



2016 BREWERS ASSOCIATION FUNDED RESEARCH GRANTS

ALL-MALT BEER - BARLEY DEVELOPMENT PROJECT

- **Partner(s):** Brewers Association, North Dakota State University, United States Department of Agriculture Agricultural Research Service, ID (USDA-ARS Aberdeen), Briess Malt & Ingredients Co.
- **Primary goal(s):** Identify and commercialize malting barley varieties better suited to all-malt brewing for cultivation in the U.S.
- **Background:** Craft brewers represent a 36% customer for U.S. malt consumption as of 2016. And yet, there are currently no malting barley varieties specifically bred for all-malt brewing in production in the U.S. Craft brewers currently use malt made from barley varieties bred for adjunct brewing, with negative stability outcomes in packaged beer.
- **Additional Information:** Study will continue development of test plots of spring and winter lines at Aberdeen; micro malting at North Dakota State University with Paul Schwarz group; 2016 seed increase of varieties of promise from 2015; pilot malting at Briess with varieties which were involved in the seed increase; brewery trials with participating breweries.

RESPONDING TO A NEW THREAT TO THE CASCADE VARIETY FROM POWDERY MILDEW

- **Partner(s):** USDA Agricultural Research Service, OR
- **Researcher:** David Gent
- **Primary goal(s):** Evaluate male germplasm for its reaction to multiple strains of the powdery mildew fungus. Communicate and disseminate results to plant breeding programs and industry.
- **Background:** Powdery mildew of hop (caused by *Podosphaera macularis*) is the most costly disease to the U.S. hop industry and, by extension, brewers. The disease is managed largely by repeated application of fungicides, with susceptible cultivars receiving on average 8.3 fungicide applications per acre per year (Gent et al., 2012). Economic losses from powdery mildew and its management have been estimated at about 15% of total crop revenue (Mahaffee et al., 2003), in addition to unmeasured costs due to greater supply instability and reduced brewing quality.
- **Additional Information:** Management of powdery mildew is accomplished most efficiently with genetic host resistance. Grant funds were used to conduct a systematic evaluation of male germplasm for its reaction to widely prevalent strains of *P. macularis*, including strains virulent on plants possessing the resistance gene R6. This work is foundational for identifying potential sources of new resistance in existing public breeding lines and accelerating development of new varieties with broad-spectrum resistance to virulent strains of the powdery mildew fungus.

NITRATE RESIDUES IN AND ON HOPS

- **Partner(s):** Washington State University
- **Researcher:** Douglas Walsh
- **Primary goal(s):** Evaluate the interactions of plant nutrition with arthropod pest abundance and disease severity. Quantify nutrient carryover into cones and subsequent beers brewed.
- **Background:** Craft brewers use innovative methods to incorporate hops in the brewing process, including dry hopping after the boil, wet hopping with fresh hops, adding hops later in the boil, and dry hopping with whole cones or pelletized hops. Most all-malt beer brands incorporate a substantially greater quantity of hops on a per unit basis than traditional American Pilsner-type adjunct lager beers.
- **Additional Information:** The overall objective is to help determine optimal nitrogen fertilization rates for hop growers. This will help ensure growers produce economically sustainable yields while providing craft brewers with hops that have optimal brewing properties.

AROMA AND FLAVOR DECIDERS IN CASCADE, CENTENNIAL, CHINOOK HOP VARIETIES

- Partner(s): Oregon State University
- Researcher: Thomas Shellhammer
- Primary goal(s): Identifying character impact compounds that are unique to Cascade, Centennial and Chinook varieties.
- Background: This year's project culminated a three-year endeavor by probing how the Cascade, Centennial and Chinook hop varieties, individually and in combination, produce unique "American-type" hoppy aroma in beer.
- Additional Information: Combinations of the three hop varieties in different proportions were used for dry-hopping, and the qualitative changes in the resultant beers were evaluated using descriptive analysis with trained sensory panelists. The study will increase industry understanding of which combinations of hops drive specific types of hoppy aroma in beer.

OREGON STATE UNIVERSITY MALT LAB

- Partner(s): Oregon State University
- Researcher: Pat Hayes
- Primary goal(s): Develop an effective and functional malting facility and malt analysis laboratory to support the growing craft malting industry.
- Background: In 2015, the Brewers Association provided support for the development of the Oregon State University Malt Lab. Brewers Association support allowed Oregon State to leverage an additional \$100,000 in funding and to develop infrastructure and capacity for malting and malt analysis.
- Additional Information: In the second year of funding the Oregon State University Malt Lab represents model public sector involvement in the grain to glass chain, supporting greater diversity in agriculture, and producing greater efficiencies, profitability, and sustainability in barley production, malting, and brewing.

MALTING BARLEY FLAVOR MARKERS FOR BREEDING GUIDANCE

- Partner(s): Colorado State University
- Researcher: Adam Heuberger
- Primary goal(s): This project will investigate relationships between barley grain metabolites and downstream sensory traits in malt and beer.
- Background: Investigating the relationship between barley and malt chemical composition and beer flavor quality is vitally important to craft brewers, who have expressed an interest in understanding malt flavor. Identifying barley metabolites that contribute to beer flavor is critical to develop new methods to pre-screen barley varieties for downstream sensory traits.
- Additional Information: Previous research showed that barley varieties contain distinct profiles of thousands non-volatile small molecule metabolites such as amines/amino acids, alkaloids, flavonoids and lipids. Many such metabolites are associated with malting quality traits. However, it is still unclear whether barley metabolites (and variation in these metabolites) can influence beer flavor and overall sensory quality. The specific objectives of the work are (1) Identify volatile and non-volatile metabolites in barley grain that vary among 10 barley varieties; (2) Determine metabolites that are associated with sensory data collected by craft brewers; (3) Determine variation for metabolites associated with sensory in the AB-Global population.

SUSTAINABLE GROWER PRODUCTION PRACTICES: 2-ROW BARLEY AND NITROGEN USAGE

- Partner(s): University of Idaho
- Researcher: Christopher Rogers
- Primary goal(s): Identification of two-row-barley cultivars with the best fit for all-malt brewing, and development of best practices for sustainable cultivation of those varieties.
- Background: This proposal plays a key role in the evaluation, selection, and development of best management practices for all-malt barely cultivars that are agronomically, economically, and environmentally sustainable.
- Additional Information: This research continues the screening of winter and spring barley cultivars as well as the development of fertilizer nitrogen best management practices that maximize plant uptake, yield, and quality and minimize disease and potentially negative environmental impacts.

HOP GROWING SUSTAINABILITY/BEST PRACTICES FOR GROWERS

- Partner(s): Hop Growers of America
- Principal: Ann George
- Primary goal(s): Hop Growers of America embarked on a 30-month project in October 2015 to develop a Best Practices program for United States hop growers.
- Background: The dramatic increase in hopping rates and change in hopping regimes (late hop additions at low beer temperatures) has focused attention on hops as a food crop, heightening concerns over food safety practices, particularly during harvest. Ensuring that hops are grown in a sustainable and responsible manner has been identified as a priority of the craft brewing industry.
- Additional Information: In the absence of a single program addressing the specific needs of the U.S. hop industry, growers have implemented programs developed for other crops that are not a perfect fit for hops. The hop industry is currently experiencing unprecedented acreage growth, and interest by individuals looking to grow hops. It is important to encourage and support these new hop growers and help ensure their production methods meets the standards of our customer base.

BARLEY BREEDING FOR CRAFT BREWING

- Partner(s): Montana State University
- Researcher: Jamie Sherman
- Primary goal(s): Improve malt quality for craft malting and brewing through the establishment of the Montana State Malt Quality Laboratory.
- Background: Montana has more malting barley acres grown than any other state. In fact, over the last decade malting barley acreage has been moving steadily west and increasingly in dry-land production. The primary objective of this grant is to upgrade and acquire equipment necessary to establish a fully functional Malt Quality Lab at MSU.
- Additional Information: Establishing the Montana State University malt quality lab will greatly facilitate evaluation of malting barley varieties with quality traits tailored to the craft brewing industry. The long-term deliverable will be to develop varieties that have stable quality useful to craft brewers while adding value to the end product via unique flavors and/or quality traits.

BARLEY BREEDING FOR ALL-MALT BREWING

- Partner(s): USDA-Agricultural Research Service, Aberdeen, ID
- Researcher: Gongshe Hu
- Primary goal(s): Evaluation of low protein germplasm lines for use in development of barley varieties suitable for all-malt brewing.
- Background: Selecting low protein 2-row barley lines from all over the world will greatly enrich the genetic diversity of barley breeding and germplasm resources; and help ensure a supply of barley varieties suitable for all-malt brewing.
- Additional Information: To improve the genetic background of North American barley lines, genetic sources for stress tolerance, better malting and brewing quality traits, and disease resistance will be introduced to create genetic diversity and improve on current barley qualities for use in all-malt beer production.

EASTERN UNITED STATES SPRING BARLEY NURSERY (ESBN)

- Partner(s): North Dakota State University
- Researcher: Richard Horsley
- Primary goal(s): Identify spring malting barley varieties adapted to the Eastern U.S.
- Background: The craft malting and brewing industries across the U.S. wish to source locally produced grains for making their products.
- Additional Information: The 2016 ESBN includes 20 barley varieties from eight different breeding programs being grown in Indiana, Maine, Massachusetts, Michigan, New York, Ohio, Pennsylvania, and Vermont. Trial data will be available for use by local university/extension personnel to educate growers and other stakeholders on varieties that perform best in their region. Trial data will also be used by barley breeding programs to identify other varieties or advanced breeding lines that may be candidates for production in the region.

MIDWEST WINTER BARLEY DEVELOPMENT

- Partner(s): University of Minnesota, Department of Plant Pathology
- Researcher: Brain Steffenson
- Primary goal(s): The overall goal of this research is the establishment of a sustainable Midwest winter barley industry for U.S. craft brewers. This requires the development of cultivars with acceptable malt quality profiles and adaptation to the climate.
- Background: This project will exploit Russian barley accessions to develop winter two-rowed barley cultivars suitable for growing malt-quality barley in the Midwest; which will provide the Midwest craft brewing industry with more locally grown ingredients.
- Additional Information: The long-term aim is to exploit the extraordinary winter hardiness of Russian germplasm for development of adapted two-rowed malting barley cultivars. The specific objectives of this research are to: 1) generate breeding populations made from crosses between selected accessions of the Vavilov collection and two-rowed breeding lines with superior malting characteristics; 2) establish regional trials across the Midwest to broadly assess the winter hardiness of the Vavilov accessions and their malting quality profile; and 3) conduct outreach events at field trials to demonstrate the potential of winter barley production to producers and end-users.

CRAFT MALTSTERS GUILD HACCP AND QUALITY EDUCATION

- Partner(s): North American Craft Maltsters Guild
- Principal: Deb Kleinman
- Primary goal(s): This project will provide support for in-person and virtual craft malt educational programs and events, resources, and other supportive materials for players in the craft malt supply chain. The emphasis is on ensuring a high quality, safe and reliable supply of craft malt for the craft brewing community.
- Background: Craft maltsters play a critical role in promoting and celebrating the small, independent, traditional and innovative culture of American craft brewers, and in strengthening regionally focused supply chains supporting local farmers, malt manufacturers, brewers and others.
- Additional Information: Grant funds will be used to close information gaps through development of education and technical training for craft brewers, craft malt houses and grain farmers. Areas of focus include methods for ensuring quality and safety throughout the craft malt supply chain; barley variety breeding and selection, cultivation methods for malt barley; craft malt start up, equipment, and production; and the benefits of craft malt for craft brewers.