

I. PERSONAL INFORMATION

Name: Carl A. Duley
 Formal Education: M.A.T. – UW-River Falls, Agriculture Education, 1985
 B.S. – UW-River Falls, Farm Management, 1983
 Extension Employment: Agriculture Agent, University of Wisconsin Extension
 Buffalo County, July 1985 – present
 Extension Rank: Associate Professor: July 1990
 Assistant Professor: July 1986 – June 1990
 Instructor: July 1985 – June 1986
 Current Position Description **(Exhibit 1)**

II. PROFESSIONAL CONTRIBUTIONS:

The University

| <u>University Service:</u> | <u>Activity</u> | <u>Year(s)</u> |
|--|-----------------|----------------|
| UW-Extension (UWEX) | | |
| Faculty Tenure Advisory Committee (FTAC) | Member | 2017 – present |
| Dean’s Council for Strategic Change | Member | 2012 – 2016 |
| UWEX Strategic Planning Steering Committee | Member | 2011 – 2015 |
| UWEX Strategic Planning Team | Member | 1995 - 2016 |
| UWEX Department of Agriculture and Life Science (DALs) | | |
| Standard Rank and Promotion Committee | Member | 2013 – 2016 |
| Standard Rank and Promotion Committee | Member | 1992 – 1998 |
| UWEX Agriculture and Natural Resources Education | | |
| Dairy Team | Member | 2004 - present |
| Nutrient Management Team | Member | 2010 - present |
| FARM Team | Member | 2002 - present |
| Management Assessment Center | Chair | 2002 - present |

The Profession

| <u>Organizations:</u> | | |
|---|--------|----------------|
| Great Lakes Hops Working Group | Member | 2014 - present |
| American Malting Barley Association | Member | 2013 – present |
| National Association of County Agricultural Agents | Member | 1985 – present |
| Wisconsin Association of County Agricultural Agents | Member | 1985 – present |
| Association of Psychological Type | Member | 1997 – 2015 |

The Community

| <u>Organizations:</u> | | |
|---|-----------------|----------------|
| Buffalo County Broadband Access Committee | Advisory | 2015 - present |
| Buffalo County Economic Development Committee | Advisory | 2014 – present |
| Buffalo County Barley Society | Advisory | 2014 – present |
| Western Buffalo County Ambulance Service | Member | 2010 - present |
| Buffalo County Farm Bureau | Member/Advisory | 1990 – present |
| Buffalo County Fair Association | Advisory | 1985 – present |

III. MAJOR PROGRAM – High Quality Brewing Raw Ingredients

SITUATION:

Wisconsin has a long history in the brewing industry and grew a majority of all raw ingredients in the late nineteenth and early twentieth century. Both hop and malting barley production disappeared as plant disease issues increased and new agricultural enterprises such as corn and dairy came into production. Individual Wisconsin craft brewers and the executive director of the newly formed Midwest Hop and Barley Cooperative approached Tim Rehbein, retired Agriculture Agent and me in 2009 about offering education and research on hop and malting barley production in Wisconsin. The craft brewing

MAJOR PROGRAM – High Quality Brewing Raw Ingredients (continued)

industry was on the rise, and there was only one commercial hop producer, with about four acres of hops. Very little or no unbiased educational resources existed for hop or malting barley production in Wisconsin.

In 2013, after gathering general information on hop and malting barley production in the United States, Germany, and Denmark and following three years of annual hop seminars, I conducted a comprehensive survey of hop producers and potential hop producers to guide our education and research program (**Exhibit 2**). A Qualtrics survey was sent to 248 hop growers or potential growers gathered from participants at annual hop seminars and emails of people expressing interest. Ninety-eight surveys were returned.

Interest in local hops grew because of a hop warehouse fire in 2006. A hop warehouse in Yakima, WA containing four percent of the nation's hops burned and prices rose overnight from \$6 per pound to \$28 per pound. This occurred at the same time the craft brewing industry was rapidly expanding and some craft brewers were not able to secure hops. The industry wanted to see hop production spread out throughout the country, to reduce the risk of shortages and of one company having such a large effect on the industry. To bring into perspective, a brewery the size of New Glarus Brewing would need about 125 – 150 acres of hops at an average yield to meet their annual needs.

Farmers in Western Wisconsin were exploring alternative crops that were less erosive and had potential local markets. A local malting barley company in Minnesota expressed interest in increased local barley to meet 10-20% of their needs (Rahr Malting, Inc.). Their interest resulted from two factors. First, corn acres were replacing thousands of acres of barley in North Dakota, because of high corn commodity prices. Second, rail was not available from North Dakota due to the volume of crude oil transported by rail from the Bakken oil fields.

Four primary purposes for the High Quality Brewing Raw Ingredients Program were:

- Can we produce quality hops in Wisconsin?
- Can we consistently produce quality malting barley in Wisconsin?
- Can we economically compete with other regions in the United States and the world in hop production?
- Can we economically compete with other regions in the United States in malting barley production?

RESPONSE:

Early in this educational program, I relied heavily on resources brought into Wisconsin from other states for educational programs. Educational expertise was developed within Wisconsin including a Team of UW-Extension Specialists, Dr. Amanda Gevens, Dr. Jed Colquhoun, Bryan Smith, and Dr. Chris Baxter along with Dr. Michelle Marks, UW-Madison. We now have a great Wisconsin team of specialists to respond to questions and needs within the hop industry. I rely on Dr. Damon Smith, University of Minnesota researchers, and local research trials for information on malting barley.

I spent 2009 and 2010 researching the hop and malting barley industries and then organized our first statewide Hop and Malting Barley Conference in 2010, funded with a SARE Mini-grant. The first step was to educate myself on both hop and malting barley production practices, handling, and markets. Most information was gathered through self-arranged professional development in Germany, Denmark, the Pacific Northwest, Oregon, and Vermont/Massachusetts. Professional contacts were established with hop and malting barley researchers from Vermont (Dr. Heather Darby), Minnesota (Dr. Kevin Smith), Oregon (Dr. David Gent), Germany LFL Research Station (Dr. Florian Weihrauch), and other University personnel (Great Lakes Hop Working Group). I also developed relationships with end users (brewers and maltsters) in Wisconsin and Minnesota.

I developed an applied research program in partnership with other Extension colleagues based on grower needs. The needs for local research were great due to virtually no current research data for Wisconsin or for the Midwest. Research projects focused on the four primary purposes for the High Quality Brewing Raw Ingredient program.

Wisconsin Hop Research:

- Disease impacts and prevention on hops – Led by Dr. Amanda Gevens and Michelle Marks
- Clean hop program – Led by Dr. Ruth Genger
- Nitrogen applications to hop – Led by Extension Hop Team, Duley/Baxter/Clark/Halfman/Schroeder/Koepp (**Exhibit 3**)

MAJOR PROGRAM – High Quality Brewing Raw Ingredients (continued)

Wisconsin Malting Barley Research:

- Purchase plot equipment (four foot plot drill, six foot no-till drill, four foot plot combine, plot sprayer) owned by Buffalo County Barley Society
- Variety Trials – Led by Duley in cooperation with Jerry Clark.
 - Spring trials of two and six row varieties, evaluated for yield, protein, and malt quality (**Exhibit 4**)
 - Winter trials of two and six row varieties, evaluated for winter hardiness, yield, protein, disease, and limited malt quality standards (**Exhibit 5**)
 - Vavilnov winter barley trials. Started with evaluating 380 varieties, reduced to 78 of the most winter hardy varieties evaluated for winter hardiness and lodging (**Exhibit 6**)
- Nitrogen Trials – Led by Duley in cooperation with Jerry Clark. Trials tested specific varieties with nitrogen rates from 0 pounds to 90 pounds and evaluated for yield and protein levels.
- Fungicide Trials – Led by Duley, in cooperation with Dr. Damon Smith and Jerry Clark. Trials looked at both timing and effectiveness of fungicide applications to malting barley for control of Fusarium Head Scab. Plots evaluated for yield and Deoxynivalenol (DON) levels. (**Exhibit 7**)

Hop and Barley Grants:

- SARE Research and education Grant, High Quality Beverage Raw Materials for the Craft Brewing Industry, \$196,953. Co-author and Principal Investigator (PI) (**Exhibit 8**)
 - Wisconsin DATCP FY18 Specialty Block Grant, Sustainable Soil Nitrogen Management for Hops in the Midwest, 2019 – 2021, \$60,630. Lead Author and PI (**Exhibit 9**)
 - SARE Mini-Grant 2018, Sustainable Nitrogen Soil Fertility for Hops, \$3,000. Lead Author and PI
 - Compeer Feasibility Grant, 2018, Small Malting Facility Feasibility, \$4,100. Lead Author and PI
 - SARE Mini-grant, 2016, Wisconsin Hop Fertility Trial – Soil and Petiole Testing, \$2,400. Lead Author and PI
 - SARE Mini-Grant 2010, Hop Conference, \$3,000.
 - SARE Farm Partnership Grant, \$21,996. Lead Author and PI
 - SARE Mini-grant, Travel to Vermont, \$3,000. Lead Author and PI
 - American Malting Barley Association (AMBA) grants, 2016, 2017, 2018, \$3,070 per year. Lead Author and PI
 - UMN, Vavilov Barley Study, \$3,000
- Total \$307,289

Teaching Methods Used:

Workshops, Seminars, Field Days:

| <u>Event</u> | <u>Subject Matter Taught</u> | <u>Date</u> |
|--|---|----------------------|
| 1. American Malting Barley Association Barley Improvement Conference | Bringing Malting Barley Back to Western Wisconsin (Exhibit 10) | January 10, 2019 |
| 2. Malting Barley Brewer Discussion | Buffalo County Malting Barley Research | July 19, 2018 |
| 3. Malting Barley Twilight Meeting | Buffalo/Chippewa County Malting Barley Research plots | July 19, 2018 |
| 4. 2018 Hop Summer Field Day | Facilitated Discussion on Hop Production | June 8, 2018 |
| 5. 2018 9 th Annual Hop Seminar | Facilitated Discussion on Post Harvest Hop Quality | February 24, 2018 |
| 6. Malting Barley Field Day | Buffalo County Winter Barley Trials | June 19, 2017 |
| 7. Chippewa County Malting Barley Field Day | Malting Barley Research Trials | August 1, 2017 |
| 8. 2017 Hop Summer Field Day | Hop Grant Programs | August 10, 2017 |
| 9. Western Ag Agent Field Day | Malting Barley Research Plot Discussion | May 16, 2017 |
| 10. 2017 8 th Annual Hop Seminar | MN Hop Breeding Programs | February 25, 2017 |
| 11. 2016 Summer Hop Field day | Facilitated Hop Research Project Report | July 8, 2016 |
| 12. ANRE Conference | Wisconsin Hop and Barley Program | May, 2016 |
| 13. 2016 7 th Annual Hop Seminar | Facilitated Hop Association Discussion | March 12, 2016 |
| 14. UW-Stout, Midwest Brewers Conference | Hop and Barley Production for WI Craft Brewing Industry | October, 2015 |
| 15. 2015 Hop Summer Field Day(s) | Organizer | August 14 & 15, 2015 |

MAJOR PROGRAM – High Quality Brewing Raw Ingredients (continued)

| <u>Event</u> | <u>Subject Matter Taught</u> | <u>Date</u> |
|--|---|--------------------|
| 16. 2015 Malting Barley Twilight Meeting | Spring Fungicide Trial | July 16, 2015 |
| 17. Statewide Malting Barley Webinar | Western Wisconsin Research Experience | March 10, 2015 |
| 18. 2015 6 th Annual Hop Seminar | Economics of Hop Production (Exhibit 11) | March 7, 2015 |
| 19. 2014 Farm Technology Days | Hop and Barley Educational | August 12-14, 2014 |
| 20. 2014 Malting Barley Twilight Meeting | Spring Malting Barley Variety Trials | July 17, 2014 |
| 21. 2014 5 th Annual Hop Seminar | Hop Harvesting Options | March 1, 2014 |
| 22. 2013 Malting Barley Twilight Meeting | Buffalo County Malting Barley Project | August 5, 2013 |
| 23. Barley Quality and Analysis Tour | USDA Cereal Grains Lab – Madison | July 19, 2013 |
| 24. 2013 Hop Summer Field Day | Organizer | July 15 & 16, 2013 |
| 25. 2013 Farm Technology Days | Hop and Barley Educational | July 11-13, 2013 |
| 26. 2013 4 th Annual Hop Seminar | Wisconsin Hop Association Discussion | March 2, 2013 |
| 27. 2012 3 rd Annual Hop & Barley Seminar | Wisconsin Malting Barley Update | August 18, 2012 |
| 28. 2012 Farm Technology Days | Hop and Barley Educational | July 17-19, 2012 |
| 29. 2011 Farm Technology Days | Hop and Barley Educational | July 12-14, 2011 |
| 30. 2011 2 nd Annual Hop & Barley Seminar | Barley Production and Malting Options Hop Harvesting Options | April 9, 2011 |
| 31. 2010 Farm Technology Days | Hop and Barley Educational | July 20-23, 2010 |
| 32. 2010 1 st Annual Hop & Barley Seminar | Why Consider Hops and Malting Barley? | February, 2010 |

Individual Consultations:

- Received numerous referrals from county staff, brewers, hop producers, and UW-Extension Specialists on hop and malting barley production and marketing potential.

Other Media:

- County webpage serves as a statewide source for hop and malting barley information.
- Occasional TV and radio appearances on hop and malting barley production

Educational Articles, Papers, PowerPoints, and Published Stories:

- “Bringing Barley Back to Western Wisconsin” – Duley, PowerPoint, 2019
- “Western Wisconsin Malting Barley Fungicide Trials” – Duley/Smith/Clark, Fact Sheet, 2018
- “Western Wisconsin Malting Barley Variety Trials” – Duley/Clark, Fact Sheet, 2018
- “Malting Barley Field Day Diagram” – Duley, Educational Aid, 2014, 2015, 2016, 2017, 2018
- “Wisconsin Hop Production & Downy Mildew Research: A 2014 Update – Marks/Gevens/Genger/Duley, 2014
- “Balancing Risks for Growers Exploring New/Old Crops: The Beverage Raw Material Production Educational Experience in Wisconsin (Hops and Malting Barley)” – Duley, Presentation, Risk Management Education Conference in Denver, CO, March 27, 2013.

Research and Demonstration:

- Winter Malting Barley Trial – SECOBRA Barley Breeders, Spain/Canada/Uruguay, Duley, 2017-18
- Nitrogen Utilization in Hops Research Trial, Duley/Baxter/Clark/Halfman/Schroeder/Koepf, in Partnership with Fine Bine Farms, Bohica Hops, Davali Ridge Farm, 2017 and 2018
- Fungicide Use to Reduce Fusarium Head Scab in Malting Barley, Duley/Smith/Clark, 2015, 2016, 2017, 2018
- Malting Barley Response to Nitrogen Fertilizer: Yield and Protein Levels, Duley/Clark, 2015, 2016, 2017, 2018
- Spring Malting Barley Varieties for Western Wisconsin, Duley/Clark, 2013, 2014, 2015, 2016, 2017, 2018
- Winter Malting Barley Trials, Part of 14 State Trial Run by Kevin Smith University of Minnesota, Duley, 2014, 2015, 2016, 2017, 2018, 2019
- Vavilov Winter Barley Trial, One of 4 Sites Nationwide Vavilov Varieties Were Evaluated, Duley, 2016, 2017, 2018, 2019

Multiplier Contacts:

- Extension Ag Agents, Midwest Hop and Barley Cooperative, Wisconsin Hop Exchange Cooperative, American Malting Barley Association, Rahr Malting, Inc., Buffalo County Barley Society

MAJOR PROGRAM – High Quality Brewing Raw Ingredients (continued)**IMPACT:**

Hop programming has reached 1080 producers and potential producers (registered participants in hop seminars and field days) since 2010. Of these participants, 368 reported they had never attended an UW-Extension educational program and 45% of participants continue to be new to extension hop education programs.

In 2009, there was one commercial hop producer in Wisconsin, growing hops on less than 10 acres. USA Hops reported 297 acres of hops grown in Wisconsin in 2017 (last data available) for sales of about \$2.7 million dollars. The Pacific Northwest (PNW) still produces 97% of the hops grown in the United States and Canada. About 10 million pounds are currently imported into the United States giving plenty of growth potential for Wisconsin hops.

Quality and price continue to be factors even with the growth of the industry. Research in Wisconsin on Downy Mildew and Powdery Mildew and treatment protocols developed by UW-Extension have greatly improved hop cone quality. In 2013, 93% of growers could not identify the disease issues in their hop yards (**Exhibit 2 p. 31**). In 2016, disease control was still a major issue, but 74% felt confident in identifying the major disease problems in their hop yards (**Exhibit 12 p. 25**). Growers also changed trellis construction to improve both hop yield and quality. In 2013, 46% of Wisconsin hop growers indicated their trellis height was less than 17 feet and plants established in a straight line on the trellis (**Exhibit 2 p. 8**). This practice would reduce yield potential by about 25% and increase hop disease issues. In 2016, 76% of hop growers reported trellis height over 17 feet and all commercial growers reported trellis strings in a “V” arrangement (**Exhibit 12 p. 25**).

An informal survey, I conducted of ten Wisconsin Craft Brewers indicated that hop quality they receive from Wisconsin hop producers has improved with fewer diseased cones. Improvement in post-harvest handling, quality consistency, and price continue to be a challenge. Brewers are willing to partner with hop growers to develop unique Wisconsin varieties and better meet Wisconsin craft brewing needs.

Profitability continues to be an issue as there is currently an oversupply of hops in the United States. Many Wisconsin craft brewers were not in business in 2006-08 when hop prices were extremely high and don't understand the risk of relying solely on PNW hops. The Wisconsin hop industry has not been effective in creating relationships with craft brewers, necessary for marketing. Wisconsin hops cannot compete with the prices from the PNW and must compete on quality, unique varieties, and local relationships. Marketing will be the primary focus of the 2019 hop seminar.

Malting barley research plots were established to gather needed data on yield and quality. Studies have looked to identify the “right” variety, which provides the quality needed for the malting industry and yield needed to provide enough income to compete with other commodity crops. A majority of growers in Wisconsin and Minnesota have grown Pinnacle barley (NDSU) as low protein levels are easy to maintain. Unfortunately, commercial yields have not been able to duplicate plot yields, it has increasing dormancy issues (doesn't sprout until held for 8-9 months), and it has a stay green gene that causes uneven maturity. Growers are looking for a different variety for commercial production and may switch to Odyssey (Lima Grains) or Full Pint (Oregon State University) (**Exhibit 4**). Relationships were established with European breeders for possible varieties that would perform better in Wisconsin. At this time, Odyssey and Full Pint show promise especially with distilleries in that it does not produce glycosidic nitrile, a costly by-product in the distillery industry.

Winter barley fits better in Western Wisconsin rotations and generally has less weed and disease issues. Unfortunately, winter trials have not shown consistent winter survival. Breeding programs throughout the US are trying to increase winter survival. Results in Buffalo County have been inconsistent in these trials. An additional winter barley study was planted in Buffalo County for three years. The Vavilov Barley Study, is led by Dr. Brian Steffenson evaluating old winter barley varieties the N.I.Vavilov Research Institute of Plant Industry located in Saint Petersburg, Russia. Initial crosses were made in 2018 with the most winter hardy lines identified to strengthen the winter hardiness of malting barley breeds in the US (**Exhibit 5**).

The Buffalo County Barley Society was established and commercially produced malting barley for Rahr Malting, Inc. in 2014, 2015, 2016, and 2017. Barley produced in those years met Rahr/New Glarus Brewing quality requirements. Excess rain and unfavorable weather conditions during anthesis led to high DON levels in 2018. The 2018 crop has been purchased by a local grain miller that is using the barley as pearled barley at only a slight price reduction from malting price.

MAJOR PROGRAM – High Quality Brewing Raw Ingredients (continued)

A small-scale malting plant feasibility study, funded by Compeer, to be completed in 2019, will determine if a farmer small-scale plant can be profitable. The results of this study could bring more interest to malting barley production. An increase in malting prices would also bring interest back from growers.

I was asked to present at the 2019 AMBA Barley Improvement Conference on January 10, 2019. Participants were polled during my presentation on continuing this program. Some of the best barley researchers in the United States participated in this session. The results were Canadian Barley Breeder, Dr. Ana Badea and Lima Grains Breeder, Dr. Zack Gaines, are sending their newest varieties exhibiting Fusarium resistance to be included in the 2019 variety plots. Second, barley breeders throughout North America are using results from winter barley trials in Buffalo County in their breeding programs.

IV. MAJOR TEACHING EVENT: 2018 Summer Malting Barley Field Day

Situation:

Malting barley field days or twilight meetings were held each year since 2013 with attendance ranging from 12 to 55 participants per event. All spring barley plots were in one location in 2018 and I had at least two years of data on all research conducted. I was receiving more calls from throughout Wisconsin, Southeast Minnesota, and Northeast Iowa about my work. Statewide news releases were sent and individual email invitations were sent to individual farmers and breweries that had contacted me about malting barley. Many of the inquiries had little knowledge of malting barley and quality parameters required by the industry.

The main purpose of the teaching event was:

- To understand quality and research needs for malting barley in Western Wisconsin.

Materials and Methods Used:

The field day was designed in two parts. First, participants met in the plots and walked as a group to look at plots including variety, fungicide, nitrogen rate, and relay planting (barley and soybeans grown together in strips at the same time). Basic plot maps were provided for participants (**Exhibit 13**). It was an informal session and questions ranged from the difference between two row and six row barley, to identification of Fusarium Head Scab in the field. Thirty-two participants came to this portion of the field day. Dr. Lucia Gutierrez, UW-Madison Small Grain Breeder, explained her oat breeding program, which a trial was at the same location. The second part of the field day was more traditional presentation formats.

Plot signs were maintained in the field until harvest about three weeks later. A number of the local meeting participants reported they stopped by the plots to visualize differences in variety maturity, disease severity, and growth.

Participants:

The primary audience for the field day was farmers currently or considering growing malting barley. Participants for the meeting were from Wisconsin, Minnesota, and Iowa. Secondary audiences included county land conservation employees, crop supply businesses, National Resource Conservation Service staff, and brewery owners.

- 32 participants attended field educational portion
- 38 participants attended the formal presentation portion

Evaluation:

Evaluation was for one event with 18 of the 38 participants completing the evaluation (**Exhibit 14**). All topics taught by me showed a positive improvement of 1.2 or greater using a four point sliding Likert Scale (1 = very little understanding and 4 = a lot of understanding). I also team taught the section on Winter Barley and Double Crop Research with Beck Zhong, PhD candidate in the barley breeding program at the University of Minnesota, which participants indicated an increase in knowledge of 1.33 on the same Likert Scale.

MAJOR TEACHING EVENT: 2018 Summer Malting Barley Field Day (continued)

A secondary result of this field day was an afternoon visit to the plots by a prominent brewer in Wisconsin serving on the board of directors for AMBA. He recommended that I present at the biannual AMBA conference in Albuquerque, NM in January, 2019, and as a result I was invited to present on the research gathered in Western Wisconsin.

V. MAJOR RESEARCH PROJECT: Malting Barley Fungicide Trials

Situation:

One key question for Wisconsin malting barley production is, can we produce malting barley that meets the high standards and consistency required by craft brewers? Malting barley is more like growing fresh vegetables than growing other agricultural commodities such as corn or soybeans. Malting industry standards are very strict and barley not meeting standards, cannot be sold as malting quality. The difference for malting quality and feed grade barley in 2018 is \$5.90 per bushel for malting quality barley versus \$1.98 per bushel for feed grade. Fusarium Head Scab resistant varieties are in almost all barley breeding programs across the world, but very little progress has been made in selecting for the trait. The barley industry, worldwide will not accept transgenic genes therefore; progress is slower than in many other crops. Deoxynivalenol (DON) level is used as a marker or predictor for the presence of Fusarium graminearum and other potential fungus organisms.

Fungicides are available for treating barley for Fusarium Head Scab and potentially will reduce infection by about 50% from untreated barley. The malting industry standard for DON is <1 ppm for large scale brewers and <.5 ppm for craft brewers.

The purpose of these research trials was:

- To measure the effectiveness of fungicide treatments on malting barley for Fusarium Head Scab control.

Methods and Materials:

Dr. Damon Smith assisted with the protocol and research layout of the trial (**Exhibit 7**). The trial was conducted in Buffalo County and Chippewa County for four years beginning with crop season 2015. The trial was changed slightly each year as information became available from other states and results was focused on 2018 data. All treatments were replicated four times using standard randomized block layout design. All plots were four feet by 10 feet and the previous crop was soybeans. The Buffalo Plot was established using no-till and the Chippewa Plot was established using conventional tillage methods. Buffalo County plots were on silt loam soils located on land owned by members of the Buffalo County Barley Society. Chippewa Plots were on sandy soils on land own by Chippewa County.

Three varieties were included; Robust – UMN variety released in 1983, Pinnacle – NDSU variety released in 1999, and Odyssey – Lima Grain, released in 2013. Tilt was used to protect against leaf diseases. Prosaro was applied at anthesis (flowering). Miravis has some systemic activity with the goal of extending the days in which fungicide protection can be applied. Plots were evaluated for visual head scab, yield and DON. DON tests were conducted by the University of MN Barley Lab through a USDA ARS grant. All other costs were covered by an AMBA grant, Rahr, or by Buffalo County.

Results:

Fusarium Head Scab infections in 2015, 2016, and 2017 were very low and little difference was seen in the plots. Infection was significant (above 1 ppm for industry, 0.5 ppm for most craft brewers) in 2018.

| Treatment | Buffalo County | | Chippewa County | |
|---|----------------|-----------|-----------------|-----------|
| | Yield (Bu) | DON (ppm) | Yield (bu) | DON (ppm) |
| 1 Robust; Non-treated Check | 49.280 | 4.533 | 40.503 | 0.613 |
| 2 Robust; Tilt Foliar App | 57.700 | 3.450 | 48.477 | 0.578 |
| 3 Robust; Tilt Foliar App; Prosaro Head Emerge | 51.968 | 3.225 | 51.820 | 0.498 |
| 4 Robust; Tilt Foliar App; Miravis Ace Head Emerge | 53.006 | 2.450* | 52.188 | 0.480 |
| 5 Robust; Prosaro After Head Apply 5-days after head emerge | 57.494 | 3.067* | 44.961 | 0.565 |
| 6 Robust; Miravis Ace After Head Apply 5-days after head Emerge | 58.236 | 2.550* | 50.461 | 0.558 |

MAJOR RESEARCH PROJECT: Malting Barley Fungicide Trials (continued)

| | | | | |
|---|---------|--------|---------|--------|
| 7 Pinnacle;Non-treated Check | 74.651 | 3.750 | 23.552 | 0.055* |
| 8 Pinnacle;Tilt Foliar App | 81.908* | 4.200 | 37.356 | 0.090* |
| 9 Pinnacle;Tilt Foliar App;Prosaro Head Emerge | 84.908* | 4.250 | 67.228* | 0.218* |
| 10 Pinnacle;Tilt Foliar App;Miravis Ace Head Emerge | 85.056* | 2.800* | 83.260* | 0.068* |
| 11 Pinnacle;Prosaro After Head Apply 5-days after head emerge | 81.304* | 2.667* | 57.956 | 0.078* |
| 12 Pinnacle;Miravis Ace After Head Apply 5-days after head Emerge | 75.235 | 1.660* | 83.027* | 0.100* |
| 13 Odyssey;Non-treated Check | 39.721 | 3.900 | 37.894 | 0.565 |
| 14 Odyssey;Tilt Foliar App | 53.984 | 7.433 | 51.930 | 0.425 |
| 15 Odyssey;Tilt Foliar App;Prosaro Head Emerge | 56.770 | 5.800 | 79.292* | 0.310 |
| 16 Odyssey;Tilt Foliar App;Miravis Ace Head Emerge | 49.651 | 4.975 | 62.580 | 0.240* |
| 17 Odyssey;Prosaro After Head Apply 5-days after head emerge | 62.259 | 3.167 | 73.217* | 0.423 |
| 18 Odyssey;Miravis Ace After Head Apply 5-days after head Emerge | 61.857 | 4.167 | 81.349* | 0.245* |

*statistically different from plot average, P=0.10

Information gathered in 2018 on this research trial were very inconsistent. Timing of fungicide applications at Buffalo County were not timely because of rainfall. It appeared Miravis lowered DON levels in Chippewa County. No treatments in Buffalo County brought DON levels to levels required by the malting industry. All treatments in Chippewa County were below the <1 ppm level required by large scale brewers and 12 of 18 treatments were <0.5 ppm required by the craft brewing industry. A minimum of one additional year of data is needed to make recommendations for these treatments.

A second unknown Fusarium species was identified in these samples. The sample is currently being tested at USDA ARS in Illionis to determine its effect on malting barley quality. Rahr Malting, Inc. is leading this investigation.

VI. PROFESSIONAL IMPROVEMENT

Event

American Malting Barley Association Biennial Meeting
 Mental Health First Aid
 Soil and Water Meetings, UW-Extension
 Pest Management Update Meetings, UW-Extension
 Agronomy Update Meeting, UW-Extension
 International Tri-Annual Barley Improvement Conference
 Emergency Medical Responder
 University of Minnesota, Barley University
 International Tri-Annual Barley Improvement Conference
 Hop and Malting Barley Education Tour (self-arranged)
 Hop and Malting Barley Education Tour (self-arranged)
 Hop Union Grower/Brewer Seminar

Location and Date

Albuquerque, NM – 2019
 Menomonie, WI - 2018
 Annually
 Annually
 Annually
 St. Paul, MN – 2017
 Wabasha, MN - 2017
 St, Paul, MN – 2016
 Corvallis, OR – 2014
 Vermont and Massachusetts, 2013
 Germany and Denmark, 2011
 Yakima, WA, 2010

Future Professional Development Needs:

- Continued educational opportunities in Hops and Malting Barley
- Alternative Agricultural Crop Enterprises
 - Industrial Hemp; University of Vermont, Penn State University
 - Heritage Grain Production; Maine Grain Alliance
 - Oat Production for Human and Animal Feed; UW-Madison – Dr. Lucia Gutierrez
 - Kernza Production; Dr. Valentin Picasso – UW-Madison
- Crop Production Update Meetings offered by UW-Madison, Extension
- Soil Conservation/Cover Crops – Science based research opportunities
- Human Resource Management – Self-study and resources outside of agriculture