded separately in order to observe any difference weed suppression.

The study documents that there are very clear differences in the number of weeds that emerged through the 4", 2" treatment plots of the cranberry leaf mulch, and no-treatment control. Additional funding with a 2012 SCBG will repeat this process to attempt to validate the single year of study completed with 2011 SCBG funds.

B. From analyzing the data and graphs that are shown in Figures 1 and 2, it is evident that there was a significant comparison of one of the two organic fungicides to the conventional fungicide that is currently being used in the cut-flower industry. The organic fungicide Regalia, performed similarly to the conventional fungicide, Heritage, for the two years this research was conducted. **This shows strong evidence that Regalia can be used in place of conventional fungicides in order to keep field workers, florists and consumers safe as well as the environment**. **The graphs also show the organic fungicide, Cease, does not perform at the same level as either Heritage or Regalia which indicates that this fungicide does not provide the protection the cut-flower industry needs** in order to provide an extended period of harvest of high-value flower products.

Figures 3 and 4 and Table 1 document the data collected on the cranberry leaf mulch. The data shows how effective the cranberry leaf mulch suppressed weed growth. The data shows significant reduction in the number of weeds that grew in plots with cranberry leaves as compared to the no-treatment plot cranberry leaves. The comparison between areas with 4" and with 2" shows a 75% increase in the total number of monocot weeds and dicot weeds with the 2" depth. The review of the weed suppression data for 2012 indicates a promising new product for growers and home gardeners to control weeds in cut flower production systems and in home garden annual and perennial flower and vegetable beds.

IV. Beneficiaries

One peer reviewed extension fact sheet on the results of the fungicide study for selected plant species was sent to 91 extension agents, who disseminated the information to their constituents, an estimated 8,000 or more individuals and 500 to 600 Master Gardeners, and was placed on the Horticulture Team Web Site and the Master Gardener's web site. Information was also provided to individual growers, consumers and educators that attend field days, evening walks, garden walk-in visitors, and presentations on research data.

Information was disseminated at the Commercial Flower Growers field day to 55 growers and over 20 people from the Green Industry and will continue to be disseminated at future meetings. Reports are being sent to 750 individuals through the Wisconsin Commercial Flower Growers' newsletter, and the Wisconsin Green Industry publication Green Side Up, and to approximately 250 National Cut Flower Association Members, and the report has been placed on the West Madison, University Display Garden blog at: www.universitydisplaygardens.com.

Results were also given to staff at Fred Gloeckner Company and Benary Seed. Benary is the company that supplied the Sunflower Seed for the trials and Gloeckner made the donation possible. Staff from both these companies are spreading the results to others, outside Wisconsin, who may find the results useful.

Records were maintained of growers/visitors and stakeholders visiting the West Madison Ag Research Station, Trial and Demonstration Garden web site and attendance at conferences where information could be presented. The web site drew thousands of visitors during the year.

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

A Special thanks to W. & E. Radtke Inc. for generously donating the *Echinacea* and *Rudbeckia* plants, Benary Seed Co. for donating the sunflower seeds and Cranberry Creek Cranberries farm located in Wisconsin, for donating the cranberry leaf mulch.

V. Lessons Learned

The unusual weather of this season posed multiple problems. Early in the season, 100% of the *Echinacea* were infected with aster yellows, which was diagnosed at the Plant Disease Diagnostic Clinic. Aster Yellows stunted the growth, discolored the leaves and contorted the flowers; leaving the plants in a condition not conducive to powdery mildew infection.

The drought that occurred in June and July proved to be hard on all three genera. It was difficult to keep the *Helianthus* well watered during establishment period and many had to be replaced after the first planting date. Due to the irrigation system and set up in the gardens and throughout the agricultural research station, it was difficult to keep the plants in this study well watered and the *Helianthus* had a particularly difficult time becoming established.

The research plot was sited in a very windy location. The wind impacted many of the *Helianthus*. Most grew at an angle; making it difficult to spray and take accurate data. This resulted in more branches grow towards and/or at ground level where powdery mildew is more conducive to grow. High wind gust broke off large numbers of branches throughout the data-taking period. During a storm on September 1st, there were high gusts of winds that broke the main stem of four *Helianthus* eliminating them from the study.

In the previous 2011 season, the *Helianthus* were arranged with five plants in each repetition, which proved to be compact for accurate spray application and accurate data recording. This arrangement also provided a conducive growing environment for powdery mildew development by the impeding airflow and creating an environment higher in relative humidity. The 2012 season, this was amended by having three *Helianthus* plants, one of each cultivar arranged in a triangle, in each repetition. More space was provided for each plant to grow, and gave space for more accurate data to be taken.

Powdery mildew infection occurs on the leaves, stems and/or flowers and flower buds, the quality and therefore the value of the crop is decreased dramatically. Generally the lower leaves are not cut and sold. Thus these parts do not affect the quality of the cut flowers. In the previous 2011 season, data was taken specifically on cut-flower stems of the sunflowers. This 2012 season, there were no cut flowers removed from the selections. The percent of powdery mildew of the upper halves as a whole was documented to obtain the data sets. This method was more straightforward and consistent across plant cultivars and trials and is recommended for future study. The criteria focuses directly on the portion of the plant harvested for cut flower production.

No active infection of foliar leaf spot disease was found on any of the plant selections in the research plots. The *Echinacea* and *Rudbeckia* leaves were brought to the Plant Disease Diagnostic Clinic to be tested for foliar leaf spot diagnosis. The results showed there were beginning symptoms of this bacterium on the *Rudbeckia* leaves but no signs of sporulation were found.

One problem encountered in the cranberry leaf study was the abundant development of weeds that impacted the growth and development of microclimates around the plants. In the no-treatment control plots weeds established and grew quickly, making it difficult to get accurate weed counts. The weeds also quickly grew in height next to the *Echinacea*, *Rudbeckia* and *Helianthus* in these plots, which gave the potential to develop microclimates in and around the plants. In order to elevate the weed development, the tallest weeds were pulled from the plots on July from around the base of the *Echinacea*, *Rudbeckia* and *Helianthus* and on August 1st the weeds were cut to approximately 8" in height.

In the future suggestions for study improvement include the following:

Helianthus should be seeded in 4" pots in the greenhouse and planted in the ground a few weeks later than they have been the previous two years of study. This will give healthy plants that are in good physical condition during the time when powdery mildew comes and when data is being taken.

Weeds should be pulled after inventory of weed population, to insure that weeds are not a sink for the nutrients needed for good growth of plant species. Plants need nutrients to grow well, produce new growth that is more susceptible to powdery mildew.

Solid set irrigation pipes should be in-place for any future studies. Rain fall levels should be monitored. Irrigation should be applied to all plots to maintain 1" of rain a week.

VI. Additional Information

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Pottorff, L.P., Edmunds, B., May 2009, Powdery Mildews, *Colorado State University Extension*, 19 Oct. 2011 <http://www.ext.colostate.edu/pubs/garden/02902.html>

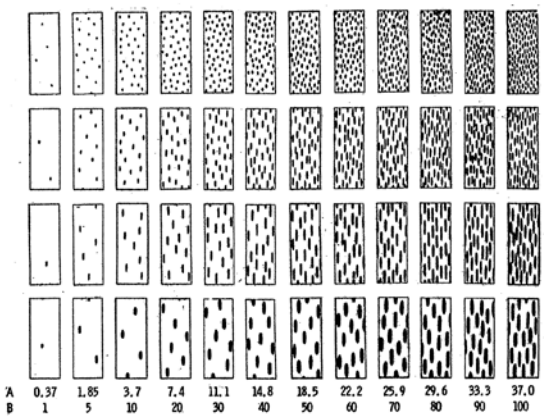
Shaw, Beverly, March 7, 2011, Rudbeckia Leaf Spot, Purdue *Plant and Pest Diagnostic Laboratory, Purdue Extension*, 18 Oct. 2011 <http://www.ppdl.purdue.edu/ppdl/expert/Rudbeckia_leaf_spot.html>

Oregon State University, Plant Disease Management, 4, Sept. 2012 http://bpp.oregonstate.edu/files/bpp/webfm/pdf/bot552/BOT%20552%20Lecture%203.pdf

Wisconsin State Cranberry Growers Association. 2012. 7 Nov. 2012. www.wiscran.org

Disease Indices
Index Based on % of Area Affected

Cereal rust severity when uredia are different sizes



Actual % of leaf area covered is 0-37% (A)
100% "disease" set at 37% of leaf area covered
Area rating transformed to "relative disease" scale of 0-100% (B)
= visual percentage of severity, not of area

Peterson et al. 1948

Example of Pages from a Field Key for Late Blight

a

Key No. 3.1.1

LATE BLIGHT OF POTATOES

PERCENTAGE LEAF AREA COVERED

Key No. 3.1.2

LATE BLIGHT OF POTATOES

Blight (%)	Nature of infection
0.0	No disease observed
0.1	A few scattered plants blighted; no more than 1 or 2 spots in 12-yard radius
1.0	Up to 10 spots per plant; or general light infection
5.0	About 50 spots per plant; up to 1 in 10 leaflets infected
25	Nearly every leaflet infected, but plants retain normal form; plants may smell of blight; field looks green although every plant is affected.
50	Every plant affected and about 50% of leaf area destroyed; field appears green, flecked with brown
75	About 75% of leaf area destroyed; field appears neither predominantly brown nor green
95	Only a few leaves on plants, but stems green
100	All leaves dead, stems dead or dying

(After British Mycological Society, 1947)

Anon. 1947

VII. Contact Info

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18) Assessing soil fumigation and fumigation alternatives in WI potato production (FY11-018)

Report Date: November 26, 2012

I. Project Summary

A. In Wisconsin, potatoes are grown on approximately 63,000 acres and are the largest specialty crop industry in the state with an annual harvest of approximately 25 million cwt and a farm gate value of about $246 million. One of the limiting factors in potato production is disease. Key soil-borne pathogens include *Verticillium dahliae*, *Pratylenchus penetrans*, and *Streptomyces scabies*. While soil fumigation can be effective in limiting initial soil inoculum, it can be difficult to appropriately time and can be potentially harmful to workers and the environment. Further, the EPA is continually reviewing and revising use patterns and restrictions on soil fumigants including non-fumigated buffer zones, creating further challenges in implementation. As national leaders in integrating environmentally-responsible and sustainable production practices in potato, Wisconsin growers are interested in implementing alternatives to reduce, replace, or augment fumigation. However, for alternatives to be viable, they must be effective, have compatibility with current production practices, and be economical. We assessed the efficacy and feasibility of several fumigation, crop rotation, cover cropping, and cultural practices on soil-borne disease control in this project. Treatment efficacy was determined by measuring pathogen density in soil, plant and tuber health, yield, soil nitrogen, and other soil factors. Our field trials were on cooperator farms, at the UW-ARS in Hancock, at the UW-Langlade County airport station, and we expanded the study into a multi-year project.

B. This project was an extension of a previously funded SCBGP in 2010-2011. The 2011-2012 project served to continue multi-year investigation of fumigation, crop rotation, and other cultural practices whose impact cannot be recognized in a single year of study.

II. Project Approach

We have made significant progress on this project as of the date of this report. Specific updates on each objective of the project are detailed below (following sequence of original proposal). Our project, "Assessing the utility of soil fumigation and soil fumigation alternatives in Wisconsin potato production," was comprised of multiple field objectives both on UW research stations and on grower cooperator farms. All projects had critical involvement of Mr. Bryan Webster, UW-Plant Pathology Graduate Research Assistant, Dr. Stephen Jordan, UW-Plant Pathology Associate Researcher in Vegetable and Potato Pathology, and Mr. Kenneth C. Cleveland, UW-Plant Pathology Undergraduate Research Assistant. In this special funding allowance in 2011-2012, Mr. Webster was the sole personnel supported through this funding source.

Due to the nature of this multi-year field investigation, projects are reported on that fall outside of the time scope of this special funding allowance (2011-2012). This extended reporting is

necessary given the assessment of integrated cropping system effects that contribute to increased yield and quality, resulting from disease control.

In the fall of 2010, we established 3 trial sites for spring 2011 potato planting for the evaluation of fumigation on soil-borne disease of potato. Establishment was necessary in the fall prior to production season of potato because fumigation requires a period of time for off-gassing prior to planting.

1) **Met am sodium fumigation and alternative treatments (vine removal and cover crops) for Verticillium (PED) control of potato, 'Russet Norkotah,' at the Hancock Agricultural Research Station (HARS), Hancock, WI, Plot S25. This project was coordinated with UW-Plant Pathologists Drs. Doug Rouse (directed vine removal, manure treatments, and Verticillium soil assay) and Anne MacGuidwin (directed cover cropping treatments and conducted nematode assays).**

A trial was established 22 May 2011 at the Hancock Agricultural Research Station, Hancock WI, to evaluate broadcast metam sodium (Vapam HL, AMVAC) soil fumigation, non-fumigant alternatives, vine removal, and cover crops for control of potato early dying, caused by the complex of the *Verticillium dahliae* fungus and *Pratylenchus penetrans* root lesion nematodes. Over several years, the yield enhancing and disease controlling effects of inputs across a typical potato rotation of potato-corn-soybean-potato will be assessed. As is commercially standard in northern conventional potato production, fumigation treatments of broadcast metam sodium (40 gal/acre) were applied in the fall of 2010. Fall fumigation is necessary due to inadequate early spring conditions for effective fumigation and limited time to allow for off-gassing prior to planting of a ≥120 day crop. Fungicide, fertility and insecticide programs were consistent with grower standards for the production region. The center two rows of each plot were harvested 22 Sep 2011. Tubers were graded into marketable (US#1), undersize, and cull categories on 29 Sep 2011. At date of vine kill, assigned 'vine removal' treatments were subjected to chopping and removal of vines. Disease pressure was moderate in this field. After harvest, the field was planted to cover crops for second phase of the experiment. Prior to first snowfall, cover crops were soil incorporated. Results, to date, reflect impact of soil fumigation and vine removal on yield (quality and quantity) and pathogen incidence in the soil (Table 1). Numerically, fall fumigation resulted in higher yielding plots. However, differences were not statistically significant. Vine removal enhanced yield for both fumigated and non-fumigated treatments, but was not statistically significant. Compared to the non-fumigated, non-vine removed control, the fumigated and vine removed treatment significantly increased total yield (Table 2). *Verticillium dahliae* is notoriously elusive in soil plating assays due to their slow growth and low numbers in soil (Figure 1). Our results indicate very low numbers of *V. dahliae* in the soil; no significant differences were resolved. Cover crop effects will not be recognized until further statistical evaluation of corn yield and quality data in late fall 2012. Field corn was harvested mid-October. A preliminary look at the data suggested that there were minimal differences in yield or grain moisture among plots. The experimental field will rotate back to potato in 2014 after beans in 2013.

**Field corn and soy beans are important to this study because they are part of the normal rotation necessary for successfully growing potatoes, however, specialty crop funds were not used to cover any part of the work done with field corn or soy beans in this project.

Table 1. Preliminary effects of fumigation, cover crop, and vine removal on potato, 'Russet Burbank', yield and soil pathogen status.

Treatment Number	Treatment	Marketable Yield	Total Yield (cwt/A)	Root Lesion Nematodes/ 100 cc soil	*Verticillium dahliae* colonies/g soil
1	Rye cover crop (*commercial standard practice without Vapam*)	109.1 b	472.5 ab*	110.5 bc	0
2	'Caliente' mustard cover crop	110.2 b	478.9 ab	66.5 abc	0
3	Tillage radish cover crop	115.1 ab	487.3 ab	78.0 abc	0
4	Vines removed; rye cover crop	119.1 ab	500.0 ab	140.0 c	0
5	Vines removed; 'Caliente' mustard cover crop	112.4 ab	462.4 b	23.3 ab	0
6	Vines removed; Tillage radish cover crop	125.0 ab	528.7 a	74.5 abc	0
7	Vapam; Rye cover crop (*commercial standard practice with Vapam*)	124.9 ab	523.2 ab	4.0 ab	0
8	Vapam; 'Caliente' mustard cover crop	116.9 ab	476.3 ab	20.3 ab	0
9	Vapam; Tillage radish cover crop	115.5 ab	496.4 ab	3.0 a	1
10	Vapam; Vines removed; Rye cover crop	116.5 ab	484.9 ab	3.3 ab	0
11	Vapam; Vines removed; 'Caliente' mustard cover crop	112.6 ab	489.5 ab	19.8 ab	1
12	Vapam; Vines removed; Tillage radish cover crop	129.2 a	535.3 a	1.5 a	0

*Column means with a letter in common or with no letter are not significantly different (Fisher's LDS, *P*=0.05).

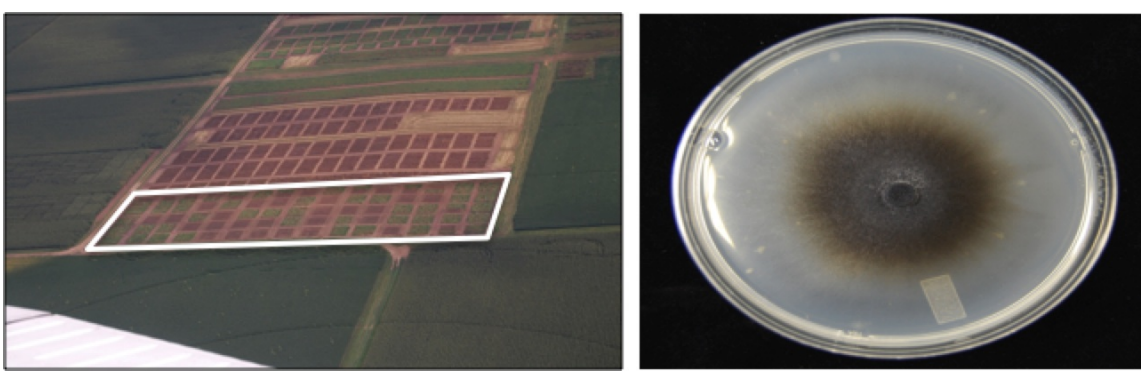


Figure 1. Aerial photo of potato fumigation alternatives trial at the UW-Hancock Agricultural Research Station (on left). Note vine removal treatments seen as bare ground in field marked in white. Culture of *Verticillium dahliae* collected from soil in potato research field, 2011 (on right).

Table 2. Impact of metam sodium (Vapam HL 40 gal/acre) pre-season soil fumigation and pre-harvest vine removal on potato ('Russet Burbank') yield.

Treatment #	Treatment	Total yield (cwt/A)	% Marketable yield (cwt/A)
1	Control (No Vapam, No Vine Removal)	472.5 a*	86.9
2	Vine Removal	484.0 a	84.3
3	Vapam HL 40 gal/acre	502.6 ab	87.7
4	Vine Removal + Vapam HL 40 gal/acre	519.3 b	84.8

*Column means with a letter in common or with no letter are not significantly different (Fisher's LSD, *P*=0.05)

2) **Chloropicrin fumigation evaluation for common scab control of potato. This project was coordinated with Dr. Chad Hutchinson of Tri-Est Ag Group, Inc. (chloropicrin manufacturers and applicators), Mr. Alex Crockford, formerly of the UWEX Langlade County Research Station, Antigo, WI, and Dr. A.J. Bussan, Potato and Vegetable Horticultural Specialist of the University of Wisconsin Madison.**

Chloropicrin is an alternative fumigant to the commonly used metam sodium (Vapam) with differential disease control properties. In addition to controlling PED, chloropicrin has been evidenced to also control common scab. It is hypothesized that a focus of use of chloropicrin on seed potatoes may aid in the reduction of reliance on fumigation in commercial potato production for processing or table stock. Seed production comprises just 10% of potato growing acreage. Additionally, it is of interest to identify the appropriate method of use of chloropicrin in an in-line approach which will reduce the overall amount of field soil treated with fumigation by nearly one half. A trial was established at the grower cooperator seed potato farm of John T. Schroeder, Langlade County, WI, in fall of 2010 to evaluate fumigation efficacy for control of potato common scab. Approximately 2 oz seed pieces were cut mechanically on 5 May from 'Pike' tubers. Seed pieces were allowed to heal before planting. A randomized complete block design with four replications was used for the trial and treatment plots consisted of four 300-ft X 20.7-ft treated sections which aligned with approximately 8 potato rows at the grower cooperator farm of John T. Schroeder of Antigo, WI. Fumigation treatments were applied on 30 September 2010 (Table 3). Tillage and planting of Pike seed was carried out as per grower standard practice. The soil type was Antigo silt loam and the field was maintained during the growing season according to standard grower practices. The center two rows of each plot were harvested 20 Sep 2011. Tubers were graded into US#1, undersize, and cull categories on 23 Sep 2011. After undersize tubers were graded out and tubers washed, but before scabbed tubers are removed, 20 tubers from each plot will be chosen arbitrarily and assessed for scab incidence.

All of our treatments, with the exception of Trt 1, C-60 at 83 lb./A broadcast, yielded common scab incidence results that were not significantly different than the untreated control. The unexpected results indicated a failure of common scab control in this grower cooperator trial. It is hypothesized that the tillage practices that took place after application of the fumigant disturbed the treated soil zone, incorporating untreated, *S. scabies* infested soil into the potato hill. The US#1 yield of all treatments (mean of trts: 262.6 cwt/acre) was significantly greater than the untreated control (171.4 cwt/acre) (Table 4). This trial, on a grower cooperator farm, was intended to assess chloropicrin containing fumigants with and without a novel solvent. The solvent allows for a reduction in the amount of active ingredient utilized for equivalent disease control results. Results of this field trial indicated a negative interaction between fumigation

treatment and tillage practices. This finding has driven a second year of research, located at the Langlade County Airport /UWEX research site to further investigate the interaction of tillage and chloropicrin fumigation. Results were extended to producers in Langlade County on October 13, 2011 at the Langlade County Airport/UWEX research farm. The progress of this objective is in line with expected timeline, as determined in original grant application.

Table 3. Fumigation treatments evaluated on grower cooperator farm in Antigo, WI, 2011.

Trt No.	Trade Name	Active Ingredient	Rate	Time of Fumigation
1	C-60 Pic	chloropicrin 60%	83 lb./A broadcast	30 Sep 2010
2	C-60 Pic	chloropicrin 60%	167 lb./A broadcast	30 Sep 2010
3	C-60 Pic	chloropicrin 60%	250 lb./A broadcast	30 Sep 2010
4	C-60 Pic	chloropicrin 60%	333 lb./A broadcast	30 Sep 2010
5	Pic Plus	chloropicrin 85% + proprietary solvent	117 lb./A broadcast	30 Sep 2010
6	Pic Plus	chloropicrin 85% + proprietary solvent	234 lb./A broadcast	30 Sep 2010
7	Pic Plus	chloropicrin 85% + proprietary solvent	351 lb./A broadcast	30 Sep 2010
8	Pic Plus	chloropicrin 85% + proprietary solvent	468 lb./A broadcast	30 Sep 2010
9	Untreated Control	NA	NA	NA

Table 4. Effect of treatments on yield, grade and incidence of common scab on tubers (treatment numbers as listed in Table 3).

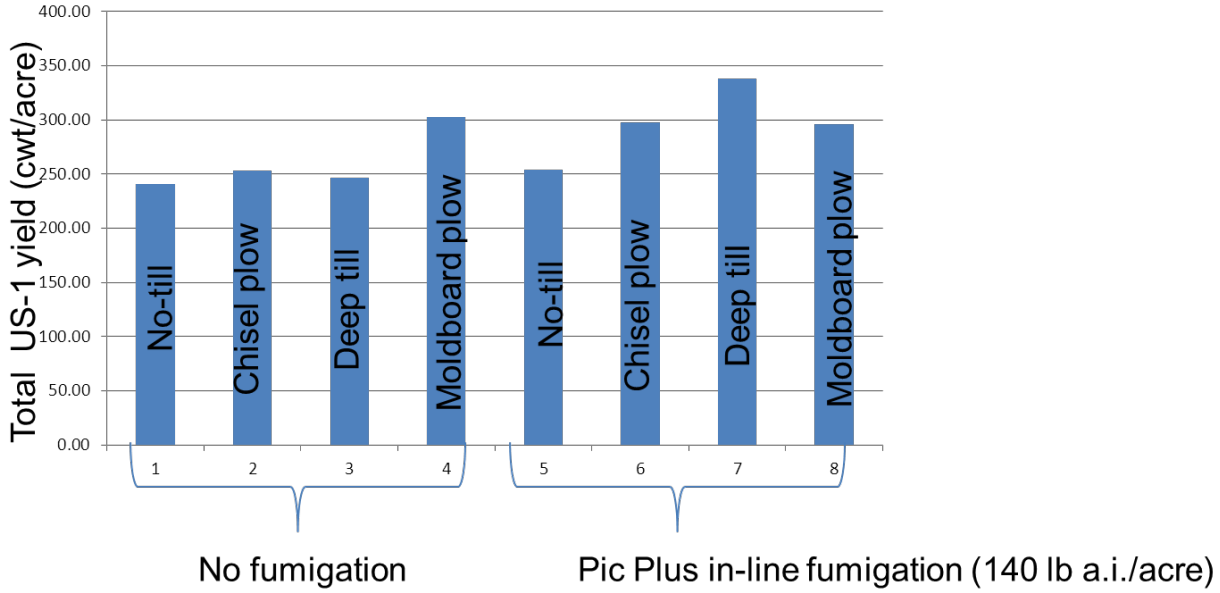
		US#1			Undersize[1]			Culls				
Trt no.	Total cwt/A	cwt/A		%	cwt/A		%	cwt/A		%	Disease[2] Incidence	
1	308.0	250.4	bc[3]	81.3%	34.1	a	11.1%	23.5	ab	7.6%	62.5%	a
2	338.9	276.6	bc	81.6%	35.0	a	10.3%	27.3	ab	8.1%	72.5%	ab
3	362.2	278.1	bc	76.8%	38.6	ab	10.6%	45.5	b	12.6%	81.3%	ab
4	372.4	302.8	c	81.3%	34.1	a	9.2%	35.5	ab	9.5%	77.5%	ab
5	296.8	232.0	b	78.2%	33.0	a	11.1%	31.8	ab	10.7%	83.8%	ab
6	324.7	250.0	bc	77.0%	32.4	a	10.0%	42.3	ab	13.0%	77.5%	ab
7	328.0	255.0	bc	77.7%	39.8	ab	12.1%	33.2	ab	10.1%	78.8%	ab
8	305.8	248.1	bc	81.1%	33.9	a	11.1%	23.8	ab	7.8%	81.3%	ab
9	240.1	171.4	a	71.4%	46.8	b	19.5%	21.9	a	9.1%	86.3%	b

1. Undersize indicates potatoes <1 7/8" in diameter
2. The percentage (out of 20 tubers per treatment) with common scab symptoms
3. Analysis of variance was performed on each data set, and Fisher's protected least significant difference (LSD) was calculated (alpha=0.05).

This trial, on a grower cooperator farm, was intended to assess chloropicrin containing fumigants with and without a novel solvent. The solvent allows for a reduction in the amount of active ingredient utilized for equivalent disease control results. Results of this field trial indicated a negative interaction between fumigation treatment and spring tillage practices (Table above). This finding gave cause for a second year of research which took place at the Langlade County

Airport /UWEX research site to further investigate the interaction of in-line (in row)-applied chloropicrin fumigation and spring tillage practice.

Initial results were extended to producers in Langlade County on October 13, 2011 at the Langlade County Airport/UWEX research farm; results from the 2012 trial have recently been statistically analyzed and will be presented to growers through the UWEX Vegetable Crop Updates Newsletter and in educational sessions at the 2013 UWEX/WPVGA Grower Educational Conference in Stevens Point, WI. Results of 2012 trial indicated that fall in-line applications of chloropicrin (Pic Plus 140 lb. a.i./acre) followed by either chisel plow, deep till, or no till in the spring resulted in higher yields than without fumigation. Overall, no-till treatments gave lower yields than any of the tillage practices, and fumigation within the tillage treatments enhanced yield with the exception of the moldboard plow tillage (Figure below). The progress of this objective is in line with expected timeline, as determined in original grant application.



Fumigation (metam sodium and chloropicrin) and in-furrow fungicide evaluation for common scab control of potato 'Yukon Gold,' at the UWEX Langlade County Airport research farm, Antigo WI. This project was coordinated with Mr. Alex Crockford of the UWEX Langlade County Research Station, Antigo, WI.

A trial was established 25 May at the Langlade County Research Area, Antigo, WI, to evaluate fungicide and fumigation efficacy for control of potato common scab. Approximately 2 oz seed pieces were cut mechanically on 15 May from US#1 Yukon Gold tubers. Seed pieces healed for 7 days before planting. A randomized complete block design with four replications was used for the trial and treatment plots consisted of four 40-ft-long rows spaced 36 in. apart with 12 in. spacing in the row. Fumigation treatments were applied in the fall of 2010. In-furrow chemical treatments were applied at planting. Furrows were mechanically covered using hilling disks. The soil type was Antigo silt loam and the field was maintained during the growing season according to standard grower practices. To minimize soil compaction and damage to plants in rows used for foliar and yield evaluation, drive rows for pesticide application equipment were placed adjacent to plots. The foliar fungicide program included: Bravo Zn at 1.125 pt/acre on 5

Jul, Bravo Zn at 2.0 pt/acre on 12 & 26 Jul and 6 Sep, Quadris at 6 oz/acre + Bravo at 1.5 pt/acre on 19 Jul & 2 Aug, Bravo Zn at 2.0 pt/acre on 9 & 23 Aug, Tanos at 6 oz/acre + Bravo Zn at 1.5 pt/acre on 16 & 30 Aug, and Bravo Zn at 1.5 pt/acre on 9 & 13 Sep. Vines were chemically killed with Reglone 1.0 pt/acre on 2 and 9 Sep 2011. Fertility and insecticide programs were consistent with grower standards for the production region. The center two rows of each plot were harvested 17 Sep 2011. Tubers were graded into marketable (US#1), undersize, and cull categories on 23 Sep 2011. After undersize tubers were graded out and tubers washed, but before scabbed tubers are removed, 20 tubers from each plot were chosen arbitrarily and assessed for scab incidence and severity. Disease severity was rated on a scale of 0-3 with 0=no disease, 1=<10% surface area symptomatic, 2=10-25%, 3=>25%. An overall symptom severity was calculated for each plot by summing the severity rating of each tuber assessed for each plot. Precipitation for the site was 9.02 in from 25 May to 17 Sep 2011. Supplemental irrigation of 1 in was applied on 28 Jul.

Disease pressure was high in this field trial with 100% of tubers in the untreated control exhibiting common scab symptoms. Numerically, all treatments controlled common scab better than the untreated control, with treatments 2, 6, 7, and 9-14 having significantly less symptomatic tubers. Overall symptom severity ranged from 8.5 in treatment 10, to 39.3 in treatment 18. Treatments 2, 6, 7, 9, 10, 11, 12, and 14 had significantly less overall symptom severity than the untreated control. Marketable yield was greatest and significantly different from the untreated control in treatment 2, Vapam 40 gal/acre. But for treatment 15, there were no significant differences in cwt/acre of culls among treatments.

Table 5. Common scab incidence, severity, and resulting potato yield for 19 control programs evaluated on 'Yukon Gold' potato in Langlade County, WI, 2011.

Treatment and rate/A (application dates)	Symptomatic tubers[z] (%)		Overall symptom severity		Marketable yield (US#1) cwt/A		Culls cwt/A	
1.Unfumigated control….....	100.0	f	37.3	efg	216.3	cdefg	43.3	ab
2.Vapam 40 gal (1)……	51.3	abcd	14.3	abc	284.6	h	24.0	ab
3.Blocker 10 pt (2)…….	72.5	bcdef	24.0	abcdef	182.1	cdef	33.0	ab
4.Blocker 10 pt Mocap 15G 20 lb. (2).....	68.8	abcdef	23.0	abcde	170.9	bcd	39.8	ab
5.Mocap 15G 20 lb. (2)….....	82.5	def	29.0	bcdef	171.1	bcd	47.6	ab
6.Blocker 10 pt NAA 0.33 oz (2)……	50.0	abcd	11.3	ab	232.5	defgh	19.2	a
7.TigerSul 1000 lb. (2)….....	56.3	abcde	16.8	abcd	211.9	cdefg	32.7	ab
8.Regalia 29 fl oz (2)……	76.3	cdef	25.0	abcdef	173.1	bcd	47.5	ab
9.Pic Plus 117 lb. (1)…….	51.3	abcd	12.8	abc	232.8	defgh	24.9	ab
10.Pic Plus 234 lb. (1)……	37.5	a	8.5	a	228.6	defgh	25.8	ab
11.Pic Plus 351 lb. (1)……	50.0	abcd	16.5	abcd	236.5	efgh	43.3	ab
12.Pic-C60 167 lb. (1)……	46.3	abc	11.5	ab	251.9	gh	26.1	ab
13.Pic-C60 250 lb. (1)……	55.0	abcd	24.0	abcdef	244.1	fgh	31.9	ab
14.Pic-C60 333 lb. (1)……	42.5	ab	9.5	a	257.4	gh	32.4	ab
15.Quadris 11.6 fl oz (2).....	98.8	f	47.5	g	96.8	a	89.3	c
16.Serenade Soil 64 floz (2)..	91.3	f	41.3	fg	161.2	bc	37.9	ab
17.Serenade Soil 128 floz (2)	88.8	ef	30.8	cdefg	164.3	bc	38.3	ab
18.Mocap 15G 20 lb.								

NAA 0.33 oz (2)……..	90.0	f	39.3	efg	114.0	ab	61.1	bc
19.AmegA 10 pt (2)……..	82.5	def	33.8	defg	179.2	cde	42.6	ab

[z]Percentage of assessed tubers symptomatic for common scab

[y]Column numbers followed by the same letter are not significantly different at P=0.05 as determined by Fisher's Least Significant Difference test.

[x]Application date of treatments, 1=Fall fumigation 30 Sept 2010, 2=at planting 22 May 2011.

Results of this portion of our project revealed the potential of several non-fumigant treatments for control of common scab. The progress of this objective is in line with expected timeline, as determined in original grant application. Results were extended to producers in Langlade County on October 13, 2011 at the Langlade County Airport/UWEX research farm. Results of this study were utilized to develop a next stage fumigation evaluation at this same location.

In 2012, we utilized the same research field at the Langlade County Airport/UWEX research farm to evaluate the utility of fumigation in a second year potato crop. In other words, we evaluated yield and quality of 'Yukon Gold' potatoes produced during the summer of 2012 in a field continuously cropped to potato for 4 years and fumigated (in a subset of plots) in the fall of 2010. Field preparations and maintenance was carried out in a manner consistent with previous year (described above). Tubers were harvested mid-September 2012 and yield was graded and evaluated for common scab as previously described (Table 6). Results indicate great variability in performance of treatment programs for the control of common scab and for protecting yield. The influence of pre-plant fumigation in a subsequent year 2 of potato production was not recognized in our results. The disease nursery supports heavy common scab pressure and has been in potato production for research for over 4 years. This site will be in non-potato rotation in 2013 and further investigation of multi-year effects of pre-plant fumigation and at-plant fungicide treatments for common scab control are planned.

Table 6. Common scab incidence, severity, and resulting potato yield for 14 control programs evaluated on 'Yukon Gold' potato in Langlade County, WI, 2012.

Treatment and rate/A (application dates[x])	Symptomatic tubers[z] (%)	Overall symptom severity	Marketable yield (US#1) cwt/A	Culls cwt/A[y]
Unfumigated control……...	62.5	15.3	143.0 ab	74.1 abc
Vapam 40 gal (1)[x]……...	47.5	11.0	120.2 ab	93.9 abc
Blocker 4F 10 pt (2)……...	68.8	18.8	117.3 ab	103.2 ab
Blocker 4F 10 pt + Serenade Soil 1.34% 4.4 fl oz (2)…….	72.5	21.8	134.2 ab	73.2 abc
Quadris 2.08F 11.7 fl oz (2)……...	42.5	10.8	118.4 ab	103.0 ab
Blocker 4F 10 pt (2) + AVD5090 0.33 oz (2)…….….	60	13.5	150.0 a	58.6 bc
TigerSul 90CR 1000 lb. (2)……	61.3	15.0	125.0 ab	108.4 a
Regalia SC 29 fl oz (2)……...	72.5	24.0	147.3 a	56.4 bc
Pic Plus 117 lb. (1) + Serenade Soil 1.34% 8.8 oz (2)……	47.5	10.3	74.5 b	121.1 a
Pic Plus 234 lb. (1)……..	51.3	11.5	130.0 ab	78.6 abc
Pic Plus 351 lb. (1) + Serenade Soil 1.34% 4.4 oz (2)……	73.8	18.5	148.4 a	84.8 abc
Pic-C60 167 lb. (1) + Regalia SC 4 fl oz/1000 ft. row (2)…...	47.5	10.0	147.0 a	78.4 abc
Pic-C60 250 lb. (1)……..	56.3	12.5	126.4 ab	98.9 abc
Pic-C60 333 lb. (1) + Regalia SC 0.5 fl oz/1000 ft. row (2)…	43.8	10.5	161.8 a	50.9 c

[z]Percentage of assessed tubers symptomatic for common scab
[y]Column numbers followed by the same letter are not significantly different at P=0.05 as determined by Fisher's Least Significant Difference test.
[x]Application date of treatments, 1=Fall fumigation 12 Oct 2011, 2=at planting 22 May 2012.

<u>In the spring-summer of 2011, we established additional trial sites for the evaluation of soil-borne disease control of potato.</u>

1) **In-furrow nematicide trial with Agri-Mek (abamectin) for control of root lesion nematodes (component of PED along with Verticillium) in grower cooperator field of Nick Somers of Plover River Farms, Stevens Point, WI on 'Russet Norkotah. This project was coordinated with Dr. Russ Groves, UW-Entomology, and Dr. Jeffrey Krumm, Syngenta Crop Protection.**

A grower cooperator research site was established in Stevens Point, WI to evaluate a non-fumigant alternative to control of diseases on 'Russet Norkotah' potatoes. The section of field under investigation did not receive metam sodium soil fumigation prior to planting. At-plant, the insecticide and nematicide, abamectin (Agri-Mek at 19.6 fl oz/acre), was applied over top of the seed piece prior to row cover. All production practices in the areas of pest and disease control, fertility, weed control, and irrigation were commercial standard for the farm. Soil was collected at emergence and at vine kill to determine populations of *Verticillium* spp. through established methods. There were no significant differences in yield or quality, or in the numbers of *Verticillium dahlia* colony counts with application of abamectin when compared to the untreated, nonfumigated control (Table 3).

Table 6. Effects of in-furrow applied abamectin on pest, pathogen, and yield of potato 'Russet Norkotah' in Plover, Wisconsin, 2011.

Treatment	**Root lesion or *Pratylenchus penetrans*, nematode counts (mean of 4 replications, 100 cc of soil)**		***Verticillium dahliae* colony counts (mean of 4 replications, 100 cc of soil)**		**Mean total yield (100 ft. of row harvested of each of 4 replications, no grade out)**
	At emergence (6/9/2011)	**At vine kill (8/5/2011)**	**At emergence (6/9/2011)**	**At vine kill (8/5/2011)**	
Untreated control	100.5	26.25	0.0416	0	636.43 lb.
Agri-Mek at 19.6 fl oz/acre rate, applied in-furrow, at planting	19.25	73.75	0.125	0	611.22 lb.

In-furrow fungicide trial with in-furrow applications on 'Russet Norkotah' for control of Rhizoctonia at HARS, Hancock WI, Plot K19 West in 2011 and Plot S4 North in 2012. This project was coordinated with Dr. Stephen Jordan of UW Plant Pathology, Mr. Mick Holm of Dupont and Mr. Glenn Carlson, Field Trials Coordinator of the Hancock Agricultural Research Station, Hancock, WI.

Potatoes were planted 2 May to initiate a field trial at the Hancock Research Station in central WI to evaluate fungicide efficacy for control of potato black scurf. Approximately 2 oz seed-pieces were cut mechanically on 27 Apr from US#1 'Russet Burbank' tubers. Seed-pieces were allowed to heal prior to planting. A randomized complete block design with four replications were used for the trial, and treatment plots consisted of four 24-ft-long rows spaced 36 in. apart with 15 in. spacing in the row. Drench treatments and seed treatments were applied at planting with 2 gallons of water with fungicide was applied per plot for in-furrow drench applications (Table 7). Standard farm practices were used during the growing season for weed and pest control, including foliar fungicides. Tubers were harvested on 14 September. Incidence of black scurf was determined from visual symptoms of 20 tubers after washing and grading. While disease severity was low for black scurf in this trial, incidence was moderate (Table 8). While numerically there were differences in yield and disease incidence among treatments, there were

no statistical differences between treatments with respect to yield or disease at the 95% confidence level (Figure 2).

Table 7. Treatment and rates of fungicides evaluated as in-furrow, at-plant treatments to control Rhizoctonia on tubers at harvest of 'Russet Norkotah' in Hancock, 2011.

Trt #	**Fungicide**	Rate
1	Untreated Control (no fungicides)	NA
2	Tiger Sul (sulfur)	44 lb./A
3	MBI-10620	0.5 fl oz/1000 row ft.
4	MBI-10620	1 fl oz/1000 row ft.
5	MBI-10620	2 fl oz/1000 row ft.
6	MBI-10620	0.8 oz/cwt
7	Vertisan EC (LEM17 EC)	0.7 fl oz/1000 row ft.
8	Vertisan EC (LEM17 EC)	1.6 fl oz/1000 row ft.
9	Picoxy SC	0.5 fl oz/1000 row ft.
10	Picoxy SC	1.3 fl oz/1000 row ft.
11	Q8y78 SC	1.6 fl oz/1000 row ft.
12	Fontelis (LEM17 SC) seed trt + Vertisan EC (LEM 17 SC) in furrow)	0.3 fl oz/100 lb. seed + 1.2 fl oz/1000 row ft.
13	Fontelis (LEM17 SC)	0.6 fl oz/100 lb. seed
14	Fontelis (LEM17 SC)	0.3 fl oz/100 lb. seed
15	Quadris	0.6 fl oz/1000 row ft.
16	Maxim MZ 6.2	8 oz/100 lb. seed

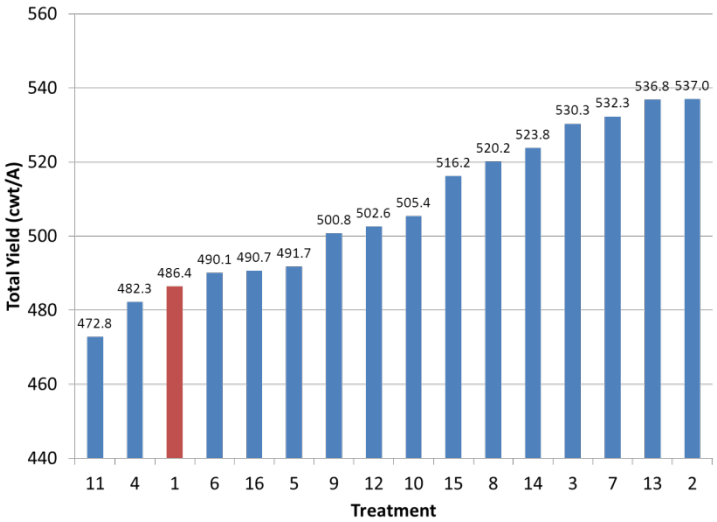


Figure 2. Total yield of tubers at harvest of 'Russet Norkotah' resulting from 16 treatment trial to evaluate control of Rhizoctonia in Hancock, WI, 2011.

Table 8. Yield, specific gravity, and Rhizoctonia incidence of tubers of 'Russet Norkotah' at harvest.

	Total Yield	Culls		Bs		Total A		Specific Gravity	Rhizoctonia Incidence on Tubers (Black Scurf)
Trt No.	**cwt/A**	**weight**	**%**	**weight**	**%**	**weight**	**%**		
1	486.4	19.5	4.1%	60.1	12.4%	406.8	83.5%	1.075	50.0%
2	537.0	25.4	4.8%	55.1	10.3%	456.5	84.9%	1.076	35.0%
3	530.3	23.6	4.4%	57.3	10.8%	449.5	84.7%	1.076	25.0%
4	482.3	26.7	5.6%	53.7	11.2%	401.8	83.2%	1.078	30.0%
5	491.7	16.6	3.3%	68.2	14.0%	407.0	82.6%	1.075	27.5%
6	490.1	17.2	3.6%	64.0	13.1%	408.8	83.4%	1.074	25.0%
7	532.3	19.7	3.7%	60.5	11.4%	452.1	84.9%	1.078	25.0%
8	520.2	22.2	4.3%	69.2	13.3%	428.8	82.5%	1.076	15.0%
9	500.8	16.8	3.3%	60.6	12.3%	423.5	84.3%	1.075	45.0%
10	505.4	16.9	3.3%	43.7	8.5%	444.8	88.2%	1.075	30.0%
11	472.8	20.9	4.3%	65.2	13.8%	386.8	81.8%	1.074	17.5%
12	502.6	23.8	4.7%	56.4	11.2%	422.4	84.1%	1.076	27.5%
13	536.8	16.4	3.0%	65.5	12.2%	455.0	84.8%	1.078	27.5%
14	523.8	30.3	5.8%	66.1	12.7%	427.4	81.6%	1.077	16.7%
15	516.2	23.9	4.6%	58.3	11.4%	434.0	84.0%	1.077	27.5%
16	490.7	22.4	4.7%	70.9	14.8%	397.4	80.5%	1.076	22.5%

In 2012, our Rhizoctonia in-furrow fungicide evaluation was conducted in a manner consistent with procedure in 2011 at the Hancock Research Station with 26 treatment programs, as listed in table below.

At-plant and seed treatments evaluated for control of Rhizoctonia and black scurf on 'Russet Norkotah' potatoes in Hancock, WI in 2012.

Trt #	Trade name	rate
1	Untreated Control	NA
2	Quadris SC	0.8 fl oz/1000 row ft.
3	Maxim MZ	8.0 oz/100 lb. seed
4	Vertisan EC	0.7 fl oz/1000 row ft.
5	Vertisan EC	1.15 fl oz/1000 row ft.
6	Vertisan EC	1.6 fl oz/1000 row ft.
7	Fontelis 1.67SC	0.15 fl oz/100 lb. seed
	Manzate FL 4.0LG	0.9 fl oz/100 lb. seed
8	Fontelis 1.67SC	0.3 fl oz/100 lb. seed
	Manzate FL 4.0LG	0.9 fl oz/100 lb. seed
9	Tiger Sul	44 lb./acre (or 136 g/24 ft. 4 row plot)
10	Regalia MAXX	0.5 fl oz/1000 row ft.
11	Regalia MAXX	1.0 fl oz/1000 row ft.
12	Regalia MAXX	2.0 fl oz/1000 row ft.
13	Regalia MAXX	4.0 fl oz/1000 row ft.
14	Regalia MAXX	1.0 fl oz/1000 row ft. + 0.8 fl oz/1000 row ft.
15	Regalia MAXX	1.0 fl oz/1000 row ft. + Moncut 1.18 oz/1000 ft. row or 1 lb./acre
16	A14382	0.226 fl oz/100 lb. seed
17	A14382 + A16148	0.226 fl oz/100 lb. seed + 0.0307 fl oz/100 lb. seed
18	A14382 + A16148	0.226 fl oz/100 lb. seed + 0.046 fl oz/100 lb. seed
19	A14382 + A16148	0.226 fl oz/100 lb. seed + 0.077 fl oz/100 lb. seed
20	A14382 + A16148	0.226 fl oz/100 lb. seed + 0.153 fl oz/100 lb. seed
21	A18232 + A16148	0.308 fl oz/100 lb. seed + 0.077 fl oz/100 lb. seed
22	A14382 + A12946	0.226 fl oz/100 lb. seed + 0.307 fl oz/100 lb. seed
23	A9459	0.08 fl oz/100 lb. seed
24	A18232	0.308 fl oz/100 lb. seed
25	Syngenta Exper.	12.0 oz/100 lb. seed + 0.35 fl oz/100 lb. seed
26	A18232+A12946	0.308 fl oz/100 lb. seed + 0.307 fl oz/100 lb. seed

The trial was harvested in October of 2012. Yield and quality results are under statistical analyses at this time.

III. Goals and Outcomes Achieved

A. Multiple field trials were established and conducted in order to achieve the performance goals and measurable outcomes for the project which included evaluation and comparison of fumigation, fungicide (biological and conventional), and cultural methods of soil-borne disease control in potato systems of Wisconsin. Common scab, Potato early dying, and Rhizoctonia diseases were studied in this project because shifts in management programs of one soil-borne

disease have impact on the others. Results of this work address both short term information needs on comparative product and program performance, and long term information needs as we progress through our multi-year rotational experiment at the Hancock Agricultural Research Station. Outcomes of fumigation and rotation studies are long term and progress, to date, has been reported in previous section.

Information has been and will be provided to producers in the state of Wisconsin through various outlets and venues including presentations at the 2011, 2012, and 2013. UWEX-WPVGA Grower Educational Meeting in Stevens Point, WI; the UW Vegetable Crop Updates newsletters in 2011 through 2013; and the Wisconsin Crop Management Conference in Madison, WI.

B. We generated data indicating relative efficacy of management programs for common scab, PED, and Rhizoctonia. This information has been directly consumed by growers and has impacted selection of disease control products and approaches in Wisconsin. This result is consistent with our anticipated goal of shifting best management strategies with respect to fumigants and fumigant alternatives for soil-borne disease control. As we are still working through our rotational and vine removal study, we do not yet have data to share with producers supporting transition to fumigation alternatives such as rotation, cover crops, or vine removal. We continue to strive for a 10% grower shift in management strategies to include fumigant alternatives with our further efforts.

Acreage of several potato cultivars with disease resistance to soil-borne pathogens has expanded during 2010-2011. 'Lamoka', a round white chipping cultivar, was grown on several Wisconsin farms. This cultivar has appreciable resistance to common scab, a persistent soil-borne, filamentous bacterium. Some use of 'Ranger Russet' which has Verticillium wilt tolerance is also notable in recent years. Growers are experimenting on farm with cover crops that have demonstrated biofumigant activity such as tillage radish and rape. This interest in on-farm evaluation of alternatives to fumigation is promising for further advancement and adoption of cultural practices in future years.

The core purpose of this project addresses the economic, environmental, and social sustainability of the Wisconsin potato industry. Maintenance of at least 95% of current acreage and productivity was seen and indicates success.

Greater than 95% of current acreage and productivity maintenance was seen in potato in the duration of this funding period. Planted acres of potatoes in Wisconsin has remained nearly constant at 62,500 acres in 2010 and 2011. Productivity or yield per acre has also remained consistent with 395 cwt/acre in 2010 and 400 cwt/acre in 2011. (cwt/acre is defined as 100 lb. units per acre, ie: 400 cwt/acre reads as 400 X 100 lb. per acre or 40,000 lb. per acre).

IV. Beneficiaries

This project has directly benefited multiple sectors of the WI potato industry. Results of our efforts have generated enhanced disease management recommendations to increase pest management and raw product quality of WI potatoes and have improved our competitiveness in the marketplace and value of finished products by the processing, chipping, seed, and fresh market sectors. WI potato growers are direct beneficiaries through improved pest management

with decreased cost of pesticides, improved crop value through enhanced quality, and increased and stable market opportunities. Potato processors and chippers will benefit through increase recovery and finished product quality. Potato farms have multiple employees that support crop production and storage. Full time employees commonly receive fair wages and health benefits. In addition to growers, processors such as McCain, Frito Lay, Kettle Foods, Alsum Produce, Okray Family Farms, Russet Potato Exchange, Bushman's Inc. and others employ hundreds of Wisconsin residents.

Nearly all Wisconsin potato farms, processors, and allied industries have benefited. Several potato farms grow processing vegetables and other specialty crops essential for diversification of the Wisconsin agricultural industries. Over 2,000 Wisconsin residents from nearly 100 hundred businesses work within the potato industry.

Maintenance of the potato industry at its current acreage and production with a total value of more than $250 million dollars impacts the farm gate value of Wisconsin agriculture. Improved competitiveness of potato processing industries through enhance end product quality provides employment opportunities for several hundred residents. Value of sustainably produced or locally produced potatoes is uncertain, but the Wisconsin potato industry is well positioned to capture the value with the Healthy Grown program and location with 250 mi radius of 25 million US citizens.

This project is essential for the financial stability and future growth of the Wisconsin potato industry. Farm gate value of potato is typically more than $250 million with value added through processing of nearly $1 billion.

V. Lessons Learned

We have experienced no delays in our programming. Due to uncertainty of multi-year funding for this work, we have had to limit one of our objectives, the potato vine removal study. Potato fields that were scheduled to be vine-removed in 2011 would not be in potatoes again until 2014, at the earliest. To accommodate this objective of the research we will assess Verticillium soil populations in 2012 of vine removal treatments that were included in the Hancock Agricultural Research Farm experiment. While we will have no potato crop evaluation of this removal in the next rotation, we will learn something of the impact of Verticillium population after vine removal effect. Fumigation and cover cropping research is multi-year in nature and may vary by production region, making research endeavors hard to fund over time and geography.

VI. Additional Information

Provide additional information available (i.e. publications, websites, photographs) that is not applicable to any of the prior sections.

Peer reviewed journals

Jordan, S.A., Webster, B.J., Crockford, A., **Gevens, A.J.** 2012. Evaluating fumigation and at-plant treatments for control of potato common scab in Wisconsin, 2011. Plant Disease Management Reports 6:V096. Online publication. doi: 10.1094/PDMR06.

http://www.plantmanagementnetwork.org/pub/trial/pdmr/reports/2012/V096.pdf

Educational meeting proceedings

Webster, B.J., Jordan S.A., **Gevens, A.J.** 2012. Potato fumigation alternatives**.** University of Wisconsin Extension-Wisconsin Potato & Vegetable Growers Association Grower Education Conference. Holiday Inn Hotel & Conference Center. Educational Conference Proceedings. (Online Proceedings).

Gevens, A.J., Webster, B.J., Jordan, S.A., Crockford, A. 2012 Evaluation of fumigation and in-furrow fungicides for control of potato common scab. University of Wisconsin Extension-Wisconsin Potato & Vegetable Growers Association Grower Education Conference. Holiday Inn Hotel & Conference Center. Educational Conference Proceedings. (Online Proceedings).

Trade magazines

Gevens, A.J., Webster, B.J., Jordan, S.A., Crockford, A. 2012. Common Scab 2011: Evaluating fumigation and at-plant treatments. Potato Grower Magazine. Volume 41 (4):28.

Oral presentations

Webster, B.J., Jordan S.A., **Gevens, A.J.** 2012. Potato fumigation alternatives**.** University of Wisconsin Extension-Wisconsin Potato & Vegetable Growers Association Grower Education Conference. Holiday Inn Hotel & Conference Center. Stevens Point, WI. January 31. 60 attendees.

Gevens, A.J., Webster, B.J., Jordan, S.A., Crockford, A. 2012 Evaluation of fumigation and in-furrow fungicides for control of potato common scab. University of Wisconsin Extension-Wisconsin Potato & Vegetable Growers Association Grower Education Conference. Stevens Point, WI. February 1. 100 attendees.

Gevens, A.J., Jordan, S., Webster, B., Crockford, A. 2012. Evaluating Fumigation and In-furrow Treatments for the Control of Potato Common Scab. Wisconsin Seed Potato Improvement Association, Inc. 52nd Annual Meeting. North Star Lanes, Antigo, WI. January 25 (3:00-3:15PM). 80 attendees.

Extension newsletters

Gevens, A. J. 2012. Vegetable Disease Updates. University of Wisconsin Extension. Wisconsin Crop Manager. March-Present. Contributor of 28 articles to date. Editor 2011-current. Online newsletter.

Gevens, A. J. 2011. Vegetable Disease Updates. University of Wisconsin Extension. Wisconsin Crop Manager. February-Present. 18 articles. Online newsletter.

Website resources offering relevant information

University of Wisconsin Potato and Vegetable Pathology Website
http://www.plantpath.wisc.edu/wivegdis/

University of Wisconsin Vegetable Production Team Website
http://vegetables.wisc.edu/

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19) Survey of Christmas tree fields for a new root rot disease (FY11-019)

Report Date: March 1, 2013

I. Project Summary

A. This project to survey for a new root rot disease in Christmas tree fields was started in 2011 to look into the causes of tree losses observed by growers. 2012 was the second year for this survey. Three new pathogens were detected in this time frame that could have an economic impact on production of fir trees in Wisconsin. Christmas tree production in Wisconsin ranked 5th in the nation with about 1.8 million trees harvested annually and an annual economic impact of $50 million.

B. This project is not connected to previous SCBG funding

II. Project Approach

This project is a collaboration of DATCP Plant Industry Laboratory, the DATCP Christmas tree program and Wisconsin Christmas tree growers and their association. DATCP inspectors surveyed for *Phytophthora* root rot disease during annual Christmas tree field inspections and the lab provided diagnostic services to identify pathogens causing root rot disease. Results were shared with participating growers individually, through newsletters and meetings. The project found three new species of Phytophthora that were first detections in plants in Wisconsin. Pathogen cultures were shared with researchers for further study. The project will continue through 2014 with SCBG FB FY12 funding. See paragraph III below details.

III. Goals and Outcomes Achieved

A. Three new Phytophthora species associated with root and collar rot were found in 11 out of 26 Wisconsin counties surveyed during this project. In 2011 and 2012, 18 counties were sampled each year. In 2011 Phytophthora root rot was found in Ashland, Clark, Jackson, Lincoln, Marathon, and Price Counties. Jackson, Lincoln, Marathon and Price have a high concentration of growers. In 2012 Phytophthora species were found in 3 additional counties: Taylor, Shawano and Dodge Counties.

In 2012, a total of 304 Christmas tree growers and 702 fields were inspected, in 2011 297 growers and 689 fields were inspected. In fields where patches of declining conifers were found, inspectors carefully dug up affected trees and transported them to the DATCP's Plant Industry Laboratory for testing. In 2012 symptomatic trees were found in 58 field locations (51fields in 2011) owned by a total of 37 growers (32 growers in 2011). Twenty-six of the growers surveyed in 2012 were new participants.

Plant pathologists examined six different tree host species for Phytophthora root rot. Fraser fir appeared to be the most susceptible host followed by balsam fir. Spruce and pine were examined as well but not found to be infected with this particular disease during this survey.

Participating tree producers were notified by Christmas tree inspectors with their individual test results as they became available each fall. Survey summary articles and distribution maps were published on DATCP's Pest Survey website http://pestsurvey.wi.gov/plantdisease/ornamentals.html, and the WCTPA newsletters. See paragraph VI. "Additional Information" for a copy of the most recent article. Updates were also published in DATCP's Pest Bulletin.

Anette Phibbs gave presentations at the Wisconsin Christmas Tree Producers winter conventions in Keshena, Jan, 2013 and in Wausau, Jan 2012. The latest PowerPoint presentation will be available on the Pest Survey website http://pestsurvey.wi.gov/program/presentations.html. The DATCP Christmas tree program set up and staffed a booth with displays and factsheets about this survey. Christmas tree program staff also distributed information at the 2011 and 2012 WCTPA summer meetings (Wild Rose, Aug 2012).

DATCP Plant Industry Laboratory is collaborating with researchers that are Phytophthora experts throughout the country. Cultures of the new *Phytophthora* species were shared with Dr. Gary Chastagner of Washington State University who is conducting studies to find root rot resistant fir trees and Field Crops Pathologist Dr. Damon Smith at University of Wisconsin-Madison.

B. The survey goal of finding and identifying a new root rot disease was accomplished. In fact three new species of Phytophthora were identified that, to the best of our knowledge, have never been found in fir trees or any other plant in Wisconsin.

Our goals to survey 250 producers and 650 fields were exceeded both years. The projected number of tree samples (65) estimated to be processed in the laboratory represents a maximum sample capacity. The actual number of samples submitted for tested depended on the number of symptomatic trees actually present in the field. Fifty-one (2011) and 58 samples (2012) were tested at the lab for Phytophthora. Trees were also examined for other common diseases, pests and disorders that were reported to growers as well.

All activities spelled out in the work plan such as field sampling, purchasing of supplies, laboratory testing, report writing and publishing were performed according to the projected timeline.

IV. Beneficiaries

Christmas tree growers benefited by receiving accurate diagnosis of root rot diseases in their individual trees. The survey raised awareness of this particular root rot diseases and also raised awareness of issues with planting practices that impact tree viability. Growers, researchers and government learned during the first two years of survey that at least two of these Phytophthora pathogens are most likely widespread throughout the growing area but outbreaks of serious disease problems are localized. The research community benefited by receiving cultures of these

pathogens that now can be studied further, including studies for host range and resistance. The development of resistant trees is of course a long range goal.

V. Lessons Learned

The drought's impact on agriculture and tree production in the state also affected this survey. Christmas trees in the Central Sands Counties that have low water retaining capacity, suffered heavily from the drought in 2012. Inspectors noted some fields lost 80% of transplant and seedling stands. Out of 446 fields inspected in the 25 counties in the drought zone, 21.7% of fields were affected, 10.3% had heavy losses. These fields were not sampled for this survey, because of the obvious impact of drought conditions. The project will continue with SCBG FB FY12 funding through 2014. The fall harvest seasons of 2013 and 2014 will bring more opportunities to sample trees, hopefully under more normal growing conditions in central Wisconsin. The 2012 drought emphasizes the value of being able to survey over multiple years.

We hope to update root rot management recommendations in collaboration with UW Extension by the end of the of the FY12 grant cycle.

VI. Additional Information

Provide additional information available (i.e. publications, websites, photographs) that is not applicable to any of the prior sections.

DATCP inspectors surveyed for *Phytophthora* root rot disease during annual Christmas tree field inspections. This project was started in 2011 to look into the cause of tree losses observed by growers. It is funded with USDA Specialty Crop Block Grants and Wisconsin Christmas tree producers have the opportunity to participate through fall of 2014. In fields where patches of dying or declining conifers were found, inspectors carefully dug up affected trees and transported them to the DATCP's Plant Industry Laboratory for testing.

Figure 6. Balsam fir dying from *Phytophthora* root rot disease. Photo: Sara Ott

In 2012 a total of 304 Christmas tree growers and 702 fields were inspected. Root rot suspect trees were found in 58 field locations owned by 37 growers. In 2012, 18 total counties were sampled, adding eight new counties to the 2011 survey (Dodge, Eau Claire, Jefferson, Racine, Rock, Shawano, St. Croix and Waukesha).

From each field two to six suspect trees, depending on tree size were combined into one sample per field. Trees that were suspected to have root rot in the field were mostly Fraser fir (35), followed by balsam fir (8), spruce (7), pine (6) and Canaan fir (2). Evidence of *Phytophthora* was found in 15 fir samples. Fraser fir (12) was the most commonly infected tree host, followed by only two balsam and one Canaan fir. The most frequently detected species of *Phytophthora* was *P. europaea* (12) and a single *P. sansomeana*.

These are the new species of *Phytophthora* first detected in Christmas trees during the 2011 survey. The better known root rot pathogens *P. cactorum* and *P. citricola* were also identified in 2012. The map below combines all finds of *Phytophthora* root rot in 2011 and in 2012, plus two detections of P sp. 'kelmania' in 2010.

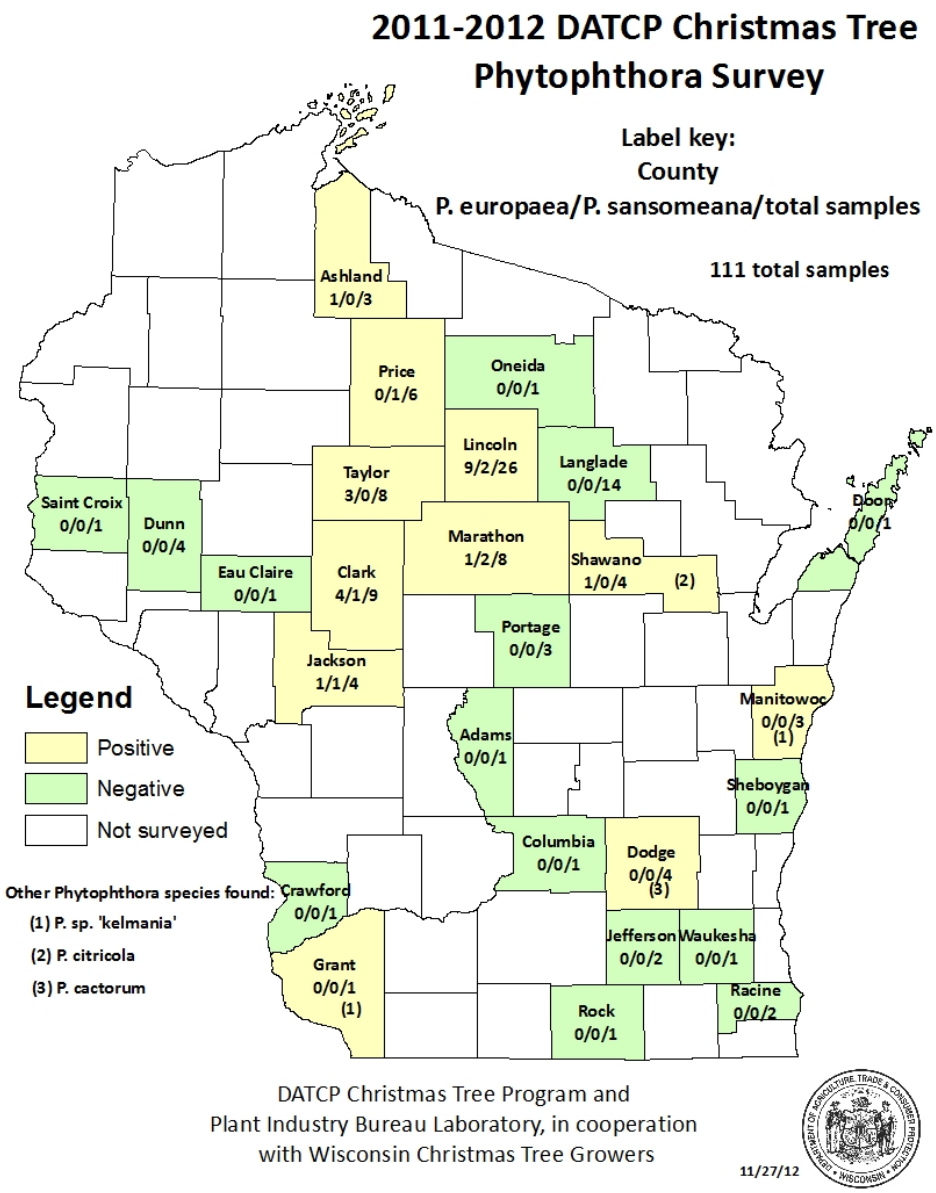
Figure 7. Self-girdling, compacted root ball, lacking fine roots

DATCP Plant Industry Lab has shared cultures of the new *Phytophthora* species with several researchers, including Dr. Gary Chastagner of Washington State University who is conducting studies to find root rot resistant fir trees. *P. sansomeana* is known to affect certain fir trees, especially Fraser fir but much needs to be learned yet, particularly about *P. europaea* and *P. sp. kelmania.*

OTHER TREE PROBLEMS: When tree roots were cleaned off and examined at the laboratory, 31 of 58 samples showed problems with root development, such as shallow, compacted, J-shaped or self-girdling roots and lack of fine roots. These problems are the result of planting practices that may be worth reviewing. Carefully planting trees, so they can develop deep spreading roots with ample fine roots will enable them to take up more water and nutrients.

This would allow trees to better withstand drought conditions and root infections. Eighty percent of the trees that tested positive for *Phytophthora* also exhibited some form of root development problem compared to 44% of the trees with root problems that tested negative for Phytophthora.

Besides Phytophthora root rot we diagnosed several other diseases such as four fir samples with *Armillaria* root rot, a few with blue stain fungi, white rot and other wood decay fungi. Frost cracking of trunks and branches was killing trees as well. This is likely due to an early warm–up in spring followed by a hard frost in April. Christmas trees in Central Sands counties, that have low water retaining capacity, suffered heavily from the drought in 2012. Inspectors noted some fields lost 80% of transplant and seedling stands. These fields were not sampled for this survey, because of the obvious impact of drought conditions.



The 2011 and 2012 surveys showed that *Phytophthora* root rot disease appeared to be in localized patches in the state. Our laboratory methods that are DNA based, allow us to detect the pathogens whether they are actively growing or not. The lab results show that the new *Phytophthora* pathogens are present in many of the Christmas tree growing counties (10), but they are water molds that require wet conditions to infect and kill trees. We hope that this multi-year study and the collaboration with experts throughout the U.S., will help us to learn more about these new *Phytophthora* root rots and how we can manage them.

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20) Development of best management practices workbook for Wisconsin cranberry production (FY11-020)

Report Date: November 14, 2013

I. Project Summary

A. Wisconsin cranberry growers are faced with the challenge of producing a crop in a sensitive wetland environment under increasing regulatory requirements and with more sophisticated chemicals and equipment. As a result, the complexity of cranberry production has increased requiring that growers have an extensive understanding of complicated issues related to water, nutrient and pest management, as well as understanding regulatory and legal requirements. One of the challenges for growers is to find the information that is relevant to their crop and region. There is also increasing pressure on growers to provide some metric of sustainability and their efforts to improve. This project provides growers with tools that allow easy access to region-specific regulatory information, nutrient management recommendations, pest management tools and strategies that are specifically focused on WI cranberry production. It provides growers with a tool that allows them to evaluate current production practices and the impact of changing production practices.

B. This project did not build on a previous Specialty Crop Block Grant

II. Project Approach

A no-cost extension to this project was approved 12/19/2013 for a new termination date of 8/31/2014. This included a revised plan of work, which was subsequently revised again and approved 4/15/2014. These changes were to accommodate the original PI being on maternity leave November 2011 to June 2012, as well as the PI leaving her position at UW-Madison for another institution in May 2013. The latest revised work plan focused on adapting the Cranberry Best Management Practices Guide from a printed product to the development of an online resource compendium. This plan was to accommodate the delays that had occurred, as well as to meet grower interest in the ability to review online information related to crop production.

The UW Libraries "Research Guide" on the American Cranberry (http://researchguides.library.wisc.edu/cranberry) was chosen as the most appropriate home for this online compendium of production information. The cranberry research guide (curated by UW librarian Erin Carrillo) is one of the most popular guides of the series and already contained a section then titled "Growing Cranberries." Workmaster and Carrillo worked collaboratively from February to August 2014 to modify the structure of this site and to update and edit the content posted there. The site now contains a section "Resources for Grower BMPs" in place of "Growing Cranberries." This section now contains the following subheadings (which reflect the chapters originally envisioned for the print version of the guide): The Cranberry, Anatomy of a Cranberry Marsh, Conservation and Environmental Issues, Nutrient Management, Water Management, Canopy Management, Chemical Safety, Integrated Pest Management, Weed Management, Insect Management, Disease Management, Pollination, Physiological and

Environmental Stress, and Harvest and Post-Harvest Handling. Workmaster searched and evaluated available resources and provided content and structure outline to Carrillo. As curator of the site, Carrillo posted the information in accordance with site software capabilities and copyright rules. The site can be viewed on mobile devices and is searchable. The site also features a live research feed that gleans cranberry-related articles from various academic journal databases, as well as historical information and images. We are currently update the feed to highlight plant and field production research separate from that on topics related to health and food science. An additional accomplishment was the compilation of a full collection of WSCGA Cranberry School Proceedings to the UW Libraries digital archives collection that will be fully searchable.

Information about the research guide site has been shared with growers via the July 2014 newsletter of the Wisconsin State Cranberry Growers Association (WSCGA) and in a presentation by Workmaster and Carrillo to the Research Committee of the Wisconsin Cranberry Board, Inc. An outline of the material was presented and feedback was elicited from growers.

III. Goals and Outcomes Achieved

A. Workmaster and Carrillo met regularly to assess the feasibility and progress of the guide's transition. Workmaster reviewed available online resources related to cranberry production across the U.S. and Canada and evaluated them for inclusion in this compendium. Workmaster also met and communicated with UW extension and research faculty for input to sections relevant to their specialties. Subheading outlines and associated documents were sent to Carrillo for posting. Carrillo also provided expertise on copyright and electronic formats. Since the research guide website is a dynamic entity and corrections and additions will be ongoing to reflect developing information available, no formal "launch" of the site was marked. Monitoring and maintenance of the site content and structure will continue this fall, with particular attention to the live research feed, as mentioned above. Presentation on the use of the online resource was performed this summer (see above) and will continue this fall and winter, as during the 2015 season.

B.

Project activity	Accomplishment
Update collection and review resources for online database	Original content of the UW Library research guide was evaluated and revised. New information and resources were identified, including input from UW extension specialists and USDA scientists
Development of online resource	Research guide website was restructured to reflect focus on BMP resources. New information posted according to revised site structure and outline.
Marketing of BMP resource to growers	Announcement of site in newsletter of the Wisconsin State Cranberry Growers Association. Presentation and demonstration to the Research Committee of the Wisconsin Cranberry Board, Inc. to raise awareness and solicit grower feedback
Launch cranberry resource	UW research guide continuously online, so no formal

website	launching. Growers and other viewers encouraged to periodically visit to see development.
Monitoring and maintenance of website content and forums	Research guide format is a dynamic environment that allows for ease of updating and maintenance of information. Further updating will occur, especially to areas needing more information and to the live feed providing research information.
Presentation on the use of the BMP online resource with additional evaluation of grower utilization during 2015 season	Demonstration of site use is planned for the 2015 WSCGA Cranberry School and evaluation of site use will be made at 2015 growing season field days.

IV. Beneficiaries

The main beneficiary envisioned for this project are the more than 250 cranberry growers of the state of Wisconsin. With the increased ease of access to online information, growers will be able to more readily find information via computer and smartphone on a range of crop production topics. Other beneficiaries include other industry workers, students, and the general public.

V. Lessons Learned

This project had a lot of changes in staff which prompted changes in project direction due to expertise of available staff. In the end, a very useful, high-quality product was created and shared with its intended audience. This project speaks to the success of good communication between project staff, state Department of Agriculture staff and USDA-AMS staff. It shows that things don't always go as planned but flexibility and perseverance are worth the effort!

VI. Additional Information

NA

VII. Contact Info

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21) Optimizing calcium rates for pickles (FY11-021)

Report Date: November 16, 2012

I. Project Summary

A. Pickling cucumbers have been grown in Wisconsin for decades, starting out with small individually planted and hand picked plots throughout the state to current multi-thousand-acre machine harvested farms located primarily in the central sands. Although we have had pickles in Wisconsin for so long, there has been very little studied on the effects and efficient use of nutrients that are essential to the plant. The UW extension service gives out general recommendations for the macronutrients of Nitrogen, Phosphorus and Potassium but does not have recommendations for the secondary macronutrients and micronutrients. The focus of this study was to look at one of the most important secondary macronutrients which is calcium and define a recommended amount that should be applied as well as correct timing of application on less than 2 percent organic soils.

Calcium is an essential part of the plant cell wall structure and provides for normal transport and retention of other elements as well as strength in the plant. It is crucial to cell elongation and is important for the uptake of most macro and micro nutrients. It is responsible for strong growth and is very important in bud set and water uptake. Deficiencies of calcium will cause leaf tips, edges and new growth to turn brown and die as well as chlorosis and distorted leaf margins. If a deficiency occurs during the bloom phase it can effect shoot growth resulting in abortion of flowers and bud structures ultimately causing a reduced yield. Too much calcium in early growth stages will also cause stunting of plant growth and can interfere with the uptake of magnesium and potassium. Calcium is an immobile element. This means that it can be present in the soil but is not always available to the plant. If the plant has used all the available calcium in the early stages of growth, supplemental amounts are necessary to apply as the plant is producing fruit.

B. This project took our results from the first year's trial (2010 SCBG funded project with the same name) and looked at one specific calcium source at variable rates to determine the optimum rate of application. The first year multiple rates were used of a straight Ca source and we established that there was very little difference between treatments due to what we felt was very limited uptake of the straight Ca product. This year we used a 5-0-0-10Ca product that we believed would have a better uptake due to the Ca being mixed with N. The rates were similar but the application of the product was applied using commercial irrigation equipment which is what any standard grower would use instead of the CO2 powered sprayer we used the first year in small plots.

II. Project Approach

The field where the trial was conducted was planted on July 1st. Soil samples were pulled before planting. A standard fertilizer program was followed on the cucumbers minus any calcium treatments. At moderate bloom stage, August 2nd, three treatments of 10, 25, and 50 units of Ca and a check were applied through irrigation, repped twice across two pivot circles in the field. A

total of 55 acres were used for the trial with one pivot covering 25 acres and one pivot covering 30 acres. A 5-0-0-10Ca product was used with enough 32% N to make the nitrogen application even across all treatments (25 units nitrogen). The trial was harvested on August 14th, with 2 samples from each treatment of 17.5 feet of row handpicked. These samples were graded using standard industry sizing for processing pickles.

III. Goals and Outcomes Achieved

A. In 2011 the Ca was applied with a CO_2 - powered sprayer backpack sprayer that ensured high uniformity and precision in the rates of application. Applications with commercial equipment invariably result in considerably less uniformity and precision. This year the Ca application was by way of injection in irrigation water. Careful monitoring of the amounts of water and quantities of Ca solution provided estimates of the uniformity and precision of the Ca applications. Indications were that at the target of 10 lb. Ca/a plot –to-plot rates actually ranged from 9.0 to 10.2, for a mean rate of 9.6 lb. Ca/a. The range in plot-to-plot variability increased with the rate of Ca application, being 18 to 30 % at the target Ca rate of 50 lb./a. The calculated mean rate of Ca application was only 39.5 lb./a.

Having an estimate of the variability in Ca application rates with commercial equipment is important for two reasons. First, it explains why there were no significant treatment effects on total cucumber yields at the 5 and 10 % probability levels (Table 1). It also explains why there were so few treatment effects on the weights of the different grades of cucumbers (ARM report table). Secondly, growers need to be aware of this amount of variability and how it can influence cucumber responses to Ca applications. There may well be a good response in some parts of a field and not others.

The primary objective of the study this year was to establish the optimum rate of Ca for cucumbers. This was determined by fitting an equation to the relationship between rate of Ca application and cucumber yield response (Fig. 1) and solving (differentiating) that equation to come up with the optimum Ca rate. The value calculated was 39 lb. Ca/a. At this rate, the predicted cucumber total yield increase would have been 23 cwt, or 2,300 lb./a.

Before recommending that producers apply 40 lb. Ca/a, an economic analysis needs to be performed to determine if a 2,300 lb./a cucumber yield increase more than pays for the Ca applied. At a market value of $7/bu and 50 lb. cucumbers/bu, the value of the cucumbers is $0.14/lb. Thus, the 2300 lb. increase has a total value of (2300)($0.14), or $322/a. The 5-0-0-10Ca costs $242/T. One ton of the product contains (0.1)(2000 lb.), or 200 lb. Ca. Thus, the Ca costs $234/200 lb., or $1.17/lb. Ca and the 40 lb. Ca/a had a cost of $46.80. The return/cost ratio is, therefore, $322/$46.80, or $6.88/$1.00 invested in the Ca.

A precautionary note is required here. This was a single site study on a particular soil, under a particular set of cultural practices and prevailing weather conditions. Changes in any one of these variables will undoubtedly alter the cucumber yield response to foliar Ca. As an example, on a soil with higher exchangeable Ca, response to the Ca applied could be substantially less. Multiple site and year studies would be required to establish what producers can reasonably

expect from foliar Ca applications. Producers need to be aware of this precautionary note when foliar Ca application is recommended.

B. The primary objective of the study this year was to establish the optimum rate of Ca for cucumbers. This was determined by fitting an equation to the relationship between rate of Ca application and cucumber yield response (Fig. 1) and solving (differentiating) that equation to come up with the optimum Ca rate. The value calculated was 39 lb. Ca/a. At this rate, the predicted cucumber total yield increase would have been 23 cwt, or 2,300 lb./a.

IV. Beneficiaries

A presentation of results will be given to the attendees of the Midwest Pickle Association in Grand Rapids, MI on December 4, 2012. Fifteen or more members are expected to attend. We will be able to publish the final report on the PPI (Pickle Packers International) website in February 2013 and possibly in the newsletter of the Wisconsin Potato and Vegetable Growers Association.

The initial results will help all cucumber growers start to understand that using approximately 39 lbs. of calcium per acre at moderate bloom stage should show them an economic advantage of $6.88 for every $1.00 spent at 2012 pricing of that nitrogen product.

V. Lessons Learned

Our main problem was that the irrigation equipment was unable to apply the exact amount of Ca product that we were expecting. But with the monitoring that we did during the application we were able to determine how much Ca was applied and made note of the amounts used to get us to the actual amounts put on the field.

VI. Additional Information

See attachments *Hanson Data Final Report*, *Hanson Results 2*, and *Calcium Trail Application* for more details on the project.

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22) Specialty Crop Grants Manager (FY11-022)

Report Date: October 1, 2014

I. Project Summary

The purpose of this project was to facilitate the efficient distribution of funds and the timely review and oversight of the projects funded under the SCBG. The Specialty Crop Block Grant program provides important funding to improve the profitability of Wisconsin's specialty crop industry. The Wisconsin Department of Agriculture, Trade and Consumer Protection (WDATCP) provides the staffing resources that facilitate the distribution of these funds to sub-recipients in this state. The Grant Manager provides outreach on the program, reviews submitted proposals, prepares the application for USDA, develops contracts and administers the grants. In addition the Grant Manager provides oversight of the program and reports to the USDA.

When the SCBG program first provided funding to Wisconsin in 2007, paperwork and reporting was handled by state-funded staff. However, during the past four years the workload associated with the grant review, tracking and reporting has significantly increased. As each additional grant cycle has been added, the number of grants that must be tracked has significantly increased due to considerably larger SCBG appropriations starting in 2010. Because of the increased workload and increase in importance of these industry funds to our state's grower groups, A dedicated staff member was needed to administer the extensive number of grants and provide the level of oversight and reporting required by USDA. As more specialty crop industries have emerged and grown, staff time was also needed to promote the program and provide assistance to potential applicants.

The 2009 and 2010 SCBGs funded this position from January, 2010 through July 2012. It has been extremely successful, increasing awareness of the program, increasing quality of applications, and increasing compliance/quality of reports and program evaluations by individual grant recipients. The 2011 grant focused on increasing grant promotion and outreach activities and streamlining administrative tasks involved with grant administration.

II. Project Approach

Grant tracking for reimbursements, contracts and project reporting has become more efficient. Much of this is due to stronger relationships with repetitive recipients and a greater understanding of common misconceptions and difficulties new recipients may have. We have done a better job communicating expectations to grant recipients and they are more familiar with procedures and requirements than past recipients.

We have also placed a great amount of effort on program outreach. The grant RFP contact list has increased by 25%. Six grant workshops were held for each year for the 2013 and 2014 competitive processes including four to promote the program and two specifically to help applicants learn more about the application process and ways to make their projects and proposals more likely to be funded. Quality of proposals increased and many potential

applicants with ineligible projects were redirected to other grant opportunities that would better suite their needs. This has greatly reduced the number of ineligible applications and projects unlikely to be funded. Only one of the 2013 and 2014 applications of the fell into this category.

There has been more time for the Grants Manager to meet with current grant recipients to assess their project progress and more communication to help projects early in difficulties so they could be tweaked before ever needing to move the project to an amendment. We are working to complete both a grant manual for new recipients and site visit protocols. Both will be implemented early in 2015.

Plan of Work activities:

Evaluate systems for tracking reimbursements, gathering report information and project Evaluations

The current tracking system involves simple Excel spreadsheets and outlook task reminders. We are moving toward a Sharepoint database that will allow more DATCP grants to be managed in a similar capacity since the SCBG Manager now works with many more grant programs than when the position was created in 2010. For the 2014 competitive process, we introduced an on-line application with the hopes of creating consistent formatting which would also streamline program management. This had mixed success. The application was created in-house with current available DATCP web-capable software. While it did achieve the main goal of consistent formatting, the format didn't make compiling the USDA application easier and had some glitches that made it difficult for some applicants to use. Since we are not in a financial position to purchase special grant or application creation software, we may or may not use the on-line application in the 2015 competitive process.

Reporting has become a much simpler process due to better communication with recipients. We are also looking into some additional evaluation metrics that align with other DATCP-managed grants. As duties have been added to the SCBG Manager's workload, we have added an additional staff member to help track payments and reports.

Conduct competitive grant process including evaluation and changes for next grant cycle

We have implemented several changes to our competitive process including hiring two new economic development staff members who will work with specialty crop producers and processors who can assist in identifying state specialty crop industry needs and can assist with SCBG outreach. We improved transparency in our grant review process with more detailed documentation of the review meetings and changed the SCBG manager's role in the process to ensure grantees could get assistance with their project ideas while maintaining the integrity of unbiased selection.

Conduct 3 - 4 SCBG proposal development workshops each year

6 workshops were conducted in September, October, January and February 2012-2013 and 6 in October, November and January of 2013-2014. These workshops helped candidates decide if their projects were appropriate for the grant and helped them improve their applications.

Promote SCBG program at industry field days, conferences, and through individual contact

The SCBG Manager attended the WI Fresh Fruit and Vegetable Conference in January of 2013 and 2014 and the Midwest Local Foods Summit in 2014. The Fresh Fruit and Vegetable conference is an extremely valuable conference because many different specialty crop industries are represented with producers, processors, researchers and industry advocates attending. Updates on over 30 Specialty Crop Block Grants were presented as well as outreach about the grant program itself. This conference not only provides an opportunity for the SCBG Manager to gage the interest of growers and processors on specific projects and their results, but allows for the opportunity to speak with grower group members, leaders, and advocates on current important industry issues, allowing for tailored outreach to future groups based on these connections.

Attendance at the Midwest Local Foods Summit was also a valuable opportunity to connect to broaden the applicant pool for the 2014 competitive process since local food projects are a relatively new priority for Wisconsin's Specialty Crop Block Grant program. This event was a catalyst for 5 SCBG applications in 2014.

Attendance at other events included:

- WI Cherry Board to promote the grant and help the board narrow some project ideas for potential application – March 2013, January 2014
- Wisconsin Agricultural Economic Forum, January 2013 and 2014 where many WI specialty Crop industry representatives and University researchers currently holding open SCBG projects attend. This has been a good event for discussing industry priorities as well as project ideas and current project progress.
- Dane County Extension Local Food Connections meeting to witness one of the events funded by the 2012 SCBG for connecting local producers with wholesalers/distributors/ and institutional food buyers – March 2013
- WI Apple Growers Association Field Day to hear industry research and talk with growers, processors and board members about industry issues and potential project ideas. – July 2013
- WI Cranberry Growers Association Field Day to listen to presentations on grant projects, gage grower interest in those projects and talk with grower, processors and association board members about industry problems and priorities in the future – August 2013, 2014
- WI Potato and Vegetable Growers Field Day to listen to presentations on grant projects, gage grower interest in those projects and talk with growers and processors about industry problems and priorities in the future - July 2013, August 2014
- UW Field Day – Hancock Research Station to listen to presentations on grant projects, gage grower interest in those projects - July 2013, 2014
- WI Ginseng Growers Field to listen to presentations on grant projects, gage grower interest in those projects and talk with grower, processors and association board members about industry problems and priorities in the future - August 2013,2014
- Site visit to Wisconsin Potato and Vegetable Growers Association, August 2014
- Wisconsin State Fair to meet with grower group members to discuss potential industry issues and project ideas – August 2013 and 2014

One of the highlights was the ginseng field day. This industry has come a really long way with the help of the SCBG. 10 years ago there was speculation that Wisconsin's ginseng industry was

going to die out. This year, there were over 100 attendees at the field day and there are only 150 growers in the state. Growers are signing up for texts for pest alerts during the growing season. Growers at the field day were sharing techniques with each other and singing the praises of the research staff. Four years ago when I attended my first ginseng field day, one of the biggest concerns from researchers was that growers weren't implementing recommended practices from the project results. Now most growers have adopted the best management practices and the program is truly working. While SCBG has only been one funding source for this industry, they are grateful and extremely appreciative and gracious in acknowledging where the funding comes from.

Evaluate effective outreach activities and recommend changes to make more effective
Conducting grant workshops with other government organizations such as USDA and University of Wisconsin Extension staff was an effective way to spread the word about the SCBG program. Because the SCBG Manager now works with about 6 other grant programs, the audience for SCBG outreach has easily expanded. The addition of two more staff who will work specifically with specialty crop growers and processors will also make it easier for outreach to take place. Having a dedicated minority outreach staff member in DATCP's farm center has made outreach to underserved groups more effective as well. Without this funding, our SCBG program would be far less successful. We are very excited to move forward, especially with expanded funding from the 2014 Farm Bill.

III. Goals and Outcomes Achieved

One of the biggest successes of this grant was creating a position that was grant funded for two SCBG cycles and is now part of Wisconsin's state budget. This is the epitome of grant funding. We had no way to fund a grants manager in 2008. But the need to have someone dedicated to the successful management of federal funds to help promote and grow agricultural industries was recognized. Grant funds were secured as the position morphed over time and eventually, the funds were no longer needed as permanent funding was sourced. This is the ultimate goal of most grant funds and we are proud to have the thriving program we have due to this grant.

Goal 1: A primary goal for this position was to maintain a comprehensive database to use for tracking the SCBG awards, reports, reimbursements and evaluations. Tracking this information in one electronic and physical location, having one person responsible for the collection and recording of the Specialty Crop Block Grant requirements will continue to enable DATCP to better monitor, evaluate, and streamline the program.

Outcome Measure: Streamlining the tracking process will be measured through time sheet activity records, amount of time spent on non-tracking related SCBG activities such as number of engagements attended, and an increase in number of applications submitted for each year's competitive grant process.

Benchmark: Currently 56 grants are being managed by the SCBG Manager taking up 85% of her time.

Target: By September 30, 2013, grant evaluation and tracking will comprise only 70% of the SCBG Manager's time.

Tracking and management now comprise only about 50% of the SCBG Managers time. This was calculated based on tracked time distribution and amount of time spent on outreach activities. We feel we have a good handle on administrative processes but will continue to look for additional ways to streamline our tracking and management practices in the future.

Goal 2: Increase awareness of the specialty crop block grant program. This will be accomplished through grant writing workshops, promotion of SCBG program at specialty crop industry field days and events, and through other industry communications and personal interactions.

Outcome Measure: Success will be measured by increased offerings in SCBG promotional activities and increased attendance at these programs.

Benchmark: in 2010/early 2011 SCBG Manager attended 3 conferences, 2 field days and put on 2 SCBG application writing workshops.

Target: by Sept 30, 2013, the SCBG Manager will have increased these contacts to 10 per year.
The SCBG Manager attended

We have exceeded our goals in increasing our outreach efforts. In 2013 and 2014, the Specialty Crop Block Grant Manager attended 20 events and 24 events respectively. Three other staff also attended more than 12 events where they promoted the SCBG program including the Buy Local, Buy Wisconsin Road Show events and Wisconsin Agricultural Tourism Association meetings and events, Wisconsin Local Food Network events and meetings. Additionally, two additional positions have been added for work with specialty crop producers, processors and stakeholders. These positions will not only provide outreach on the SCBG program, but will be connected to industry representatives and producers alike, so they can assist in soliciting input on priorities for the grant and can recommend the program to applicants with important project ideas.

IV. Beneficiaries

This project has benefited all Wisconsin specialty crop producers and processors. Without this project, the WDATCP would not have been able to effectively manage this grant program and might have chosen not to accept the funds which benefit so many specialty crop producers and processors in our state. Even if we did accept the funds, no outreach efforts would have been conducted so only those who were previously aware of the grants would benefit. In particular, Wisconsin's smaller grower associations, underserved producers and processors, and organizations interested new grant priority areas such as nutrition education and buy local initiatives have benefitted from outreach efforts to expand the grant priorities. This has helped diversify Wisconsin's Specialty Crop Block Grant recipients and is helping to strengthen some of our smaller specialty crop industries, adding value to farms' products. The program has also helped sub-recipients disseminate their project results so more producers and processors can take advantage of practices and procedures recommended from project results. Wisconsin's citizens

have also benefited from this project because many of the sub-recipients have developed practices, procedures, and industry innovations that protect environmental resources, educate the public on healthy eating, or increase the safety of the food citizens eat. Without this Grants Manager project, most of the great things the Specialty Crop Block Grant program does, would not take place in the state of Wisconsin. We are extremely appreciative of the opportunity for us manage this program in a way that directly benefits our farmers and our citizens.

V. Lessons Learned

This project morphed over time to not need much of the salary budget that was originally planned. Because we consistently communicated changing needs with USDA-AMS staff and this grant allows for some flexibility in its administration, we were able to add several additional projects which enhanced competitiveness of several specialty crops important to Wisconsin farmers. We greatly appreciate this flexibility in the program as do our state specialty crop producers and processors.

VI. Additional Information

None

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23) Disease and Canopy Management in Northern Wine Grapes (FY11-023)

Report Date: October 31, 2014

I. Project Summary

A. This project serves Wisconsin's 100+ commercial grape growers and 80+ wineries by providing information that is specifically relevant to the "cold-climate" or "northern" varieties on which our state's rapidly growing grape and wine industries are based. The main objective was to evaluate northern grape varieties for sensitivity to copper and sulfur fungicides. Copper and sulfur are effective fungicides, but they have the significant drawback of injuring leaves of some grape varieties. Since the northern varieties are relatively new, their reaction to copper and sulfur is not known. Although not originally proposed, we also included in our trials the fungicide difenoconazole, which is effective against several diseases but also has been reported to injure certain grape varieties. Prior to the start of this project, University of Wisconsin faculty and staff established research vineyards and were active collaborators on the Northern Grapes Project (NGP), which was funded by USDA Specialty Crops Research Initiative (SCRI) October 2011 through September 2013. We initiated the copper and sulfur sensitivity work on that original SCRI grant. The SCRI NGP was renewed for the period October 2014 through September 2016. The SCBG described here provided critical bridge work between the two SCRI NGP grants.

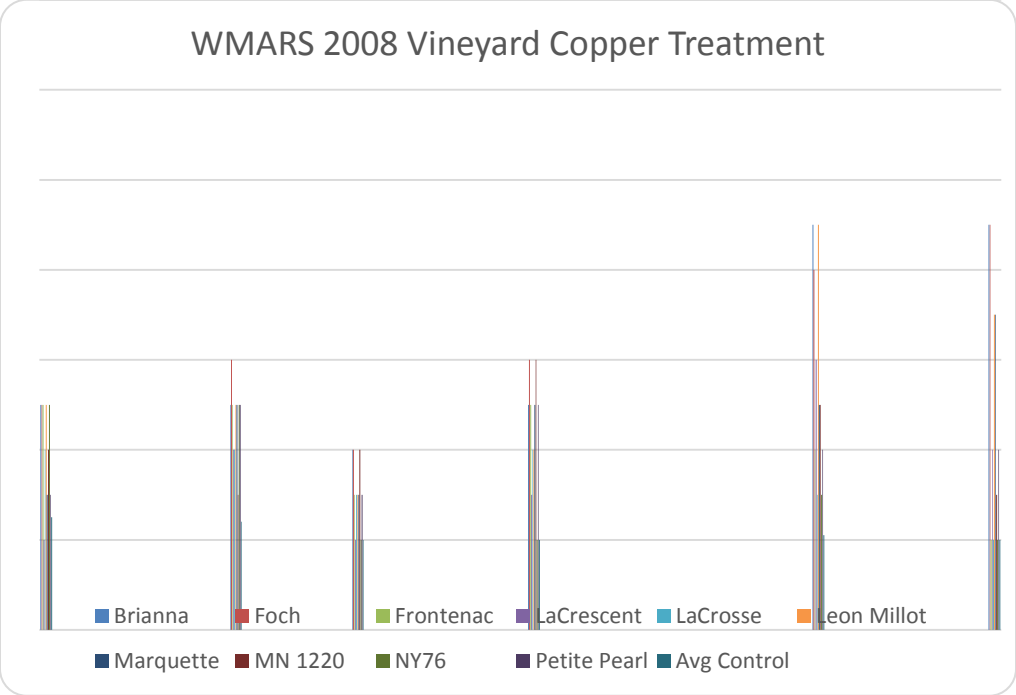
B. UW-Madison professor Rebecca Harbut was the recipient of FY12 SCBG project #12-015, entitled "Development of Research Based IPM and Grape Canopy and Fruit Maturity Index Tools." Upon Harbut's departure from UW-Madison in May 2013, UW-Madison professor Patricia McManus led the project. The project focused on establishing an IPM framework for both table grape and wine grape growers in Wisconsin that included simple data collection (e.g., pest monitoring and crop phenology) and emphasized delivery to growers through on-line IPM reports and in-field workshops. The project reported herein was separate from that project, but it used the same vineyard resources at West Madison and Peninsular Agricultural Research Stations (WMARS and PARS) near Madison and Sturgeon Bay, respectively.

II. Project Approach

In the summer of 2014, we conducted four field experiments in which we rated the level of injury (burning or discoloration) on grape leaves treated with fungicides at their highest labeled rate: copper (Cuprofix Ultra 40 Disperss, 3 lb/acre); sulfur (Microthiol Disperss, 10 lb/acre); or difenoconazole (Inspire Super, 20 fl oz/acre). Shoots that were not sprayed served as a control. At both WMARS and PARS locations, trials were conducted in vineyards established in 2008 and 2012. Treatments were replicated four or five times on each variety in the 2008 and 2012 vineyards, respectively. At WMARS, sprays were applied on June 20, July 17, July 30, and August 20. A severe hailstorm at PARS on July 14 stripped leaves from vines, preventing us from conducting ratings there. Therefore, the data reported in Figures 1-3 are from the two experiments at WMARS.

At approximately 2-week intervals starting in early July and ending in early September, one person rated foliage on a scale where 1= no injury; 2 = mild injury; 3 = moderate injury; 4 = severe injury. Values less than 2 were considered biologically and economically insignificant. Such minor damage probably would not impact yield, fruit quality, or vine health, and most growers would not be alarmed at this level of injury. At ratings above 2, growers might grow concerned. Data were statistically analyzed separately for each date by a protected Least Significant Difference test; differences were deemed significant if $P \leq 0.05$.

In the legends to Figures 1-3, the varieties that had both an average injury rating greater than 2 and were statistically different from the control, and the dates on which both criteria were met, are noted. While we cannot make firm conclusions from two trials conducted at one site in one year, most varieties showed little response to repeated applications of copper, sulfur, or difenoconazole. Notable exceptions are that Foch and Leon Millot sustained severe injury from sulfur. The sensitivity of these sibling varieties to sulfur has been noted before, and they served as good indicators in our trials.



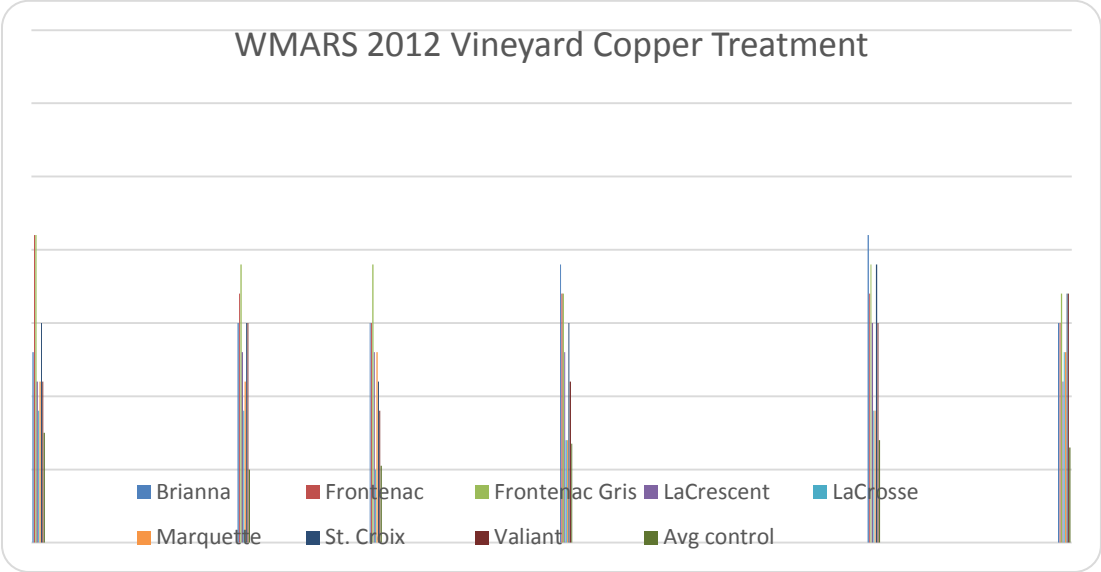
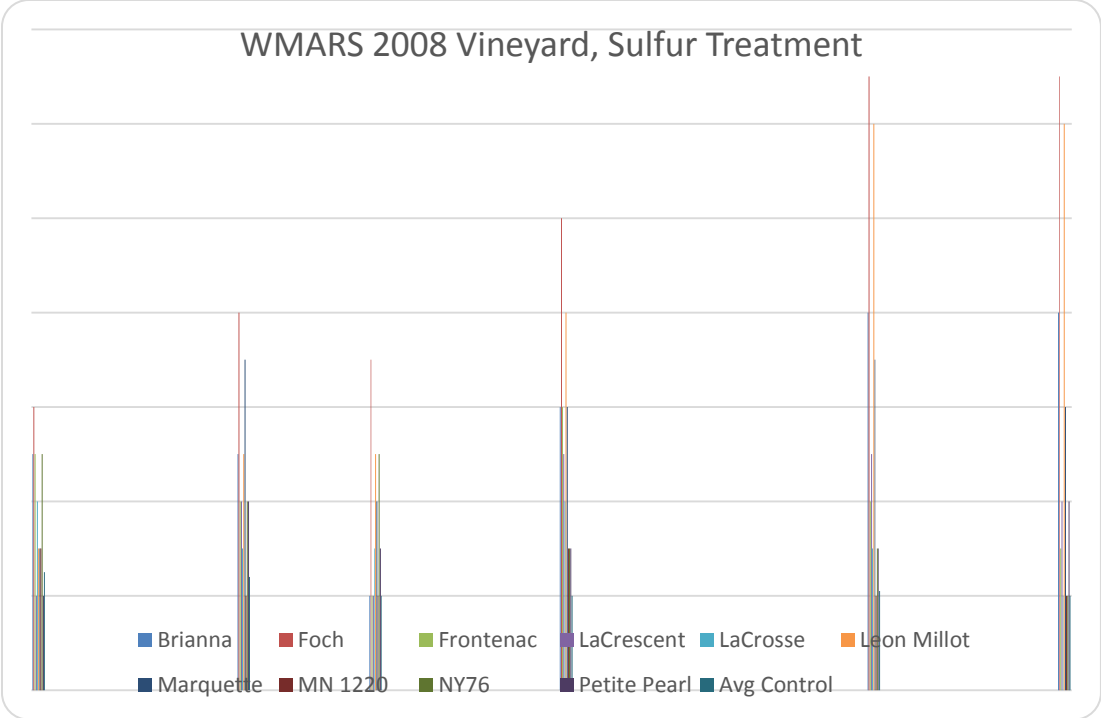


Figure 1. Sensitivity of grape leaves to copper (Cuprofix Ultra Disperss) at WMARS in 2014. 1= no injury; 2 = mild injury; 3 = moderate injury; 4 = severe injury. In the 2008 vineyard, varieties that had significantly greater injury than the control *and* had average rank greater than 2: Brianna on 8/27 and 9/9; Foch on 8/27, and 9/9; Leon Millot on 8/27, and 9/9; and St. Croix on 9/9. In the 2012 vineyard, varieties that had significantly greater injury than the control *and* had average rank greater than 2: Brianna on 8/27; Frontenac on 7/1, 7/15, 8/6, and 8/27; Frontenac Gris on 7/1, 7/15, 7/24, 8/6, 8/27, and 9/9; and St. Croix on 8/27.



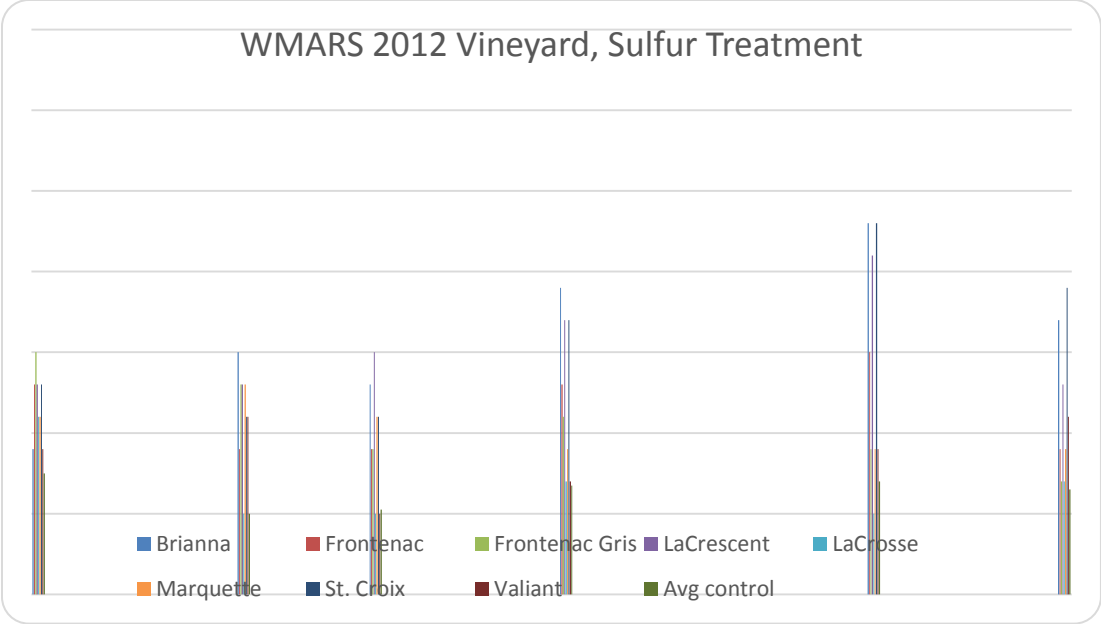
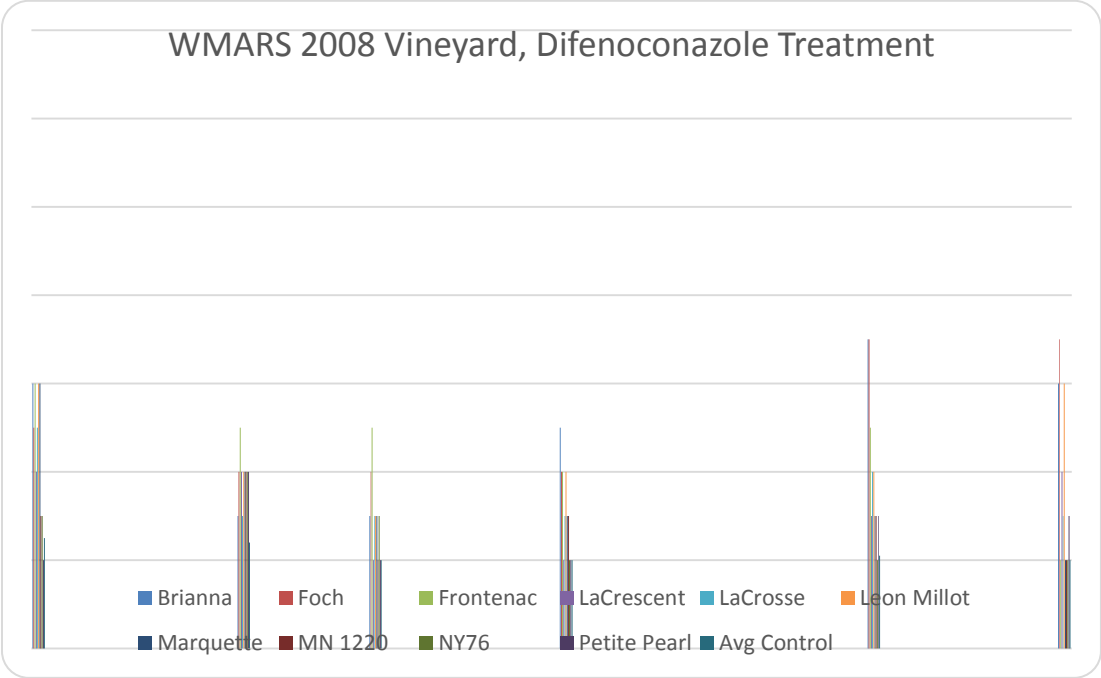


Figure 2. Sensitivity of grape leaves to sulfur (Microthiol Disperss) at WMARS in 2014. 1= no injury; 2 = mild injury; 3 = moderate injury; 4 = severe injury. In the 2008 vineyard, varieties that had significantly greater injury than the control *and* had average rank greater than 2: Brianna on 8/27 and 9/9; Foch on 7/15, 7/24, 8/6, 8/27, and 9/9; Leon Millot on 8/6, 8/27, and 9/9; and Marquette on 7/15 and 8/27. In the 2012 vineyard, varieties that had significantly greater injury than the control *and* had average rank greater than 2: Brianna on 8/6, 8/27, and 9/9; LaCrescent on 8/6 and 8/27; and St. Croix on 8/6, 8/27, and 9/9.



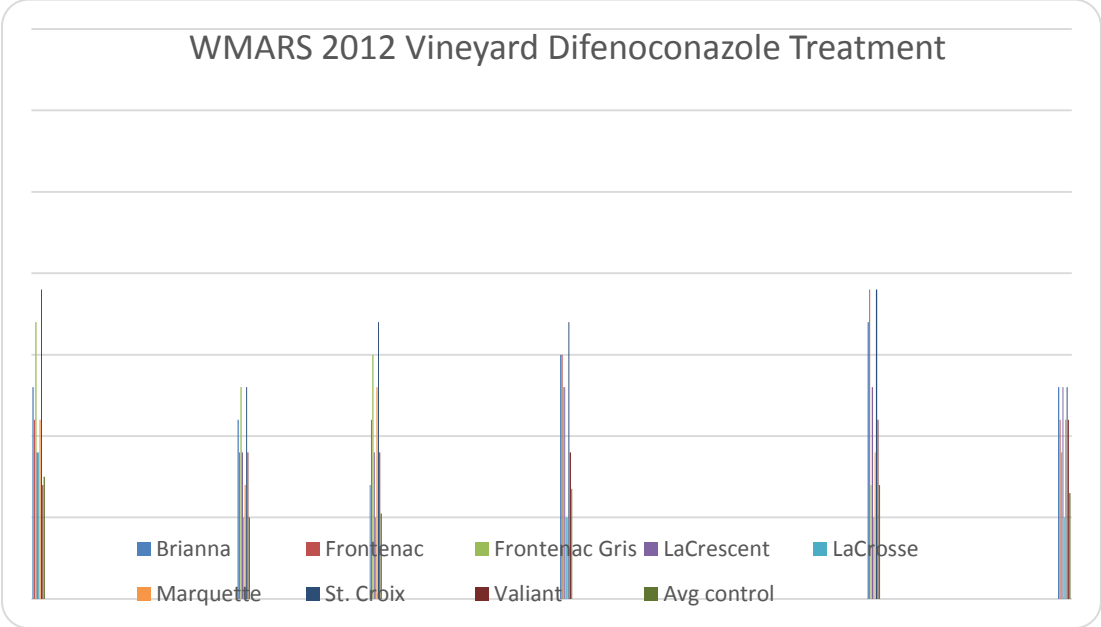


Figure 3. Sensitivity of grape leaves to difenoconazole (Inspire Super) at WMARS in 2014. 1= no injury; 2 = mild injury; 3 = moderate injury; 4 = severe injury. In the 2008 vineyard, varieties that had significantly greater injury than the control *and* had average rank greater than 2: Brianna on 8/27 and 9/9; and Foch on 8/27. In the 2012 vineyard, varieties that had significantly greater injury than the control *and* had average rank greater than 2: Brianna on 8/27; Frontenac on 8/27; and St. Croix on 7/1, 7/15, 7/24, 8/6, and 8/27.

III. Goals and Outcomes Achieved

A. The sensitivity of grape foliage to fungicides is probably influenced by environmental conditions before and after spraying, making it necessary to repeat experiments over locations and years to gain confidence in the results. The data gathered in 2014 at WMARS will be analyzed with results from experiments conducted in 2012, 2013, 2015, and 2016. Once completed and published, this will be the most comprehensive study of copper and sulfur sensitivity in wine grapes in the scientific literature. The data will be directly applied to advise growers in developing disease control programs.

B. We met our goal of quantifying the sensitivity of northern grape varieties to copper and sulfur. Additionally, we have data on sensitivity to difenoconazole, an effective fungicide that has been reported to injure certain grape varieties. While the loss of two trials at PARS was a disappointment, the vines put out new growth and are going into winter in good shape. We expect that they will fully recover and that we can continue our work on sensitivity to fungicides with SCRI NGP funds in 2015 and 2016.

IV. Beneficiaries

The primary beneficiaries are grape growers and winemakers in Wisconsin. Wisconsin is home to more than 100 commercial vineyards, plus an additional 100+ hobbyists, some with aspirations of expanding into commercial production. There are more than 80 licensed wineries distributed throughout the state, up from fewer than 20 just a decade ago. A recent NGP report (*Vineyards and Wineries in Wisconsin: A Status and Economic Contribution Report*, B. Tuck, 2014) documents that in 2011, the winery and grape growing industries in Wisconsin had an economic impact of about $120 million (combined impact of grape production, wine sales, and associated tourism). Disease management is commonly listed as a top production concern by grape growers in Wisconsin (e.g., B. Tuck report listed previously, and *USDA NASS 2011 Grape and Wine Industry Survey*). Knowing how to incorporate copper and sulfur into spray programs will lead to more efficient use of fungicides and directly benefit growers' incomes, because copper- and sulfur-based fungicides are generally less expensive than other fungicides and are valuable for fungicide resistance management. The longer-term impacts of this project will be fewer rejected shipments of grapes because of better disease control and less environmental impact.

V. Lessons Learned

We knew at the outset that this one-year project would not provide enough data to provide conclusive recommendations for growers. However, the funds proved critical for bridging the gap in USDA-SCRI funds.

VI. Additional Information

None

VII. Contact Info

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24) Herbicide Drift Awareness Campaign (FY11-024)

Report Date: October 7, 2014

I. Project Summary

A. Grapevines are susceptible to herbicides, specifically 2-4D and Roundup, which can kill the vines. As more growers plant vineyards across the state, more incidences of damage to grapevines by drift are being seen. Growers need to understand what causes drift, how their vines are affected by drift, how to report damage to the proper authorities and how to talk with their neighbors about the problem.

In addition, the new Roundup Ready Corn and Soybeans pose an additional risk as crop farmers will be able to spray these herbicides directly on crops that may be in the same vicinity as vineyards. This project helped us create materials to get the word out now before grapevines are killed and more disputes arise as these new specialty seeds are distributed.

B. WGGA has received SCBG dollars previously but not for anything related to herbicides.

II. Project Approach

In this project, we hired a consultant to research what herbicide drift was, how it impacts grapevines, how to treat plants suspected of being hit with spray drift, how to document a suspected drift incident and where to report such incidents. This information was collected in an "Herbicide Spray Drift Guide for Wisconsin Grape Growers" which was distributed to the grape growers in the state. The information was also put into a brochure called "Use Care When Applying Herbicides Near Grapes" to be used as a handout for grape growers to give to their neighbors, local applicators and others that may be applying herbicide in the vicinity of their vineyard.

The grant also provided for a workshop where a specialist was brought in to discuss herbicide drift, its impacts on grapevines and how to document a drift occurrence. The printed materials backed up what was taught in the workshop.

III. Goals and Outcomes Achieved

A. The *Herbicide Spray Drift Guide for Wisconsin Grape Growers* and *Use Care When Applying Herbicides Near Grapes* handout brochure were both researched, written and distributed. 134 Wisconsin grape growers received a copy of the Guide and 12 copies of the handout.

A workshop was held that covered spray drift and its ramifications with speakers from Iowa State University and the Wisconsin Department of Agriculture, Trade and Consumer Protection. 46 growers participated in the workshop.

B. Develop a Manual – Done.
Distribute to 100 growers – Done.

IV. Beneficiaries

The project has benefited the 134 growers who received the manual and the handout brochures so that they are educated on the issue of herbicide drift and can speak to their neighbors on this issue. It also benefits those neighbors who now will understand that drift is damaging to vineyards and that they have a legal obligation to prevent spray drift.

V. Lessons Learned

This project offers a clear outlined path that grape growers can use to communicate with their neighbors before a problem occurs or if drift happens, it tells growers steps they can take to save their vines and document the situation. We hope that better communication between growers and their row crop neighbors will prevent drift problems.

VI. Additional Information

A Spray Drift Manual and Handout are attached.

VII. Contact Info

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25) Development of Good Manufacturing Processes for the Wisconsin Hop Production Industry (FY11-025)

Report Date: September 15, 2014

I. Project Summary

A. This project focused on establishing a web-based tracking database for Wisconsin and regional producers and processers to provide them a tool to capture and document their hop production and processing data (in accordance with Good Manufacturing/Agricultural Principle) such as farm chemical and cultural logs, quality control, documentation practices, and chain of custody documentation from production through processing. Regional hop production and processing is rapidly expanding. However, the small scale hop production industry in Wisconsin and the Great Lakes Region lacks resources for proper hop production and processing documentation relating to food safety and product quality tracking. This project created a database for producers to document cultural and processing data, serving to unify grower practices, creating quality, safety, and consistency, thus removing barriers to sales expansions within the state.

B. This project, was not based on a previously funded SCBG project.

II. Project Approach

1. SURVEY PHASE. This phase of the project focused on designing and implementing data gathering from growers, brewers, and consumers regarding the quality control aspects production, utilization, and consumption. The goal of this stage was to discern any patterns between the three groups that could be addressed simultaneously within the early database architecture. Details of each survey segment are detailed below:

    a. Brewers: 60 brewers were surveyed, with 30 responding (50%) ranging from 500 barrels to 90,000 barrels production size, both distributing and non-distributing. Respondents represented the following States approximately:
        i. Wisconsin (84%)
        ii. Illinois (5%)
        iii. Minnesota (5%)
        iv. Michigan (5%)
    b. Data from this survey set are presented in Section VI, Appendix C
    c. Results from this survey set reveal:
        i. 50% of respondents fall within the 500-5000 barrel production size
        ii. 60% of all respondents considered knowing exactly where or by whom are to be at least <u>somewhat</u> important and 40% consider it <u>highly</u> important
        iii. 60% of respondents report having at least 1 quality related incident with their finished beer due to raw ingredient related problems. 20% have had numerous issues and 20% have had no issues

iv. 100% of respondents report that having knowledge of the production practices imposed on their raw ingredients are at least somewhat important (30%), highly important (60%), and critically important (20%)
v. Of the 5 questions posed to the respondents nearly all brewers believe that knowing the storage conditions post-processing (50%) to be the most critical aspect of hop quality, followed closely by knowing the chemicals used during production (40%)
vi. Interestingly, 30% of the respondents in each case reported that chemical usage on the crop and post/pre-processing storage were of the least concern
vii. 60% of the group reported that obtaining information on the production practices of their hops was either Very Difficult (10%) or Somewhat Difficult (50%)
viii. When asked specifically whether they would use a web-based system to track production quality parameters, 90% reported that they would use it at least occasionally (40%) or frequently (60%) to add value to their brewing process.

2. Part II of the survey phase engaged over 60 hop growers ranging in size from 1000 plants to over 15000 plants, with 50% responding. This survey's purpose was to understand the level of sophistication across various farm scales. The specific questions can be viewed in Section VI, Appendix A. The most enlightening responses are as follow:
    a. 80% respond as using a wide variety of synthetic herbicides, fungicides, and insecticides that should be recorded and made available to the state and customers
    b. Less than 30% report using any "natural" amendments or production chemicals
    c. 85% report that they use moderate to large scale harvesters or contract harvest
    d. Those who perform their own harvesting respond that they harvest in an enclosed space (85%)
    e. However ~70% report that they have a dedicated space for harvesting and drying activities. This means the remaining 30% use a transient or multi-purpose space that may or may not be suitable for food handling activities.

3. Part III of the survey phase focused on grower production practices to gain insight into the mindfulness of the growers regarding the importance of food safety. 60 hop growers were surveyed with 50% responding. Details of the survey can be found in Section VI, Appendix B. The most meaningful responses are detailed below:
    a. 100% respond as recording their chemical applications but only ~40% use electronic/digital means. The remainder use uncontrolled paper forms or notebooks
    b. More worrisome is the fact that ~20% responded that they DO NOT have a pesticide applicator's license despite reporting that they are the applicator on their farm (100%)
    c. 70% report that they have proper storage conditions for agri-chemicals but ~30% are storing inappropriately, usually the home/garage

d. Growers are focused on yield parameters as the primary importance and consider quality factors as secondary. This could lead to a notion of quantity over quality and drive production factors that may negatively impact cone chemistry (over-fertilization)
e. Over 50% of respondents report using farm implements to apply chemicals to their plants (air blast or boom sprayers). These are the most accurate and also provide insight into the mentality of the grower. Those using hand pump or backpack sprayers (~30%) are less accurate and are likely either applying far too much or too little chemical, both of which are deleterious.
f. Approximately 45% of growers apply chemicals when they see a problem whereas 50% apply based on recommendation of a crop professional or adhere to a production plan. There is evidence that waiting to apply until a problem leads to chemical resistance and overall poor quality.

1. DATABASE PHASE. The objective of this phase was to use the survey data to design a database that captured the most critical aspects of production, processing, and usage gained from the survey results. Key data entry labels were determined using specific survey questions as markers. Brewer survey results drove the database output and end user interface.
    a. Database platform decision. When designing a database one must understand its primary function and user proficiency before embarking on a format. For this project the main parameters were:
        i. Open access to any registered user
        ii. Free of charge
        iii. Ease of data entry and retrieval
        iv. Low initial cost
    b. Multiple platforms were investigated including:
        i. Hosted service offsite
        ii. Native client self-hosted, software package
        iii. Cloud-based applications
        iv. Native client hosted, custom software.
    c. For ease of execution, cost (little to no cost), and user experience it was determined that a Cloud-based service was most appropriate. Several cloud services were investigated and ultimately it was decided to utilize open source Google Docs with a Seybold database underlying.
    d. It was decided that Growers create a profile in the system that includes details of their harvesting and drying facility, pesticide applicator's license, etc. This profile is static and may be updated by the grower at any time as changes are made to their system. Growers are also responsible to provide application data on fertilizer and chemical applications (date, type, etc), harvest timings, cultural production milestones (training, pruning, etc). All of these fields are optional. Should data be queried for a grower with incomplete records, the program will return a message stating the grower elected to omit data critical to this particular report.

e. Processors will be required to provide temperature data pre-post processing, lot numbers, tracking data, chemistry data, etc. Also required in their profile is food processing license number or certificate, inspection records, etc. Similar to the Grower, all data fields are optional.
f. Brewers or users of the database may query any combination of production/processing records. For instance, should all the data be recorded, a brewer may search a lot number from a particular registered processor and find a list of all growers who contributed to the lot. The brewer may dive deeper into each grower record to discover their harvest dates, drying temperatures, chemical application logs, etc. Conversely, should a brewer find a particular grower of interest, the brewer may search a processor's lot numbers by the grower ID to find what lots to which that particular grower contributed.

2. DATABASE STATUS. The database is currently in development and scheduled to go live in January 2015.

III. Goals and Outcomes Achieved

A. The primary objective for this project was to demonstrate an increase in sales of locally produced hops to brewers by means of supplying complete, integrated data regarding production and processing. The concrete evidence of the project's success will be measured over the coming 2-3 years however early brewer interest has led to increased sales (3 new brewer customers) by obtaining them as new customers. Engaging brewers to talk about these quality aspects improved their confidence and increased pre-harvest allocation of the crop and thus, sales. We expect that number to increase after the database goes live and brewers have a chance to experience how much information is at their command.

B. Project Approach Part II details the actual project accomplishments and is in keeping with the overall objectives.

IV. Beneficiaries

All groups have benefitted from the data gathering phase as it shed light on surprising facts that allowed us to design data collection methods to capture deficiencies. Specifically, each group is detailed below:

Beneficiaries:

1. Growers. While only 30 growers responded more than 150 growers in the region will potentially benefit from this project's completion. The database is available to anyone producing hops to sell. Conservatively, if only 20% of the growers experience a 10% increase in sales a total of $45,000 simply by using the database. We expect the actual numbers to be closer to 40-50% of growers nearing $120,000.

2. Processors. There are very few processors in the region (4 at last count) however they all have an opportunity to participate in the database project. Some processors are grower-owned via co-op while others are privately held. Utilizing the database, processors can demonstrate their commitment to quality and reinforce their expertise to the brewing industry.
3. Brewers. Brewers, while not the primary beneficiary of the project, will experience increased confidence in the ability of regional growers and processors to provide a raw ingredient with confidence and traceability. This will result (and in some cases already has) in increased purchases of local hops.

V. Lessons Learned

Beginning this project we assumed we understood the mindset of the growers and the needs of the brewers, expecting few surprises from either group. However we were intrigued by the following discoveries:

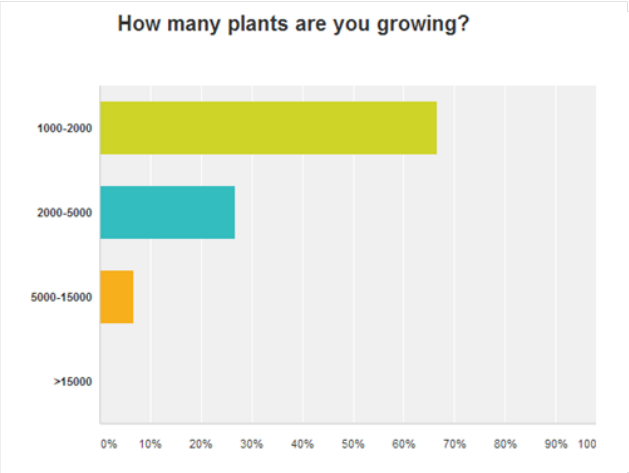
1. Small scale brewers were more likely to be concerned with quality and their ability to confidently and consistently access quality information from their distributors.
2. Nearly all brewers, regardless of size, experienced raw ingredient quality issues that caused them significant financial burden, usually dumping an entire brew due to poor quality hops.
3. Brewers were more concerned with the storage conditions of their hops as the primary cause of quality issues. This aspect is important yet it presents a teaching opportunity for the database users. Explaining how production practices impact hop quality will further bolster confidence in the brewing community
4. 100% of brewer respondents were engaged with the idea of a quality database and would use it at least occasionally (5-6 times/year)
5. Growers are more concerned with quantity than with quality. This contradicts the general notion that small scale producers must compete on quality with the very large growers. More education is needed here.
6. While all growers reported using synthetic agricultural chemicals, only 80% reported having the proper licensing.
7. A rather high percentage of growers (45%) do not follow a written plan for chemical application activities and instead wait until they see problems to act. This is greatly troubling as most quality issues are disease and pest related. Waiting until one notices an issue for most hop diseases is a major problem for long term disease control.

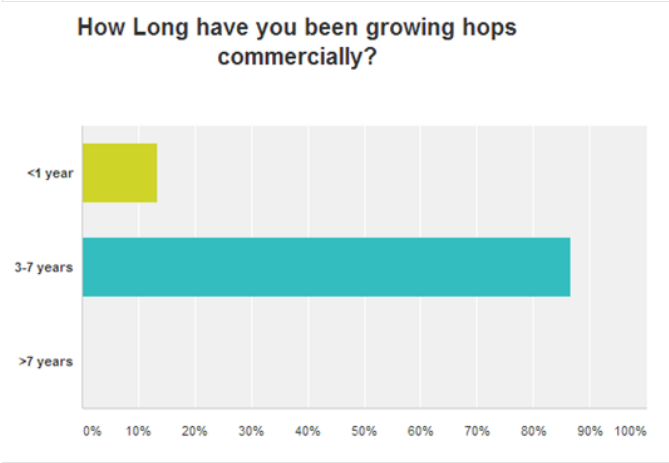
VI. Additional Information

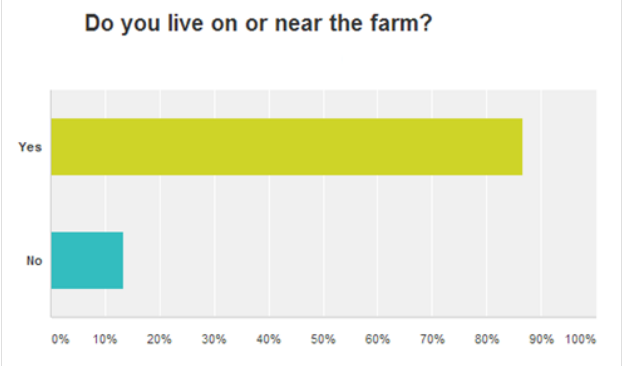
See addendums A, B, C

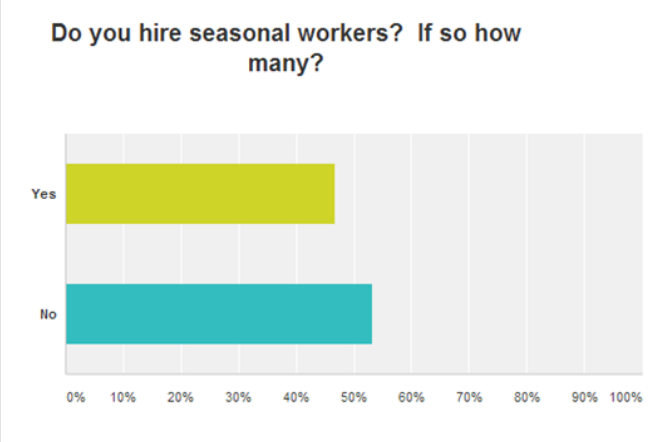
Addendum A

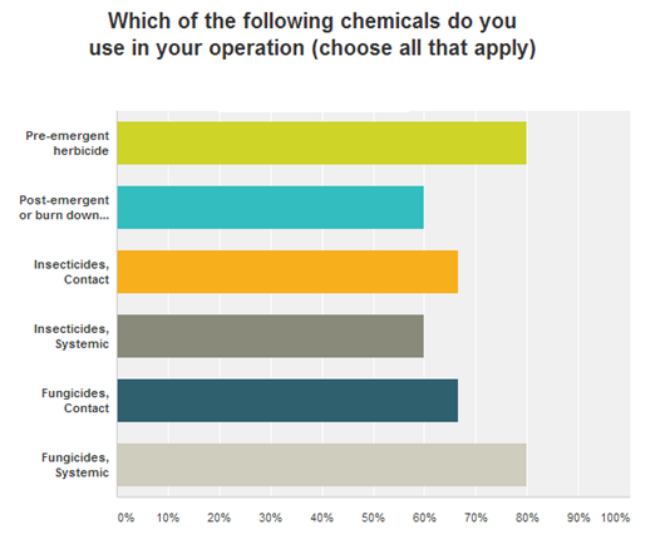
Grower Survey 1 Results

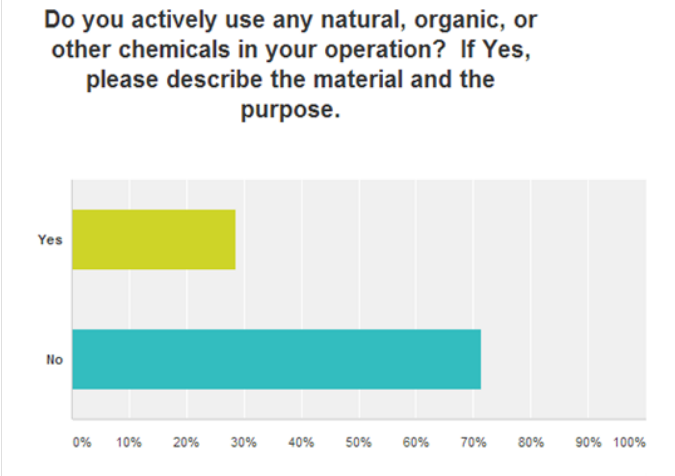




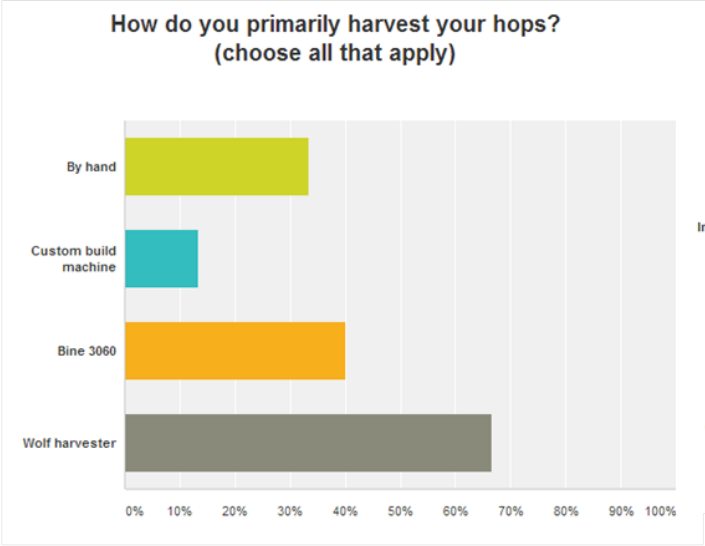


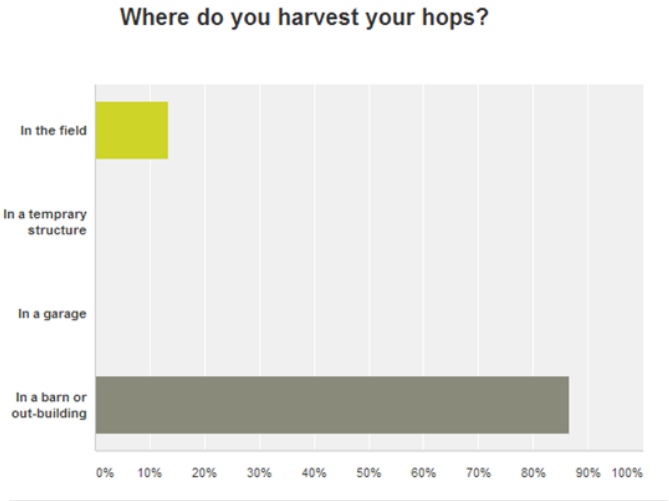


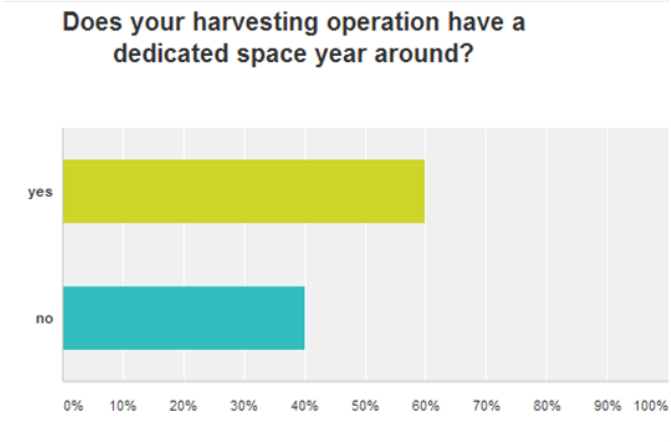


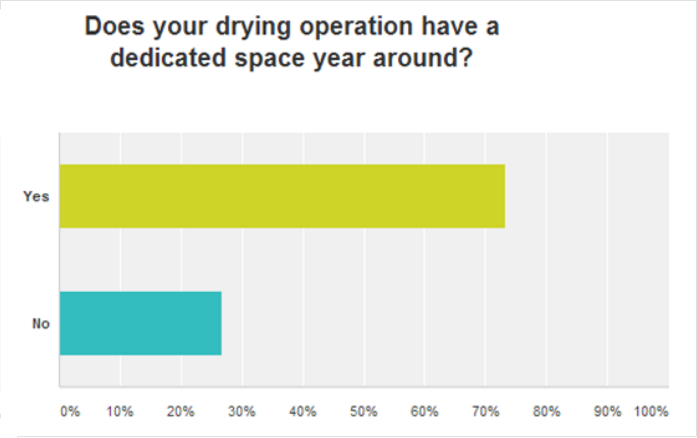


Grower Survey 1 Results



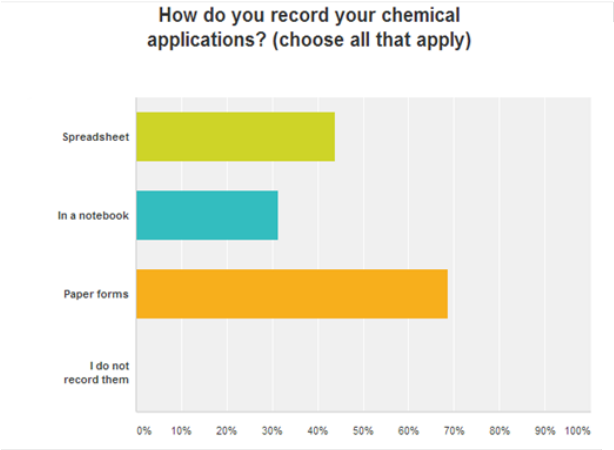


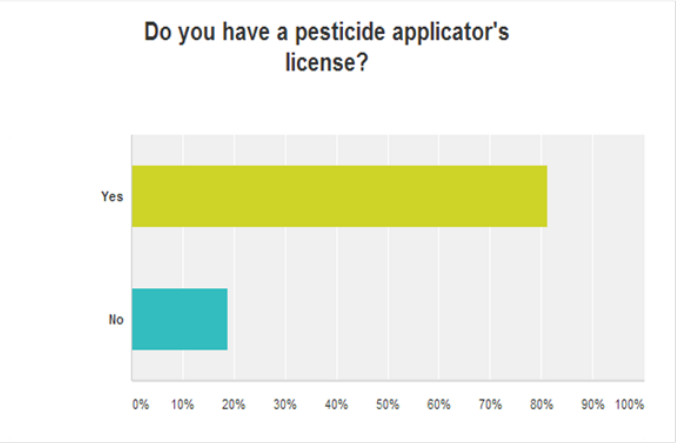


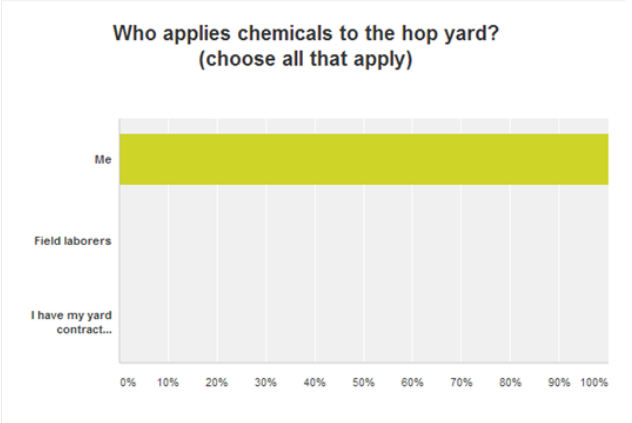


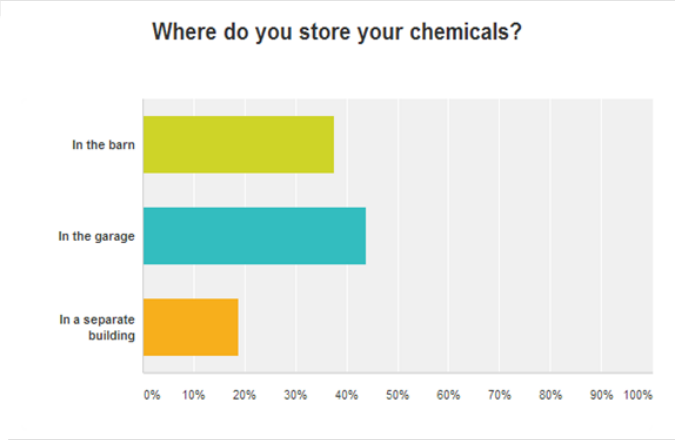
Addendum B

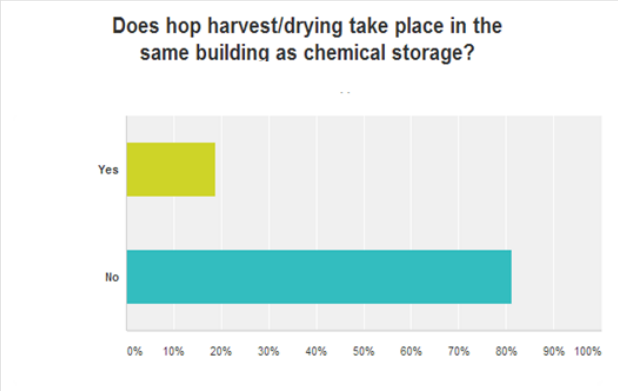
Grower Survey 2 Results

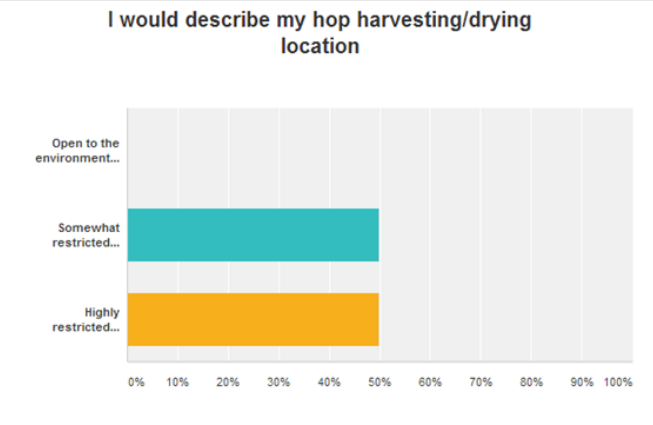












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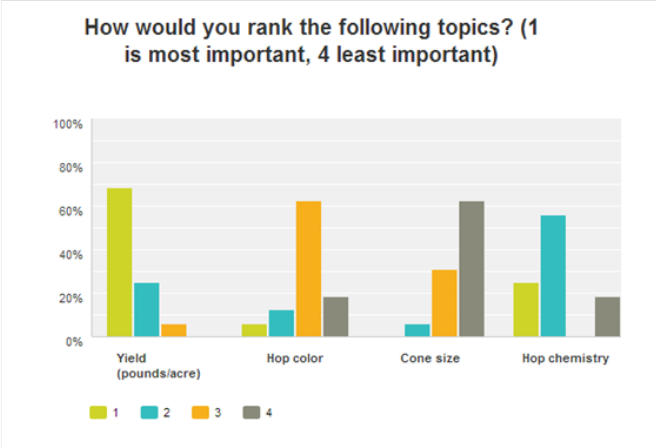
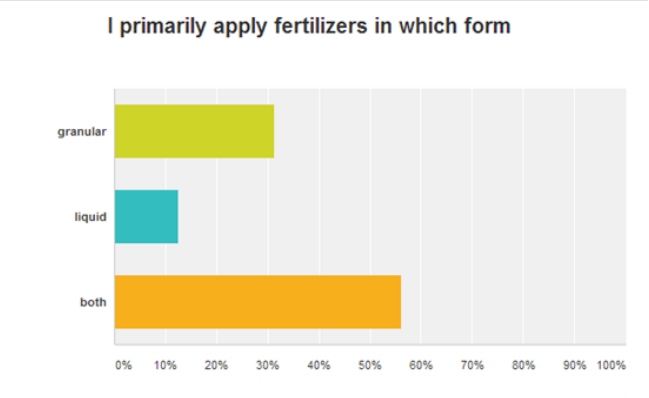
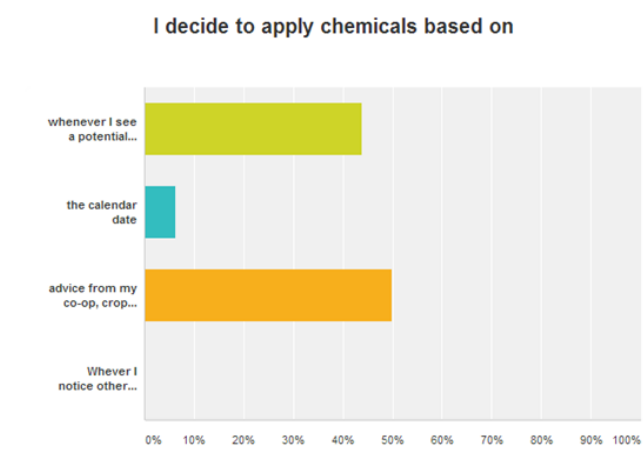
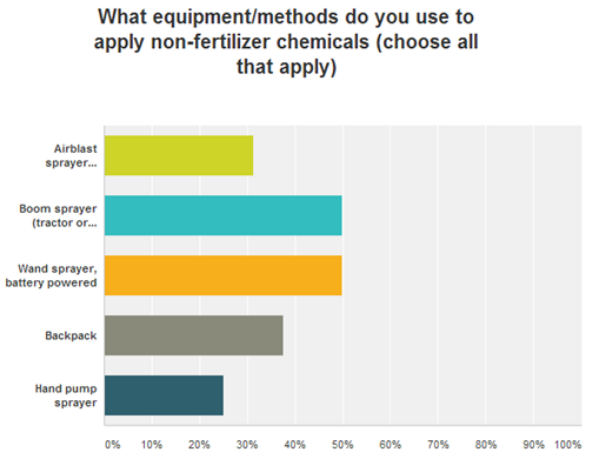


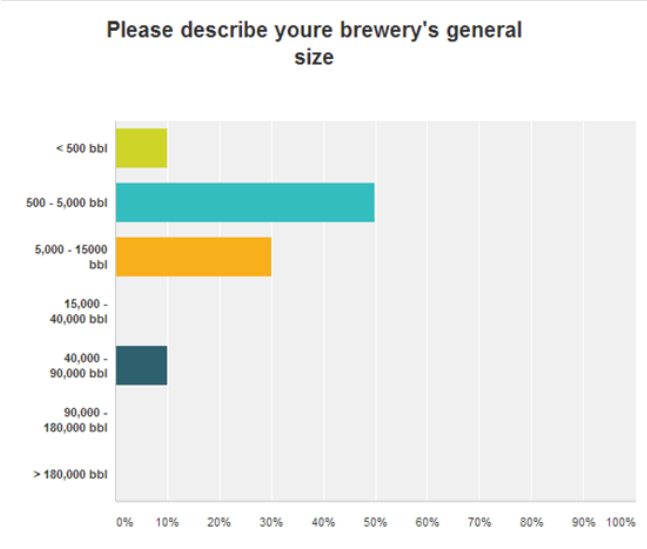


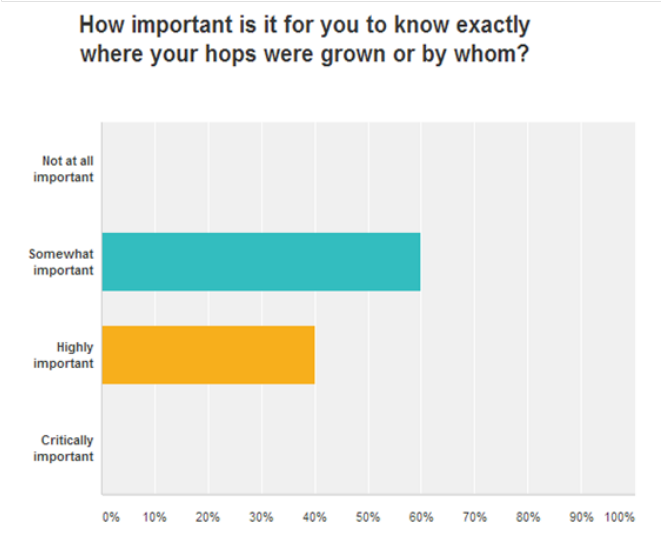


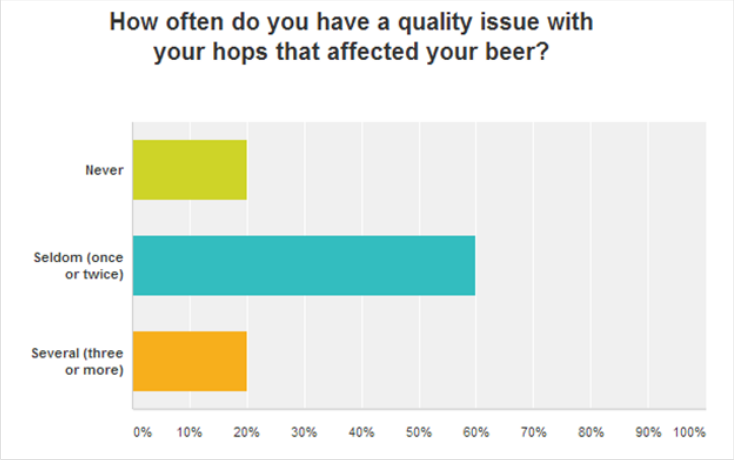


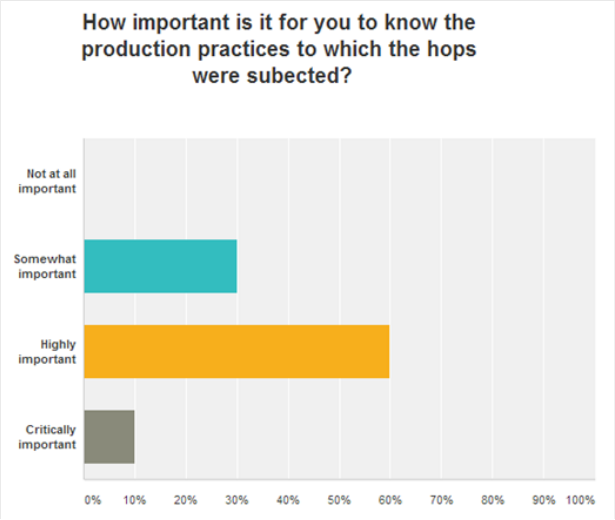
Addendum C

Brewer Survey Results

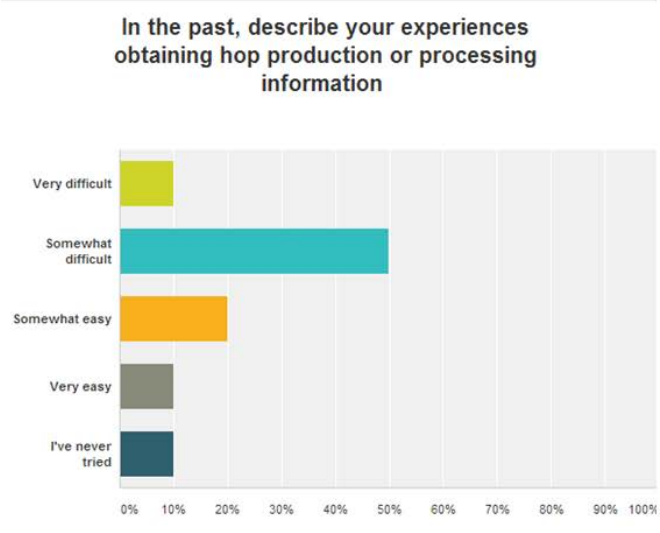


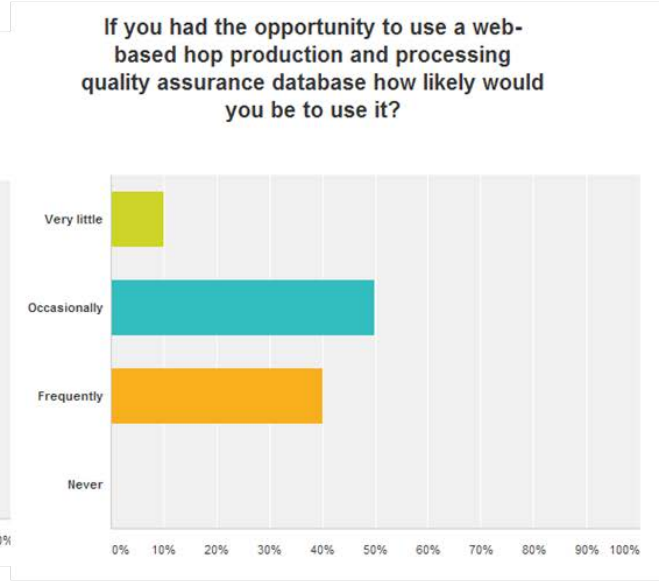


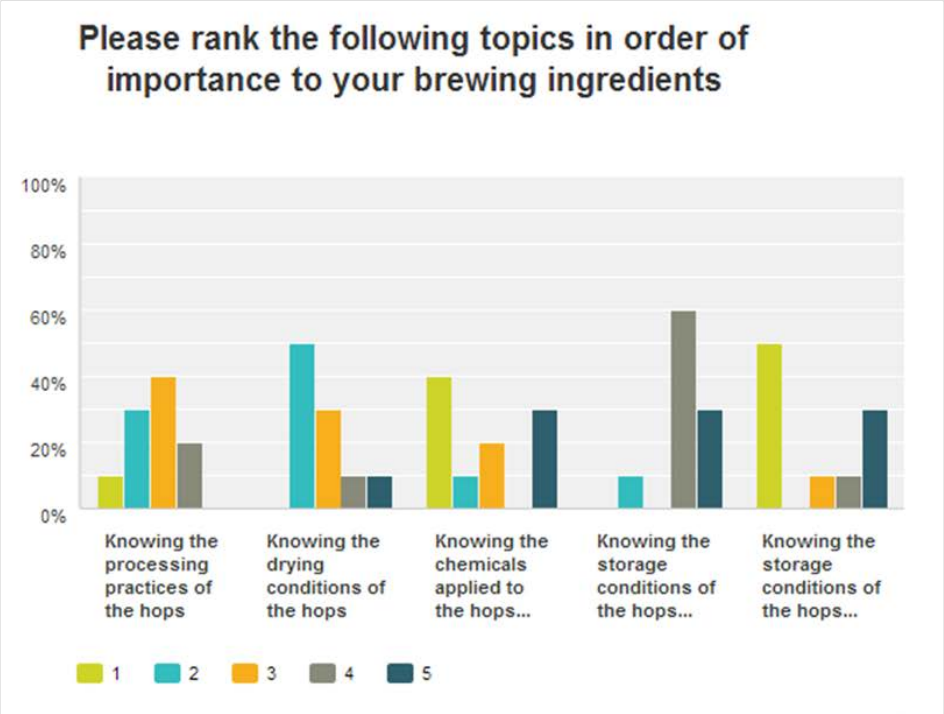




Brewer Survey Results







26) Cranberry trade mission with China (FY11-026)

Report Date: November 17, 2014

I. Project Summary

The specific purpose was to conduct promotional activities to educate Chinese food buyers on the quality, versatility and health benefits of adding cranberry products to the Chinese diet and thus increasing exports of cranberries to China.

Cranberries are Wisconsin's largest fruit crop and are an important part of Wisconsin's economy. Producing 60% of the nation's cranberries, Wisconsin harvested almost 5 million barrels of cranberries in 2013. Cranberry production in Wisconsin is a $300 million industry and contributes approximately 3,500 jobs to Wisconsin's labor force. Cranberry production in Wisconsin has been steadily increasing due to improved growing techniques and expanded acreage. However, market demand has not kept up with the supply and cost of production is exceeding prices at market. Because national consumption is relatively stable, it is time for Wisconsin cranberry producers to focus on emerging international markets such as China where potential for sales expansion, once in the market place, is enormous.

This project was and is timely because China is one of the fastest growing economies with a rapidly increasing middle class with purchasing power. Dried fruits are a very popular food in China currently and cranberries have the potential to fit into the Chinese diet in snack foods, baked goods, juice drinks and many other products. Because of several years of surplus harvest, cranberry companies are looking at developing international markets to increase demand and consumption to help increase prices. However, many of these companies have little to no experience in exporting their products and need the help of Wisconsin Department of Agriculture, Trade and Consumer Protection International Marketing staff to make successful connections into international markets.

The specific activities included: identifying cranberry buyers in China, coordinating travel to Wisconsin where buyers met with Wisconsin growers, processors and representatives of the Wisconsin State Cranberry Growers Association, participating in educational activities covering cultivation, harvest, processing of cranberries, food/value-added product/menu applications and one-on-one meetings with Wisconsin cranberry companies.

B. The project did not build on any previous grant funding.

II. Project Approach

Staff contracted with a Chinese contractor with experience in the food industry to identify 5 buyers in China and coordinate travel logistics for each of the buyers to Wisconsin and accompany the group. The DATCP staff in collaboration with the Executive Director of the Wisconsin State Cranberry Growers Association created an itinerary for the buyers, arranging

meeting with growers, processors and representatives of the Wisconsin State Cranberry Growers Association. The buyers represented different aspects of the retail sector and included a journalist who writes for lifestyle magazine focusing on featuring western food.

Mission participants came from different cities and regions in China, representing different aspects of the retail market:

Beijing Hechuanyi Food Co., Ltd, Mr. Aning Zhao: Beijing Hechuanyi Food Co., Ltd, founded in 2000, mainly distributes snack foods to different shopping centers in Bejing. In 2004, the company developed their own brand "Shangzhen", and in 2008, another brand "Bonds" was also created. Then, in 2012, the company founded another producing sub-company, named Beijing Shangzhen Food Co., Ltd and was authorized the production certificate. Various types of products are carried by Beijing Hechuanyi Food Co., Ltd, including nuts and dried fruits. With a complete system of marketing and logistics, the company's products have entered most of the retail systems in northern China and their sales network is gradually extended to the second and third tier regions.

Hebe Cambridge International Co., Ltd, Mr. Kevin Deng: Established in Hong Kong and now headquartered in Shenzhen, Hebe Cambridge is an integrated company of importing, developing, producing and selling natural food, functional food and cosmetics. Their target focuses on the beauty and healthcare market in China. The company has managed to use hi-technology from Japan and the U.S. to develop a series of anti-aging functional products using natural fruits and fruit juices. Their products now are available in most southern retail systems and franchises like Watson.

Nanpu Food (Group) Co., Ltd, Mr. Zhenyu Tao: Nanpu Food (Group) Co., Ltd has mainly engaged in fast moving consumer foods for 23 years, and in 2013 its annual sales revenue has increased by 30%. In addition, the company distributes several famous brands such as 'Nestle', 'Martell'. Meanwhile, the company has their own dried fruits and nuts brand 'Tenwow', whose annual revenue is over USD 166 million. The company knows about the Chinese market well and has built a solid position in the market, beating other competitors. It mainly focuses on importing international brands foods into China and distributes into Chinese market via effective distribution system and chain management system.

Shanghai Qian Sheng Hong Trading Co., Ltd, Mr. Dafeng Chen: Established in 2004, Shanghai Qian Sheng Hong Trading Co., Ltd is a professional trading company focusing on importing, distributing high-quality food stuffs from all over the world. It now has a wide range of sales channels throughout China including e-commerce such as T-mall, Yihaodian, etc. and supermarkets like Ole', RT-Mart, etc. Varied types of products are carried by Shanghai Qian Sheng Hong Co., Ltd, including snack foods, biscuits, oatmeal, coffee and other foods.

Ringier China, Mr. Yunqi Li: Established in 2002, Ringier China is a professional magazine and forefront of the main media in culinary industry. The magazine combines glorious foods to the concept of leisure and healthy life, helping to promote the life quality. Ringier China has its offices for distribution in major cities, including Beijing, Guangzhou and Shanghai. It has formed integration on delicious foods and healthy life for readers. Different kinds of recipes

from different countries are described in Ringier, introducing various food cultures. The main goal of the magazine is to spread regional cultures and bring a colorful life to readers.

Education:
Cranberries are not well known in China, so part of the project included educational opportunities directed at the buyers. Dr. Sherry Tanumihardjo, Professor of Nutritional Sciences, University of Wisconsin Madison gave a presentation on the health benefits of cranberries, which set the stage for the rest of the week's program. Of particular interest to Mr. Deng, was the link between cranberry juice consumption and urinary tract infection (UTI).

We took the buyers to the heart of cranberry country in Wisconsin, Wisconsin Rapids. Here, the tours and company meetings took place. We toured the Cranberry Discovery Center (http://www.discovercranberries.com/) which has displays featuring how the cranberry plants grow and harvesting equipment. The gift shop featured many cranberry products to show to the buyers the various applications for cranberries, from wine, salsa, cranberry flavored coffee and tea, chocolate covered cranberries, etc. Tom Lochner, Executive Director, Wisconsin State Cranberry Growers Association gave a presentation to the buyers about how the cranberry is grown, harvested and processed. At this same meeting, our contractor, SMH Shanghai, Roger Zhang, gave a presentation to the Wisconsin cranberry producers about the opportunities for cranberries in China. Each buyer talked about his company. After these presentations, one-on-one meetings between the buyers and Wisconsin companies were held. The buyers met with these companies: The Cranberry Network; Oceanspray; Oskri, Inc.; and Wisconsin's Best Cranberries.

The buyers toured two cranberry marshes. Elm Lake Cranberry Marsh is a grower for Oceanspray. It is a multi-generational operation. The family also has test plots of cranberries for Rutgers University. Habelman Brothers Company, a fresh fruit packer, sells fresh cranberries (in grocery stores) as well as sells into the processing stream. This is a family run operation and multi-generational. These two tours of marshes, prior to harvesting season, allowed the buyers to see the fruit growing. At Habelman's, we were shown the sorting equipment and packaging lines.

III. Goals and Outcomes Achieved

A. The overall objective of this project is to increase sales of fresh, frozen, or dried cranberries and concentrate to China. However, because this project will be implemented on an abbreviated timeline, and an increase of sales cannot be measurable within the grant time line. We measured an increase in Chinese buyer interest among Wisconsin cranberry companies.
Benchmark: No Wisconsin cranberry companies have currently established relationships with any Chinese buyers.

We did learn that one cranberry product company had exported sweetened dried cranberries to China, but not consistent or ongoing shipments and another cranberry company has an exclusive agent in Beijing.

Target: 10 Cranberry companies will participate in a reverse buyer's mission with 5 Chinese companies. 65% will report establishing a business relationship with at least one Chinese buyer.

Invitations to meet the Chinese buyers were sent by DATCP and the Wisconsin State Cranberry Growers Association to the entire cranberry industry. Tours and meetings were scheduled with 9 companies that expressed interest in meeting with the Chinese buyers, but one company had to cancel their meeting due to a family emergency.

Tours: Gardner State Cranberry, Oceanspray, Mariani, Habelman Brothers, Elm Lake Cranberry Marsh, Meetings: Gardner State Cranberry,Wisconsin's Best Cranberries, Mariani, Oceanspray, The Cranberry Network, and Oskri, Inc.

Outcome Measure: Participants in the reverse buyer's mission will be surveyed about their experience participating in the events.
Here are the inital feedback after the event:

1. Mr. Hendry Chen from Shanghai Qianshenghong
He has been in contact with all the U.S. companies after back from the mission except for Mariani as the brand already has an exclusive agent in Beijing. Since his company does the E-commerce channel, he is very interested in launching the Oceanspray cranberry products via their Tmall stores. But he has not heard back from Oceanspray yet,

2. Mr. Kevin Deng from Shenzhen Cambridge
He is quite busy with their healthcare show in September. He indicated that he has worked out a plan with their management to launch a cranberry project later this year. He will start the formal communication with the U.S. suppliers from the end of this month.

3. Mr. Aning Zhao from Beijng Hechuanyi
Mr. Zhao now still sources from local importers of the U.S. dried cranberry products as part of their product line as the volume has not reached direct sourcing. But Mr. Zhao is very interested in the dried cranberry slice from one company and will contact to see if there is potential in cooperation.

4. Mac from Nanpu
Nanpu also now sources from local importers. They will consider direct sourcing if the volume sees obvious growth this year.

5. Betty's Kitchen (Mr. Li)
We have confirmed the future article on the December edition of the magazine as they usually require the article 2 months before the publishing. The article will be translated and send to you for file.

B. We came close to our goal of finding 10 interested cranberry companies to meet with the Chinese buyers. Nine companies had originally committed to meeting with the buyers, but one had to back out due to family emergency.

IV. Beneficiaries

We believe this project has opened the door to greater direct sales of Wisconsin grown cranberries to Chinese importers and will help to build the cranberry market in China, increasing future sales and helping make cranberry growing more profitable in our state. Direct immediate beneficiaries include:

Wisconsin State Cranberry Growers Association (representing over 200 Wisconsin growers) – the Executive Director helped coordinate the itinerary and presented to the buyers. Now this organization is known to the Chinese buyers, which includes a writer for a food publication in China. This will have direct benefit in the future as China's market for cranberry products grows, putting Wisconsin in the forefront for cranberry exports.

DATCP – benefited by coordinating the itinerary and also attending all of the meetings and tours with the buyers and cranberry companies. Staff was educated on the production of cranberries, processing of cranberries and the variety of products that can be produced. This will help as we move forward promoting cranberries to China as well as other countries in the future.

The companies that met with the Chinese buyers benefited by learning about the opportunities to sales of cranberry products in China.

The buyers benefited by the project which could lead to sales of cranberry products in China and increasing any existing sales in China.

V. Lessons Learned

While we feel this project was extremely successful, it only included educating the buyers who came to the US to meet with growers. To significantly increase exports of cranberries to China quickly, the Chinese public must be educated on cranberry products and their health benefits. It will be helpful if future similar projects can include components involving work in the importing countries to introduce the products and educate the public about them. Extra education for the buyers about how cranberries can be eaten, and used in products, ie bakery and snacks would also expedite the market increases. Information on health benefits should be translated into Mandarin so that the Chinese public can have access to the information.

The DATCP staff became more knowledgeable about the production and processing of cranberries. The meetings and tours were very valuable and increased our knowledge of the capabilities of the companies for exports. This knowledge is very useful in conducting these types of projects.

VI. Additional Information

Because developing sales and business relationships takes time, future evaluations will be conducted with the buyers, so more detail on mission successes will be gathered in 6 months to a year.

VII. Contact Info

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