

Barley CP Planning 2015 Planning Meeting Report
408 Hayes Hall, the University of Minnesota, St. Paul Campus
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Participants: Phil Bregitzer, Wynse Brooks (by phone) Bob Brueggeman, Mike Davis, Jerry Franckowiak, Gongshe Hu, Rich Horsley, Aaron Lorenz, Subas Malla (by phone), Sanchin Rustgi (by phone), Mark Seastrand, Jamie Sherman, Kevin Smith, Mark Sorrells (by phone), Brian Steffenson, Frances Trail (by phone), and Marv Zutz
Also present were graduate students at UM: Tyler Tiede, Jeffrey Neyhart, and Celeste Falcon.

Purpose: In the fall of 2015 the Barley Coordinated Project (CP) will submit a two-year proposal of coordinated research. The two major objectives of the meeting were to: 1) Discuss CP research progress in FY 14-15 funding cycle; and 2) Discuss draft letters of intent (DLOIs) and begin to formulate the new CP proposal for FY16-17. All DLOIs were distributed to members of the CP prior to the meeting, and time was allotted for discussion of each DLOI.

Following general introductions, Phil Bregitzer referenced the expansion of the CP via the addition of members of the former Western CP, Gongshe Hu (ARS-Aberdeen) and Jamie Sherman (MSU). In addition, proposals were received from Mark Sorrells (Cornell), Heather Darby (UV), and Sanchin Rustgi (WSU). Several proposals were identified that should be directed at specific RAG rather than the CP, and both affected research groups agreed to do so. Following is a summary of major discussion points.

Expanded Stakeholder base—There are two major drivers of this: 1) the emergence of FHB in the West; and 2) substantial interest in locally-sourced barley and malt with which to brew beer throughout the US in non-traditional growing areas. Serving producers and users of barley in these areas requires expansion of CP activities.

Transformation—Gary Muehlbauer (not present) communicated previously that the transgenic barley expressing UDP-glucosyl transferase is in the final stages of conversion to a Rasmusson background. This gene has shown promise in wheat for reducing DON. Phil Bregitzer discussed progress and conclusions regarding the project he took over from Lynn Dahleen. Lines tested in 2014 in ND and MN are being prepared for a second year of testing. Materials further back in the pipeline are being evaluated in the greenhouse; many appear to be non-transgenic "escapes". Frances Trail reported that at least one of the lines developed by Lynn was showing positive results in her tests. Lines that are transgenic will be characterized for gene expression in cooperation with the labs that supplied the genetic construct and moved towards field trials as appropriate. As Lynn's lab is no longer in operation, further materials will not be generated and thus no further funding for this project is proposed. A general discussion of past transformation work generated a consensus that the amount of funding for this work is relatively small, and care must be taken to ensure that funded projects are sufficiently focused, and that the funding is used to leverage other available funding.

NABSEN/screening efforts—Bob Brueggeman reported that the nursery data is complete except for the delivery of some DON data. It was suggested that Montana, Idaho, and Washington lines should be included to facilitate better comparisons. Efforts to screen materials in the West are

underway but suitable nursery conditions are being worked out. A need for a nursery suitable for screening winter materials was identified. Kevin Smith is testing facultative lines at MN, but not true winters. True winter-habit lines could be screened by VT and/or Cornell, but additional funding would be necessary to expand testing beyond 100-200 lines (to enable expansion of misting systems). Another suggestion was to work with cooperators across the country with winter nurseries and rely on natural infections to provide additional data relative to elite breeding lines and varieties.

Breeding—Rich Horsley reported the release of ND Genesis, which is in its second year of AMBA plant scale evaluation. It is similarly tolerant of FHB as Quest. Another line, ND62891, is entering its first year of plant scale testing. Several other lines are advancing that are promising. Kevin also reported on several promising FHB-tolerant lines moving through his program, one of which (M160) was rated satisfactory in 2014 Pilot Malt tests. Wynse Brooks and Subas Malla reported that several extant VT cultivars are FHB tolerant, and several new FHB-tolerant lines are being developed. Gongshe Hu reported that limited testing in the Midwest has shown surprising levels of tolerance in Aberdeen elite breeding materials.

Germplasm Development—Bob is investigating the genetics of a Turkish line that may be a useful and unique source of resistance. Introgression into ND Genesis and Conlon is in progress. Brian Steffenson reported that screening of 30,000 NSGC *Hordeum* accessions resulted in the identification of 40 that have shown some level of FHB tolerance. Several have been selected for population development. Two have been identified that appear to have a unique 2H QTL, and transgressive segregants from breeding populations developed from them have been identified with better resistance than Quest. An Austrian line has been identified that has resistance that may be better than that of Chevron. Resistant lines derived from promising sources of resistance that have been crossed three times to Quest are being released to breeders. An important aspect of this work has been that additional USWBSI funding for DH population development has accelerated progress in the development of these populations.

Mapping and Genomic selection—The breeding programs at VT, UM, and NDSU are continuing their work to identify, map, and use marker-assisted selection to make their programs more efficient. Known QTLs are becoming more useful as a result of further mapping work and the development of better markers, and new QTLs are being investigated to determine their utility. A promising aspect of this work has been that the application of genomic selection—for selection of both promising lines as well as new parents—has resulted in gains in efficiency and is enabling shorter breeding cycle times. More progress is needed, but producers now have access to varieties with reduced FHB susceptibility.

Pathogen Biology—Frances Trail is focusing on early ingress stages of *Fusarium* into barley. Trichomes on the lemma and palea are involved, and her work has characterized resistance responses—such as build-up of callose and lignin—in these structures. Differences have been detected between 2 and 6 row barley. Jerry Franckowiak pointed out that the *gth1* gene controlling trichomes is very close to gene *VRS1*. Early stages of infection include processes such as passage of the fungus through plasmodesmata may be susceptible to control by RNAi, and current work includes establishing a model for assessing transgenic lines that use RNAi constructs.

Training of the Next Generation of Scientists--Research reports and DLOIs reflect a heavy investment in providing opportunities for undergraduate and graduate students, and for post-doctoral researchers. In addition to receiving training, students and post-docs have made, and will make, substantial contributions to the outputs of the CP.

New Proposals

Breeding/germplasm/screening—DLOIs from currently-funded breeding/screening programs at UM, NDSU, and VT proposed continuing these efforts. Several proposals reflected increased overhead charges. A current theme of all proposals was the expanded reliance on marker-assisted selection, and developing resources (*e.g.* new mapping populations, GBS-based markers). Related to this were proposals to increase the use of genomic selection for prediction of useful cross combinations. The primary need expressed by the Western programs included in the CP is resistance screening of elite breeding materials, and also for funding to enable paying for testing in the Midwest. An important new component is the high level of stakeholder interest in the Northeast, and the consequent proposal from Mark Sorrells to develop a program at Cornell to screen materials in the Northeast, and, in collaboration with UM, to develop mapping and breeding efforts designed to deliver FHB-tolerant varieties to this region.

Transformation—Phil and Frances are actively working to produce RNAi-expressing barley that interferes with *Fusarium* infection and mycotoxin production. Phil proposed additional funding to enable proper characterizations via RNA-seq for RNAi work that is ongoing in his lab. Gary is preparing to field test the UDP-glucosyltransferase-expressing lines in the field. Kevin proposed genome-editing as a method to convert 6-row resistance sources (including Quest) to 2-row resistance sources as a means to better understand the role of *VRS1*.

Pathogen Biology—Frances proposed continuing the investigation of the *Fusarium*-trichome relationship and whether responses of these structures affect *Fusarium* ingress and whether the responses differ in 2- and 6-row barley. In addition, she wishes to address the potentially negative interaction (with respect to FHB resistance) of genes for powdery mildew resistance with *Fusarium*.