2022 (Year 3) Interim Report

for the

Saskatchewan Barley Development Commission,

Manitoba Crop Alliance,

and Western Grains Research Foundation

Project Title: Contrasting Fungicide Applications and Genetic Fusarium Head Blight Resistance for Enhanced Yield and Quality of Barley

(Project # SBDC 5086; MWBGA 2063; WGRF AGR2008)

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2. Project Numbers:

Saskatchewan Barley Development Commission: SBDC 5086
Manitoba Crop Alliance: MWBGA 2063
Western Grains Research Foundation: WGRF AGR2008

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6. Summary: Include activities during the project period, status of the project (is it on schedule), and any significant observations in related to the progress of the project.

A project was initiated in the winter of 2019-20 to investigate the potential for foliar fungicide applications combined with genetic fusarium head blight (FHB) resistance to enhance yields and/or end-use quality of barley. The first field trials were established at Indian Head, Yorkton, and Melfort in the spring of 2020, with the Brandon site postponed due to COVID-19 restrictions. For the 2021 and 2022 growing seasons, trials were conducted at all fall locations. While the originally proposed field trials at Lacombe could not proceed due to COVID restrictions and capacity limitations, Kelly Turkington continues to collaborate as a scientific authority and AAFC-Lacombe staff have completed leaf disease ratings for all sites.

Despite a few minor issues, the field trials went well in 2020 and no specific changes to the field protocols were recommended at that time. The issues encountered were due to human error (i.e., some plots lost

to spray drift at Melfort), minor misunderstandings of data collection requirements (i.e., plant counts not completed for all plots at Yorkton), or environment (i.e., variable yields due to drought at Yorkton). In 2021, the field trials went reasonably well at all locations; however, drought, in some cases severe, resulted in negligible leaf disease levels at all sites and, in some (i.e., Yorkton and Melfort), low and/or extremely variable yields combined with relatively poor grain quality. In 2022, moisture conditions were much better at all sites, but there were still challenges. Yield data were extremely variable at Melfort, potentially due to variable fertility or compaction issues. Residual N was relatively high at Melfort 2022 and, as such, only 22 kg N/ha was applied as fertilizer. However, noticeable irregularities in crop condition were observed during the growing season and grain yields were extremely variable. It is possible that the actual residual N was either lower or more variable than anticipated and the observed yield variability was a result of inconsistent fertility or other soil related issues. At Yorkton in 2022, moisture was abundant and yield potential was high; however, the plots were severely damaged by hail in late June and, in the end, yields were somewhat variable and grain quality was poor. Unfortunately, these challenges will likely result in data from the affected sites having to be excluded from final, combined analyses for certain response variables. The data that were collected for all plots (unless otherwise specified) included plant density, leaf disease ratings, grain yield, test weight, thousand kernel weight, plump seeds, thin seeds, and deoxynivalenol (DON) accumulation. Each collaborator completed the plant density and grain yield measurements for their sites in addition to collecting the leaves required for disease ratings. IHARF staff completed all grain quality assessments except DON which was completed by Seed Solutions Laboratory (Swift Current). AAFC staff at Lacombe completed all leaf disease assessments. All currently available response data has been statistically analyzed and summarized and the only data that was not available at the time of preparing this report was DON from IH-22. These preliminary analyses are intended to allow some basic initial interpretation of results, identify potential trends or issues, and to help guide future groupings of sites for combined statistical analyses (i.e., low versus high disease pressure). Extension activities to date have been minimal due to a combination of COVID-19 restrictions in 2020 and relatively few available results; however, the trial was shown and the project was discussed during the Indian Head Crop Management Field Days in both 2021 and 2022 with a combined attendance of approximately 210 participants. In 2022 at Melfort, the project was signed and briefly shown during the AAFC NARF Joint Annual Field Day (July 20, 52 attendees) and during a SaskWheat Field Day on August 9 (21 attendees).

Similar to last year, this project is still considered to be behind schedule relative to the original timelines; however, things have been progressing as expected since the last report. With AAFC-Brandon postponed and AAFC-Lacombe unable to host a site for the final two years as originally planned, we will extend field trials for an additional growing season at three sites in order to make up the shortfall. Further to this, we had requested an additional year for final data analyses and report preparation; however, this did not come with any additional funding requirements. As discussed during the last reporting period, the challenge with respect to the original reporting timelines is that much of the grain quality and disease data is not available until quite late in the winter and it is difficult for us to dedicate sufficient time to data analyses and report preparation during the field season.

7. Methods: Include approaches, experimental design, methodology, materials, sites, etc. Major changes from original work plan must be indicated and the reason(s) for the change should be specified. Significant changes from the original work plan will require written approval from the Funders.

The specific field protocols and research plan for this project were developed back in 2019 during the letter of intent and full proposal phases, with feedback from both funding organizations and collaborators. The detailed field protocol that was distributed to collaborators in early 2020 was refined early in 2022 to

include an extra set of leaf disease assessments (prior to the 2nd fungicide application), but is otherwise identical to what was approved and has previously been reported. A copy of the most recent field protocol is provided in Schedule 1 of the Appendices. To date, field trials have been conducted at Brandon in 2021 and 2022, and Indian Head, Melfort, and Yorkton in 2020, 2021, and 2022, for a total of 11 site-years. A brief description of the methods, along with any further deviations from the original protocols, follows.

The treatments were a factorial combination of three varieties and four fungicide treatments, arranged in a four replicate randomized complete block design (RCBD). The varieties were selected based on their genetic resistance to FHB (according to the Saskatchewan Seed Guide) and were CDC Bow (moderately susceptible; MS), AAC Synergy (intermediate; I), and AAC Connect (moderately resistant, MR). Information on seed size and percent germination is provided in Table 1 of Appendices (Schedule 2). The fungicide treatments were an untreated control, a flag-leaf application targeting leaf disease (Trivapro), an application at 80-100% head emergence targeting FHB (Prosaro XTR), and a dual application which received both the flag-leaf stage and heading fungicide applications. The fungicides were applied as per protocol, using field sprayers and a minimum solution volume of 187 l/ha (20 U.S. gal/ac). The treatments were applied on the same date for each variety and no sites have observed enough variance in crop stage to suggest that separate application dates might be necessary in future years.

Barley was managed with all (controllable) factors other than disease intended to be non-limiting. Detailed agronomic information for all applicable sites are provided in Tables 2, 3, and 4 of the Appendices for 2020, 2021, and 2022, respectively. The target seeding rate at all sites was 300 viable seeds/m^2, adjusted for seed size and percent germination and all locations used the same seed source. Fertilizer applications varied by site, but were equal across treatments (within a site) and all nutrients were intended to be non-limiting. Weed control measures also varied by site, but the intent was to keep the crop reasonably free of weeds throughout the season. The centre rows from each plot were harvested, taking care to avoid potential edge effects (i.e., outside rows or fungicide drift) and areas of the plot affected by wheel tracks. Unfortunately, several plots at Melfort 2020 were damaged by spray drift by AAFC staff working in the area. NARF staff assessed the damage and recommended that data from 10 plots would be affected and that these should be removed prior to any analyses. This was unfortunate, but was not due to any wrongdoing of NARF staff and the affected plots were removed prior to any statistical analyses, as per their recommendations. This was the only instance where a substantial amount of data were lost; however, as previously discussed, adverse environmental conditions have rendered data from some sites for some response variables unusable.

Various data were collected during the season and from the harvested grain samples. Emergence was assessed by recording the number of plants in 2 x 1 m sections of crop row per plot in late May/early June and converting the values to plants/m^2. These measurements were not completed for all plots at YK-20; however, data were collected from enough treatments to test for varietal differences which was all that was originally intended for this variable. Initial leaf disease pressure and subsequent treatment effects on leaf disease were estimated from a minimum of 10 leaves per plot collected from the control treatments at the flag leaf stage (prior to fungicide application) and for all plots at the late milk/early dough stages. Starting in 2022, an additional measurement was completed just prior to the second fungicide applications. This measurement period was missed at Melfort 2022, but is planned for all sites going forward. The third leaf from the head was collected for the first two sets of ratings while the penultimate (2nd leaf from head) was collected at the final measurement date. At Melfort 2020, where spray drift resulted in some data loss, the leaf disease samples were collected from healthy areas of the affected plots and the values appeared to be consistent and representative of the site; therefore, all leaf disease

data for this site was retained for these preliminary analyses. Collaborators forwarded leaf disease samples to IHARF who coordinated with AAFC-Lacombe to have the leaves rated for scald (causal agent *Rhynchosporium commune*), net-form blotch (causal agent *Pyrenophora teres* f. *teres*), and other leaf diseases (spot-form net blotch, causal agent *Pyrenophora teres* f. *maculata* and spot blotch, causal agent *Cochliobolus sativus*). Grain yields were determined from the mass of harvested grain and are corrected for dockage and to a uniform seed moisture content of 13.5%.

All locations forwarded 1 kg of cleaned grain from each plot to IHARF for further quality analyses. Test weights were determined from cleaned sub-samples for each plot using standard Canadian Grain Commission methods and equipment, including a 0.5 litre measure and cox funnel. Test weight values are expressed as g/0.5 L and are the average of two measurements per plot. Thousand kernel weights were determined by counting a minimum of approximately 1000 seeds using an automated seed counter and weighing the counted seeds to the nearest 0.00 g. The number and mass of seeds were used to calculate g/1000 seeds. Percent plump and thin kernels were determined from a 200 g cleaned sub-sample and were defined as the proportion of seeds that stayed on top of, or lodged in, a No. 6 slotted sieve (plump) or passed through a No. 5 slotted sieve (thin). Finally, a 250-300 g sub-sample from each plot was forwarded to Seed Solutions Seed Labs (Swift Current, SK) for deoxynivalenol (DON) determination. These data were reported in parts per million (ppm) to the nearest 0.00 ppm. Due to the widespread drought, DON was not detectable in any samples, regardless of treatment or location, in 2021; however, DON levels were much higher in 2022 and we were fortunate to see some meaningful treatment effects.

At this stage, all available data from all locations has been formatted for consistency and organized into master files with basic screening for quality. In order to stay current with results to date and to help facilitate future grouping of sites for combined analyses (i.e., low versus high disease pressure), data from each location were analysed separately and summarized in the Appendices. All response data were analysed using the generalized linear mixed model (GLIMMIX) procedure of SAS Studio with variety (VAR), fungicide (FUNG), VAR x FUNG effects considered fixed and replicate effects treated as random. Unless there were explicit reasons for doing so (i.e., drift damage at Melfort 2021), no individual data points have been deleted at this stage of the project; however, we anticipate that entire sites will need to be excluded from combined analyses for certain response variables due to the extreme variability and questionable validity of results. Where possible, such decisions will be made on a case by case basis for each response variable in order to preserve as much data as possible.

8. Progress during the reporting period: (e.g., laboratory, growth chamber, greenhouse, and field experiments; chemical analysis; data analysis; model development). Please briefly indicate what has been done during the reporting period in respect to meeting the stated objectives of the project.

This section is specific to the April 2022-March 2023 reporting period. Please refer to the 2020-21 interim report for progress in the first year of the project.

Seed for the 2022 season was sourced for all sites by ECRF and IHARF staff and distributed as required. Field trials were initiated and carried through to completion at all four of the initially scheduled locations (Indian Head, Yorkton, Melfort, and Brandon). All aspects of the field trials went well in 2022; however, the yield data from Melfort was unusually variable, presumably due to soil compaction and/or variation in background fertility, and the site at Yorkton was severely damaged by late June hail. Compared to the previous seasons, yield potential was quite high for several of the sites in 2022.

Each collaborating site completed the plant counts, leaf collections, and yield measurements for their respective sites but forwarded the leaf disease and grain quality samples to IHARF. IHARF completed all

the grain quality assessments that could be done in-house and coordinated with Seed Solutions Laboratory (Swift Current, SK) for DON determination on behalf of all sites. Leaf disease samples were submitted to AAFC Lacombe who are caught up on all ratings at this time. The results for these assessments in 2021 were not summarized in the corresponding report for that year, but have since been analysed and are included in the current report. A minimum of 10 leaves were assessed for each plot in all cases. Scald and net blotch were rated separately but, due to the lower overall levels of disease, only the total disease levels (percent leaf area affected) were statistically analysed and reported.

Regardless of data quality or environmental conditions, all available data has been analysed using basic statistical procedures and is summarized in order to help us identify potential issues as they arise and to better understand results from individual sites. This information will help us determine how to most effectively group locations for any future combined analyses in addition to allowing data quality to be scrutinized and excluded from future combined analyses where necessary.

9. Project Progress to date: (e.g., laboratory, growth chamber, greenhouse, and field experiments; chemical analysis; data analysis; model development; results if available). Please indicate overall project progress since its initiation.

At this stage, field trials have been conducted at 11 location-years with specific details of these trials and the work completed discussed in previous sections. All available results to date, from all three years of the project, are provided in the Appendices and will be briefly discussed in the current section. Again, seed specifications from each year are provided in Table 1 while selected agronomic information and dates of operations are provided in Tables 2, 3, and 4 of the Appendices for 2020, 2021, and 2022, respectively. Tables 5 and 6 include mean monthly temperatures and cumulative precipitation, respectively, for each site (location-year). Results from the overall tests of fixed effects for all response variables except leaf disease ratings are provided for all 11 sites in Table 7. Corresponding main effect and individual treatment means for each of these response variables are provided in Tables 8-20. Tests of fixed effects for total leaf disease and means for both the main effects and individual treatments are provided for all sites and measurement times in Tables 21-25.

<u>Plant Emergence (Table 7 and 8)</u>

These measurements were completed prior to the application of any fungicide treatments, therefore, only variety effects were included in the model. While seeding rates were adjusted for seed size and percent germination, differences between varieties still occurred at 5/11 locations. Emergence for AAC Synergy (I) was slightly lower than for the other two varieties at IH-20. All four locations in 2021 observed lower plant populations for CDC Bow (MS) compared to the other varieties. This was attributed to poorer seed quality and subsequently higher mortality for this variety. At some locations (i.e., IH-21 and BR-21), emergence was poorer than expected, potentially due to poor seedbed conditions and/or deeper than optimal seed placement. While plant populations at these sites may have increased as the season progressed, emergence counts with cereals must generally be done early, prior to tillering, or they become increasingly difficult to complete with accuracy.

<u>Leaf Disease (Tables 21-25)</u>

At the time of the flag leaf fungicide applications (T1), leaf disease levels never differed between varieties (P = 0.069-0.933) and were 1% or lower (leaf area affected) at 10/11 sites, the sole exception being ME-20 where the trend was for the most disease in CDC Bow and the least in AAC Connect (Table 22). In 2022, we introduced an additional measurement period prior to the second set of fungicide applications (T2); however, these collections were missed at ME-22. The percent leaf area affected by disease continued to be low at this time; however, variety differences were detected at BR-22 and YK-22 and, again, showed a trend for higher disease in CDC Bow relative to AAFC Synergy and AAC Connect (Table 23). Despite being one of the wettest locations, leaf disease levels at early heading were extremely low at IH-22 (0.2%). The

final leaf disease collections were completed as late as possible but before senescence; however, total disease levels at this time were still below 1% at 5/11 sites. Variety effects on final, total disease levels were significant at 8/11 sites, but the trends were not always consistent. Fungicide effects were significant at 6/11 sites and, where they occurred, were largely as expected with the highest disease levels observed in the untreated control. Differences amongst the treatments that received fungicide were rare and there was only one case (YK-20) where disease levels were slightly higher when fungicide was solely applied after heading as opposed to the flag leaf stage or dual applications. Significant VAR x FUNG interactions were detected at BR-22 and ME-21; however, the nature of the interaction differed. At BR-22, fungicide effects were only detected with CDC Bow (MS) while, at ME-21, the response only occurred with AAC Connect (MS).

Grain Yield (Tables 7, 9 and 10)

Grain yields were affected by variety at 7/11 sites and fungicide at 2/11 sites (BR-22 and IH-22), with significant VAR x FUNG interactions detected at 2/11 sites. In cases where the variety effect was significant, AAC Synergy was always amongst the top yielders. CDC Bow yielded lowest in 5/7 responsive sites while AAC Connect had the lowest yield at 1/7. For 1/7 responsive sites, Bow and Connect yielded similar to each other but lower than AAC Synergy. The sole two locations where fungicide effects on yield were significant on their own were BR-22 and IH-22, two of the wettest, highest yielding locations. At BR-22, the effects were subtle with only the dual fungicide application yielding significantly higher than the control, by a margin of 267 kg/ha or 4%. At IH-22, all treatments that received fungicide yielded similarly and all were higher than the control by an average of 393 kg/ha or 6%. The interactions occurred at ME-21 and YK-22, but were difficult to explain and may not have been genuine responses to the treatments. At ME-21, the interaction was due to there being unusually low yields with the post-heading fungicide application for CDC Bow (MS) and for both the flag leaf and dual applications for AAC Synergy. These results cannot be reasonably explained and standard error values for yield at this site were extremely high; however, unfortunately, the variability was widespread within the site and cannot be simply attributed to a few outliers. At YK-22, the interaction appeared to be due to there being a relatively strong, positive fungicide response for CDC Bow (MS), relatively little response with AAC Synergy (I), and an inconsistent, perhaps even negative, response to fungicide with AAC Connect (MR). Again, the barley at this site was severely damaged by hail which reduced the reliability of these results. Similar to ME-21, however, the variation appeared to be relatively random and there were no outliers that could be confidently identified and removed to improve the data set. Other sites where yield data quality was questionable and may need to be removed included ME-22, YK-20, and YK-21. The variability at YK-20, YK-21, and ME-21 was primarily attributed to drought and adverse environmental conditions. At ME-22, the issues were less clear; however, we speculate that they could have been caused by a combination of compaction and variable background fertility levels. Fall soil tests showed relatively high residual fertility at ME-22 and, therefore, only 22 kg N/ha was applied as fertilizer. It is possible that the site-specific N levels were either lower or quite variable, and variation in total N fertility across the site resulted in unusually high experimental error. Similar to the other sites identified as potentially problematic, there were no outliers that could specifically be identified and removed prior to analyses in order to improve data quality and our ability to detect meaningful treatment effects.

Test Weight (Tables 7, 11, and 12)

Test weight was affected by variety at 10/11 sites and fungicide at 3/11 sites, with significant VAR x FUNG interactions at 2/11 sites. While there was substantial variation across sites, attributable to environmental conditions, AAC Synergy consistently had amongst the highest test weights of the three varieties. CDC Bow had amongst the lowest test weight at 8/11 sites while test weights for AAC Connect were amongst the lowest at 7/11 sites. Focussing on fungicide effects, responses were relatively rare under the conditions encountered, but for the three sites where they occurred (IH-21, IH-22, YK-22) they were positive and primarily attributed to the post-heading applications. For YK-22, the interaction was also significant and appeared to be due to dual fungicide effects on test weight being less consistent than a

single application after heading; however, overall variability at this site was high, likely due to the hail, and these validity of these results may be questionable. The interaction at BR-22 appeared to be due to subtle, somewhat random inconsistencies in the trends for fungicide effects across varieties.

Thousand Kernel Weight (Tables 7, 13 and 14)

Thousand kernel weight was affected by variety at 7/11 sites while fungicide effects were significant at 3/11 and the VAR x FUNG interaction was significant at 1 site. When they occurred, variety effects on kernel weight were inconsistent, perhaps a function of the varieties responding differently to the range of environmental conditions encountered. In the rare cases where fungicide effects occurred, they showed slightly higher thousand kernel weights when fungicide was applied post-heading, either alone or in combination with a flag-leaf application. At YK-22, the sole site where the interaction was significant, there were inconsistencies across varieties and AAC Connect appeared to be less responsive overall but, again, we cannot rule out that these values may have been affected by hail.

Plump Kernels (Tables 7, 15, and 16)

Percent plump kernels were affected by variety at 6/11 locations and fungicide at 2/11 sites. The VAR x FUNG interaction was never significant for this variable. CDC Bow had amongst the highest proportion of plump kernels at 10/11 sites while AAC Synergy and AAC Connect had amongst the highest values at 8/11 sites and 7/11 sites, respectively. Again, fungicide effects were rare but, at IH-22, showed the highest values when the heads were sprayed. The other responsive site, YK-22, had far fewer plump kernels than any other sites and, while the overall F-test was significant, the responses appeared somewhat random and the sprayed treatments never differed from the control. Again, this site was severely impacted by the late June hail and these results may not be reliable.

Thin Kernels (Tables 8, 17, and 18)

Percent thin kernels were affected by variety at 7/11 sites and fungicide at 4/11 sites, while VAR x FUNG interactions were detected at 2/11 sites. Of the responsive sites, CDC Bow had amongst the highest proportion of thin kernels at 3/7 sites while AAC Synergy had amongst the highest proportion at 2/7 sites and AAC Connect had amongst the highest values at 6/7 sites. Fungicide effects were rare and which application had the greatest impact on percent thin kernels was not always consistent; however, the untreated control always had amongst the highest proportion of thin kernels. Going forward, data for percent thin kernels will be rounded to a single decimal place prior to analyses as we occasionally picked up treatment effects that were not biologically meaningful and tended to diminish with rounding.

Deoxynivalenol – DON (Tables 18 and 19)

Deoxynivalenol (DON) accumulation was measured for all plots at all sites, but these results are not yet available for IH-22 and no DON was detected at any locations in 2021. For context, the Brewing and Malting Barley Research Institute (BMBRI) suggests that barley with DON levels over 0.5 ppm will normally be rejected for malt; however, depending on supply, DON levels of 0.5-1.0 ppm may be considered acceptable. Of the sites where data is available and DON was detectable, variety effects were significant at 1/7 while fungicide effects were significant at 2/7 sites. Where the variety effects were significant (ME-22), the results were subtle, but as expected, with the highest levels observed with CDC Bow (MS; 0.56 ppm) and the lowest with AAC Connect (MR; 0.48 ppm) and intermediate values with AAC Synergy (I; 0.53 ppm). While the main effects of fungicide were not significant at ME-22, there was an interaction which appeared to be due to elevated DON with AAC Synergy when fungicide was applied at the flag leaf stage, but not followed up by an application after heading. This may be due to the fact that the flag leaf stage fungicide product contained a strobilurin (Azoxystrobin). Kelly Turkington observed similar trends in an AAFC trial comparing flag and head emergence fungicide timings in AC Metcalfe. None of the fungicide treatments reduced DON relative to the control at ME-22 when averaged across varieties or for individual varieties. While yield data from ME-22 will likely need to be discarded, we hope that the treatment effects on DON are valid and can provide some valuable insights. At YK-22, the DON levels were always low enough that there was no risk of rejection for malt; however we did detect a fungicide response whereby

the post-heading applications substantially reduced DON relative to both the control and the single application at the flag-leaf stage. DON levels at YK-22 were quite consistent across varieties and the fungicide effects were also consistent across varieties. At BR-22, DON levels were relatively high, averaging 0.41 ppm; however, neither variety nor fungicide treatment had any impact on the values, and no meaningful trends were observed. At IH-22, DON levels were higher than any other sites and fungicide effects were significant while variety effects and the VAR x FUNG interaction were not. The fungicide effects were as expected and similar to those at YK-22 whereby DON levels of 1.62-1.64 ppm with no post-heading fungicide application were reduced to 1.01-1.06 ppm with a fungicide application targeting FHB.

10. Extension and Communication Activities: (e.g., extension meetings; papers produced; conference presentations made; photos)

Extension and communication activities specific to this project have been limited. We had intended to introduce the project during the 2020 IHARF Crop Management Field Day; however, this event was cancelled due to COVID-19 restrictions. In 2021, however, IHARF did host a scaled back field day at Indian Head with approximately 80 participants and the plots were shown during a discussion of the project objectives, results to date, and other related projects (i.e., FHB modelling in wheat, durum, and barley led by University of Manitoba). In 2022, the project was scheduled to be featured during the IHARF Crop Management Field Day; however, the field sites could not be toured due to heavy rain and wet conditions. Nonetheless, the project was briefly discussed during indoor presentations with approximately 120 participants. In 2022 at Melfort, the project was signed and briefly shown during the AAFC NARF Joint Annual Field Day (July 20, 52 attendees) and during a SaskWheat Field Day on August 9 (21 attendees). We will continue to promote this project in 2023 where opportunities arise and this technical report may be made available online through the IHARF website (www.iharf.ca).

11. Appendices

Schedule 1 – Example Field Protocol Distributed to All Collaborators for the 2022 Season – Does Not Include Randomization / Field Map

#22-2613: FUNGICIDE APPLICATIONS & GENETIC FHB RESISTANCE FOR ENHANCED YIELD & QUALITY OF BARLEY (YR 3)

Objective: To investigate the potential merits of contrasting foliar fungicide strategies in barley production and the potential for foliar fungicide applications combined with genetic FHB resistance to enhance end-use quality of barley.

Location: Indian Head (lead), Melfort, Brandon, and Yorkton (Lacombe is unable to conduct field trials)

Design: RCBD with 4 replicates

Treatments: 4 fungicide treatments x 3 varieties = 12 treatments x 4 reps = 48 plots plus guards

#	Variety [Z]	Fungicide [Y]
1	CDC Bow (MS)	1) Untreated (no foliar fungicide)
2	CDC Bow (MS)	2) Flag (0.4 l/ac Trivapro A + 0.12 l/ac Trivapro B)
3	CDC Bow (MS)	3) Head (0.325 l/ac Prosaro XTR)
4	CDC Bow (MS)	4) Dual (Trt 2 and 3 combined – plots receive both applications)
5	AAC Synergy (I)	1) Untreated (no foliar fungicide)
6	AAC Synergy (I)	2) Flag (0.4 l/ac Trivapro A + 0.12 l/ac Trivapro B)
7	AAC Synergy (I)	3) Head (0.325 l/ac Prosaro XTR)
8	AAC Synergy (I)	4) Dual (Trt 2 and 3 combined – plots receive both applications)
9	AAC Connect (MR)	1) Untreated (no foliar fungicide)
10	AAC Connect (MR)	2) Flag (0.4 l/ac Trivapro A + 0.12 l/ac Trivapro B)
11	AAC Connect (MR)	3) Head (0.325 l/ac Prosaro XTR)
12	AAC Connect (MR)	4) Dual (Trt 2 and 3 combined – plots receive both applications)

[Z] All locations will use the same seed source on a year-to-year basis. Ratings are for FHB (MS – moderately susceptible; I – intermediate; MR – moderately resistant)

[Y] Fungicides should be applied in ~20 U.S. gal/ac at either the flag-leaf stage (Trt 2, 4, 6, 8, 10, & 12) or between 80% head emergence and 3 days after heading is complete (Trt 3, 4, 7, 8, 11, & 12). If necessary, application dates may vary with variety.

Crop Management:

1) **Drill/Plot Size:** Conserva-Pak / 14' x 35', flagged at 15' (plot size may vary across locations)
2) **Cultivar:** As per protocol
3) **Seed rate / Date:** 300 viable seeds/m^2, target early to mid-May seeding
4) **Fertility:** NPKS balanced across treatments and non-limiting (target ~100-35-17-17)
5) **Crop protection:** Registered pesticides as required to keep weeds and insects non-limiting; fungicides applied as per protocol

6) **Harvest:** Straight-combine centre rows when mature and dry. Do not harvest outside rows and there should be no wheel-tracks within the harvest area. **Pre-harvest glyphosate not permitted.** If necessary, collaborators may use diquat to assist crop dry-down; however, allowing the crop to mature and dry naturally is the preferred option. Take care during harvest not to cause excessive damage to the barley as this creates challenges for future quality analyses.

Data collection:

1) **Plant Density**: Count plants in 2 x 1 m sections of crop row after emergence is complete (i.e. approximately 10-14 days after emergence is first noted)

2) **Leaf disease ratings**: Leaves are to be collected per. Upon collection, the leaves will be placed flat in long envelopes or submarine bags, dried at room temperature, carefully packaged, and forwarded to AAFC-Lacombe (care of Noryne Rauhala/Kelly Turkington) to be rated using established protocols during the fall/winter months. Leaves will be rated for scald, net-form net blotch, and other leaf spots and collections will be completed at three separate times. If possible, collect from rows that are not being harvested for grain yield.

   a. **T1) Early Flag Leaf stage and T2) just following head emergence:** To assess early season risk and variety differences, initial ratings will be completed at early flag emergence for the **untreated plots only (Trt 1, 5, & 9, and from all replicates).** These ratings will focus on the **3rd leaf from the head**.

      i. Please label each bag with Location, Test#, Growth stage, Leaf collected, Plot#, Rep and Crop type
      ii. **- Growth stage – flag leaf emergence (GS39) and head emergence (GS 59-60)**
      iii. - Need 20-25 leaves of the Flag -2 (third leaf down from the head) for each sampling date (keep dates and plots separate)
      iv. - Put in properly labeled sub-shaped bag (DO NOT BEND THE LEAVES).
      v. - Fold each bag at the top and staple bag for each plot together with only one staple.
      vi. - Keep the bags (leaves) flat and dry the leaves in the sub bags at room temp.

   b. T3) Late-Milk/Early dough stage: All plots are to be rated at this time, at least 7 days after the 2nd fungicide applications but prior to senescence. These ratings will focus on the penultimate leaf (2nd leaf from the head).

      i. Please label each bag with Location, Test#, Growth stage, Leaf collected, Plot#, Rep and Crop type
      ii. - **Growth stage - late milk to early dough (GS77-83; leaves must be green)**
      iii. - Need 20-25 leaves of the Flag -1 (keep plots separate).
      iv. - Put in properly labeled sub shaped bag (DO NOT BEND THE LEAVES)
      v. - Fold each bag at the top and staple bag for each plot with only one staple.
      vi. - Keep the bags (leaves) flat and dry the leaves in the sub bags at room temp.
      vii. - IF LEAVES ARE SENESCING AT THIS STAGE, PLEASE CONTACT NORYNE RAUHALA FOR INSTRUCTIONS

   c. **Send leaf samples to Noryne Rauhala** in Lacombe for rating. Please email Noryne (noryne.rauhala@agr.gc.ca) prior to shipping so that we know to expect them. At the discretion of individual site-managers, leaf samples may also be forwarded to Chris Holzapfel (IHARF) who will then forward to Lacombe with the leaf samples from Indian Head.

      i. Noryne Rauhala, Lacombe Research Centre, 6000 C&E Trial, Lacombe, AB T4L 1W1, (ph: 403-302-7329), email: noryne.rauhala@agr.gc.ca

3) **Grain Yield**: Corrected for dockage and to 13.5% seed moisture content

__NOTE:__ All grain quality measurements are to be completed by IHARF staff. Forward a 1 kg (minimum) cleaned subsample for each plot to: Indian Head Research Farm – IHARF, #1 Government Rd, Indian Head, SK, S0G 2K0, Attn: Chris Holzapfel, Phone: 306-695-7761, Email: cholzapfel@iharf.ca

4) **Test Weight:** Standard CGC methodology, two measurement per plot, recorded in g/0.5 l

5) **Kernel Weight**: Count and weigh (to 0.00 g) a minimum of 500 seeds, convert to g/1000 seeds

6) **Percent Plump & Thin Kernels:** Record (to the nearest 0.1 g) the mass of grain from a 200 g cleaned sub-sample that stays on top of (or lodged in) a No. 6 slotted sieve (plump) or passes through a No. 5 slotted sieve (thin)

7) **Percent deoxynivalenol (DON)**: Retain a commercially cleaned (i.e. dockage removed) sub-sample & forward to an accredited lab for DON determination (tentatively 250 g – confirm with lab)
   a. IHARF to retain any leftover grain (approximately 500 g) as a temporary archive, until the project has concluded

Schedule 2 – Results Tables for the 2020-23 Field Trials

Table 1. Specifications for seed used in 2020, 2021, and 2022 field trials. All locations used the same seed source within any given year and the target seeding rate was always 300 viable seeds/m^2.

Variety - Year	Germination	TKW	Target Seeding Rate
	---------- % ----------	----- g/1000 seeds -----	---------- kg/ha ----------
CDC Bow (MS) - 2020	97	51	158
CDC Bow (MS) - 2021	88	52	176
CDC Bow (MS) - 2022	98	47	144
AAC Synergy (I) - 2020	99	52	158
AAC Synergy (I) - 2021	99	47	142
AAC Synergy (I) - 2022	99	47	142
AAC Connect (MR) - 2020	97	52	161
AAC Connect (MR) - 2021	99	56	168
AAC Connect (MR) - 2022	99	48	145

Table 2. Selected agronomic information and dates of operations for barley fusarium head blight management demonstrations completed at three locations in 2020.

Factor / Operation	Indian Head	Yorkton	Melfort
Previous Crop	Canola	Canola	Canola
Pre-Emergent Weed Control	894 g glyphosate/ha (May-14-2020)	None	894 g glyphosate/ha + 50 g saflufenacil/ha (May-24-2020)
Seeding Date	May-14-2020	May-7-2020	May 22-2020
Row Spacing	30 cm	30 cm	30 cm
Fertility (kg N-P_2O_5-K_2O-S/ha)	115-35-18-18	97-34-0-0	31-36-11-6 (high residual N)
Emergence Counts	Jun-4-2020	May-26-2020 (Not all trts counted in Reps 2-4)	Jun-11-2020
In-Crop Herbicides	5 g halauxifen/ha + 77 g fluroxypyr/ha + 371 g MCPA ester/ha + 62 g pinoxaden/ha (Jun-11-2020)	107 g fluroxypyr/ha +74 clopyralid + 415 g MCPA ester/ha (May 29-2020) 62 g pinoxaden/ha (Jun-8-2020)	107 g fluroxypyr/ha +74 clopyralid + 415 g MCPA ester/ha (Jun-23) 62 g pinoxaden/ha (Jul-3-2020)
T1 – Leaf Disease	July 3-2020	Jun-29-2020	July 13-2020
Flag Fungicide Date	Jul-3-2020	Jul-1-2020	Jul-11-2020
T2 – Leaf Disease	n/a	n/a	n/a
Head Fungicide Date	Jul-19-2020	Jul-13-2020	Jul-24-2020
T3 – Leaf Disease	Jul-30-2020	Jul-27-2020	Aug-5-2020
Pre-harvest Herbicide	None	894 g glyphosate/ha [z] (Aug 5-2020)	None
Harvest Date	Aug-19-2020	Aug-20-2020	Sep-28-2020

[z] The decision to apply pre-harvest glyphosate at Yorkton-2020 was due to initial drought followed by wet conditions leading to late emerging tillers and variable crop stage. Swathing was not an option, and we did not feel that diquat would have been effective under the circumstances.

Table 3. Selected agronomic information and dates of operations for barley fusarium head blight management demonstrations completed at four locations in 2021.

Factor / Operation	Indian Head	Yorkton	Melfort	Brandon
Previous Crop	Canola	Canola	Canola	Canola
Pre-Emergent Weed Control	894 g glyphosate/ha (May-11-2021)	None	894 g glyphosate/ha + 50 g saflufenacil/ha (May-14-2021)	None
Seeding Date	May-8-2021	May-13-2021	May 10-2021	May 3-2021
Row Spacing	30 cm	30 cm	30 cm	22 cm
Fertility (kg N-P_2O_5-K_2O-S/ha)	115-35-18-18	67-34-0-0 (high residual N)	82-45-11-8	110-36-0-0
Emergence Counts	Jun-8-2021	Jun-4-2021	Jun-4-2021	Jun-3-2021
In-Crop Herbicides	129 g fluroxypyr/ha + 90 g clopyralid/ha + 503 g MCPA ester + 62 g pinoxaden/ha (Jun-13-2021)	129 g fluroxypyr/ha + 90 g clopyralid/ha + 503 g MCPA ester (Jun-7-2021) 62 g pinoxaden/ha (Jun-13-2021)	62 g pinoxaden/ha (Jun-22-2022) 129 g fluroxypyr/ha + 90 g clopyralid/ha + 503 g MCPA ester (Jun-8-2021)	280 g bromoxynil/ha + 280 g MCPA ester/ha + 198 g tralkoxydim/ha (Jun-2-2021)
T1 - Leaf Disease	July 2-2021	Jun-24	Jun-30-2021	Jun-17-2021
Flag Fungicide Date	Jul-2-2021	Jun-28-2021	Jul-5-2021	Jun-17-2021
T2 – Leaf Disease	n/a	n/a	n/a	n/a
Head Fungicide Date	Jul-16-2021	Jul-14-2021	Jul-13-2022	Jul-5-2022
T3 – Leaf Disease	Jul-26-2021	Jul-21-2021	Jul-26-2021	Jul-13-2021
Pre-harvest Herbicide	None	None	None	None
Harvest Date	Aug-28-2021	Aug-27-2021	Aug-26-2021	Aug-18-2021

Table 4. Selected agronomic information and dates of operations for barley fusarium head blight management demonstrations completed at four locations in 2022.

Factor / Operation	Indian Head	Yorkton	Melfort	Brandon
Previous Crop	Canola	Canola	Canola	Canola
Pre-Emergent Weed Control	894 g glyphosate/ha (May-24-2022)	None	1422 g triallate/ha (May-12-2022) + 894 g glyphosate/ha (May-21-22)	None
Seeding Date	May-27-2022	May-12-2022	May 23-2022	May 25-2022
Row Spacing	30 cm	30 cm	30 cm	22 cm
Fertility (kg N-P_2O_5-K_2O-S/ha)	115-35-18-18	74-32-0-0 (high residual N)	22-49-19-0 (high residual N)	103-36-0-0
Emergence Counts	Jun-20-2022	Jun-1-2022	Jun-13-2022	Jun-7-2022
In-Crop Herbicides	5 g halauxifen + 77 g fluroxypyr + 348 g MCPA Ester + 62g pinoxaden/ha (Jun-23-2022)	129 g fluroxypyr/ha + 90 g clopyralid/ha + 503 g MCPA ester (Jun-6-2022) 62 g pinoxaden/ha (Jun-8-2022)	129 g fluroxypyr/ha + 90 g clopyralid/ha + 503 g MCPA ester (Jun-28-2022) 62 g pinoxaden/ha (Jun-22-2022)	280 g bromoxynil/ha + 280 g MCPA ester/ha + 198 g tralkoxydim/ha (Jun-10-2022)
T1 – Leaf Disease	July 8-2022	Jul-3-2022	Jul-8-2022	Jul-5-2022
Flag Fungicide Date	Jul-10-2022	Jul-4-2022	Jul-8-2022	Jul-6-2022
T2 – Leaf Disease	Jul-21-2022	Jul-19-2022	n/a	July 12-2022
Head Fungicide Date	Jul-22-2022	Jul-20-2022	Jul-18-2022	Jul-12-2022
T3 – Leaf Disease	Aug-8-2022	Aug-3-2022	Aug-2-2022	Jul-28-2022
Pre-harvest Herbicide	None	None	None	None
Harvest Date	Sep-17-2022	Aug-30-2022	Sep-8-2022	Aug-23-2022

Table 5. Mean monthly temperatures along with the long-term (1981-2010) averages for the 2020-22 growing seasons at Brandon (2021-22 only) Indian Head, Melfort, and Yorkton.

Location	Year	May	June	July	August	Average
		---------- Mean Temperature (°C) ----------				
Brandon	2021	9.9	18.8	20.5	17.5	16.7 (+1.3)
	2022	10.2	16.6	19.5	19.2	16.4 (0.0)
	Long-term	11.4	16.6	19.2	18.2	16.4
Indian Head	2020	10.7	15.6	18.4	17.9	15.7 (+0.1)
	2021	9.0	17.7	20.3	17.1	16.0 (+0.4)
	2022	10.9	16.1	18.1	18.3	15.9 (+0.3)
	Long-term	10.8	15.8	18.2	17.4	15.6
Melfort	2020	10.1	14.3	18.2	17.6	15.1 (-0.1)
	2021	9.6	18.2	20.1	16.9	16.2 (+1.0)
	2022	9.8	15.2	18.2	18.7	15.5 (+0.3)
	Long-term	10.7	15.9	17.5	16.8	15.2
Yorkton	2020	10.5	16.4	19.9	18.3	16.3 (+1.1)
	2021	8.9	19.1	21	17.3	16.6 (+1.4)
	2022	10.6	15.7	18.6	18.9	16.0 (+0.8)
	Long-term	10.4	15.5	17.9	17.1	15.2

Table 6. Mean monthly precipitation along with the long-term (1981-2010) averages for the 2020-22 growing seasons at Brandon (2021-22 only) Indian Head, Melfort, and Yorkton.

Location	Year	May	June	July	August	Total
		---------- Cumulative Precipitation (mm) ----------				
Brandon	2021	25.8	101.2	0.2	156.8	284 (105%)
	2022	102.6	66.2	76.9	27.0	273 (101%)
	Long-term	56.5	79.6	68.2	65.5	270
Indian Head	2020	27.3	23.5	37.7	24.9	113 (46%)
	2021	81.6	62.9	51.2	99.4	295 (121%)
	2022	97.7	27.5	114.5	45.9	286 (117%)
	Long-term	51.7	77.4	63.8	51.2	244
Melfort	2020	26.7	103.7	52.4	18.5	201 (89%)
	2021	31.4	37.6	0.2	69.3	138 (61%)
	2022	90.8	78.1	34.9	37.5	241 (107%)
	Long-term	42.9	54.3	76.7	52.4	226
Yorkton	2020	16.7	33.6	80.1	49.3	180 (66%)
	2021	24.6	18.1	35.2	69.7	148 (54%)
	2022	137.9	57.9	38.4	90.8	325 (120%)
	Long-term	51.3	80.1	78.2	62.2	272

Table 7. Overall tests of fixed effects for variety (VAR), fungicide (FUNG), and VAR x FUNG for selected barley response variables at 11 location-years. P-values less than or equal to 0.05 indicate that an effect was significant for the corresponding response variable. P-values below 0.1 are also worth noting.

Source	BR-21	BR-22	IH-20	IH-21	IH-22	ME-20[Y]	ME-21	ME-22	YK-20[Z]	YK-21	YK-22
	Emergence (p-values)										
Variety (VAR)	0.003	0.775	<0.001	<0.001	0.091	0.239	0.003	0.401	0.830	<0.001	0.155
	Yield (p-values)										
Variety (VAR)	<0.001	<0.001	<0.001	<0.001	0.058	0.214	0.001	0.624	0.010	0.036	0.109
Fungicide (FUNG)	0.864	0.029	0.144	0.373	<0.001	0.759	0.715	0.156	0.250	0.945	0.448
VAR x FUNG	0.616	0.088	0.746	0.512	0.147	0.964	0.020	0.206	0.504	0.655	0.015
	Test Weight (p-values)										
Variety (VAR)	0.460	<0.001	<0.001	<0.001	<0.001	0.002	0.001	0.001	0.005	<0.001	0.019
Fungicide (FUNG)	0.682	0.206	0.258	0.003	<0.001	0.957	0.307	0.158	0.187	0.625	<0.001
VAR x FUNG	0.560	0.053	0.657	0.212	0.416	0.974	0.894	0.712	0.387	0.257	0.004
	Thousand Kernel Weight (p-values)										
Variety (VAR)	0.053	0.617	<0.001	0.775	<0.001	0.005	0.115	<0.001	<0.001	0.040	<0.001
Fungicide (FUNG)	0.918	0.173	0.099	0.131	<0.001	0.436	0.585	0.312	0.045	0.581	<0.001
VAR x FUNG	0.379	0.769	0.258	0.889	0.547	0.841	0.757	0.655	0.483	0.596	0.022
	Plump Kernels (p-values)										
Variety (VAR)	<0.001	<0.001	0.113	0.357	<0.001	0.976	0.210	0.006	0.136	0.002	<0.001
Fungicide (FUNG)	0.594	0.283	0.626	0.178	<0.001	0.413	0.214	0.300	0.841	0.139	0.019
VAR x FUNG	0.329	0.533	0.487	0.851	0.099	0.805	0.762	0.115	0.725	0.482	0.162
	Thin Kernels (p-values)										
Variety (VAR)	0.006	<0.001	0.034	0.001	<0.001	0.355	0.754	0.085	0.594	0.026	<0.002
Fungicide (FUNG)	0.535	0.035	0.339	0.972	0.010	0.689	0.265	0.362	0.733	0.050	0.004
VAR x FUNG	0.240	0.017	0.831	0.805	0.008	0.409	0.592	0.358	0.862	0.333	0.094
	Deoxynivalenol (p-values)[X]										
Variety (VAR)	–	0.878	0.559	–	0.394	0.819	–	0.047	0.650	–	0.274
Fungicide (FUNG)	–	0.533	0.642	–	<0.001	0.343	–	0.275	0.483	–	<0.001
VAR x FUNG	–	0.683	0.082	–	0.427	0.802	–	0.009	0.046	–	0.826

[Z] Emergence data not collected for all plots at YK-20; [Y] Ten (of 48) plots had to be discarded at ME-20 due to damage caused by spray drift

[X] DON was undetectable in all samples at all sites in 2021 and is not yet available for IH-22

Table 8. Main effect means for variety main effects on barley plant density at 11 sites in 2020-22. The target seed rate for all varieties was 300 viable seeds/m^2. Main effect means within a site followed by the same letter do not significantly differ (Tukey, P < 0.05).

Main Effect	BR-21	BR-22	IH-20	IH-21	IH-22	ME-20[Y]	ME-21	ME-22	YK-20[Z]	YK-21	YK-22
Variety	---------- Emergence (plants/m^2) ----------										
Bow (MS)	127 B	183 A	222 A	134 B	192 A	231 A	199 B	191 A	207 B	207 B	244 A
Synergy (I)	159 A	187 A	195 B	161 A	215 A	214 A	221 AB	212 A	239 A	239 A	240 A
Connect (MR)	149 A	184 A	218 A	184 A	204 A	217 A	234 A	203 A	253 A	253 A	226 A
S.E.M.	6.2	5.4	6.7	7.5	7.2	10.1	7.8 [Z]	11.6	4.71	5.1	8.8

[Z] Emergence data not collected for all plots at Yorkton; [Y] Overall average S.E.M. (values for individual treatments varied due to missing plots)

Table 9. Main effect means for variety and fungicide main effects on barley grain yield at 11 sites in 2020-22. Main effect means within a site followed by the same letter do not significantly differ (Tukey, P < 0.05).

Main Effect	BR-21	BR-22	IH-20	IH-21	IH-22	ME-20	ME-21	ME-22	YK-20	YK-21	YK-22
Variety	---------- Grain Yield (kg/ha) ----------										
Bow (MS)	3950 B	5863 C	4986 B	3156 B	6968 A	3394 A	2000 B	4166 A	2610 B	1948 A	5914 A
Synergy (I)	5653 A	6601 A	5609 A	3965 A	6917 A	3691 A	2728 A	4402 A	3074 A	1733 AB	6123 A
Connect (MR)	5288 A	6345 B	5429 A	3954 A	6751 A	3630 A	2484 A	4368 A	2624 B	1207 B	5795 A
S.E.M.	141.7	80.7 [Z]	123.9	120.6	84.1	138.0 [Z]	226.8 [Z]	239.8	124.7	252.3	150.9
Fungicide											
Untreated	4986 A	6139 B	5378 A	3635 A	6584 B	3487 A	2553 A	4094 A	2744 A	1636 A	5772 A
Flag	4895 A	6226 AB	5444 A	3720 A	6925 A	3691 A	2340 A	4728 A	2998 A	1575 A	6004 A
Head	4920 A	6307 AB	5258 A	3735 A	6997 A	3604 A	2382 A	4131 A	2647 A	1741 A	6036 A
Dual	5054 A	6406 A	5286 A	3677 A	7009 A	3505 A	2340 A	4294 A	2688 A	1564 A	5965 A
S.E.M.	158.8	86.3 [Z]	127.7	122.6	92.0	155.0 [Z]	239.1 [Z]	262.4	140.9	277.1	163.2

[Z] Overall average S.E.M. (values for individual treatments varied due to missing plots)

Table 10. Individual variety by fungicide treatment means for barley grain yield at 11 sites in 2020-22. Means within a site followed by the same letter do not significantly differ (Tukey, P < 0.05).

Main Effect	BR-21	BR-22	IH-20	IH-21	IH-22	ME-20	ME-21	ME-22	YK-20	YK-21	YK-22
Variety - Fung	Grain Yield (kg/ha)										
MS – untr	3960 CD	5848 de	4989 bcd	3015 B	6459 c	3203 a	2252 ab	4119 a	2800 ab	1763 a	5224 a
MS – flag	3749 D	5907 cde	5188 a-d	3194 B	6964 abc	3569 a	2112 ab	4241 a	2692 ab	1668 a	6222 a
MS – head	4235 BCD	5690 e	4830 d	3251 B	7108 ab	3438 a	1463 b	4115 a	2459 b	2066 a	6128 a
MS – dual	3855 CD	6008 cde	4938 cd	3165 B	7342 a	3365 a	2172 ab	4187 a	2489 b	2294 a	6083 a
I – untr	5767 A	6330 a-d	5682 a	3984 A	6741 abc	3772 a	3183 a	4175 a	2900 ab	1644 a	5898 a
I – flag	5575 A	6470 ab	5662 a	3979 A	6936 abc	3625 a	2484 ab	5399 a	3629 a	1987 a	6212 a
I – head	5490 A	6769 a	5611 a	4025 A	7036 abc	3749 a	3123 a	3595 a	2849 ab	1665 a	6111 a
I – dual	5780 A	6834 a	5481 ab	3871 A	6954 abc	3618 a	2121 ab	4436 a	2920 ab	1635 a	6273 a
MR – untr	5231 A	6240 bcd	5464 abc	3906 A	6552 bc	3484 a	2225 ab	3988 a	2533 ab	1501 a	6193 a
MR – flag	5362 A	6300 a-d	5483 ab	3987 A	6875 abc	3879 a	2425 ab	4543 a	2674 ab	1070 a	5578 a
MR – head	5035 ABC	6463 abc	5333 a-d	3930 A	6847 abc	3624 a	2559 ab	4682 a	2633 ab	1493 a	5869 a
MR – dual	5525 A	6377 abc	5439 abc	3994 A	6729 abc	3532 a	2727 ab	4260 a	2656 ab	763 a	5540 a
S.E.M.	257.5	122.5 [z]	154.7	137.2	139.6	250.4 [z]	320.9 [z]	399.6	233.2	426.5	240.1

[z] Overall average S.E.M. (values for individual treatments varied due to missing plots)

Table 11. Main effect means for variety and fungicide main effects on barley test weight at 11 sites in 2020-22. Main effect means within a site followed by the same letter do not significantly differ (Tukey, P < 0.05).

Main Effect	BR-21	BR-22	IH-20	IH-21	IH-22	ME-20	ME-21	ME-22	YK-20	YK-21	YK-22
Variety	---------- Test Weight (g/0.5 l) ----------										
Bow (MS)	302.1 A	320.4 A	324.6 B	287.9 B	318.5 A	334.2 B	310.8 B	316.6 B	326.7 B	271.5 B	297.8 B
Synergy (I)	303.8 A	320.1 A	328.5 A	296.6 A	319.9 A	336.2 A	315.7 A	320.0 A	329.1 A	280.0 A	299.1 AB
Connect (MR)	302.7 A	315.6 B	326.4 A	289.1 B	315.6 B	333.4 B	313.1 AB	318.7 A	327.9 AB	273.3 B	302.4 A
S.E.M.	1.00	0.84	0.50	0.61	0.93	0.62 [Z]	0.88 [Z]	1.06	0.50	0.94 [Z]	1.73
Fungicide											
Untreated	302.0 A	317.7 A	325.8 A	290.0 B	316.2 B	334.3 A	312.2 A	317.5 A	326.9 A	275.8 A	296.7 B
Flag	302.2 A	319.9 A	326.7 A	291.5 AB	316.7 B	334.8 A	314.6 A	319.7 A	328.3 A	274.0 A	296.7 B
Head	303.7 A	317.5 A	326.7 A	290.8 B	319.9 A	334.7 A	312.4 A	318.1 A	327.9 A	274.9 A	305.9 A
Dual	303.3 A	319.6 A	327.5 A	292.5 A	319.2 A	334.6 A	313.5 A	318.4	328.6 A	275.0 A	299.7 B
S.E.M.	1.16	0.97	0.58	0.65	0.97	0.68 [Z]	1.01 [Z]	1.11	0.58	1.05 [Z]	1.84

[Z] Overall average S.E.M. (values for individual treatments varied due to missing plots)

Table 12. Individual variety by fungicide treatment means for barley test weight at 11 sites in 2020-22. Means within a site followed by the same letter do not significantly differ (Tukey, P < 0.05).

Main Effect	BR-21	BR-22	IH-20	IH-21	IH-22	ME-20	ME-21	ME-22	YK-20	YK-21	YK-22
Variety - Fung	Test Weight (g/0.5 l)										
MS – untr	301.6 a	319.3 ab	323.5 b	287.7 c	315.8 bcd	334.3 a	310.8 a	315.7 b	326.9 a	273.1 bcd	291.4 d
MS – flag	298.9 a	323.1 a	325.7 ab	287.8 c	316.1 bcd	334.6 a	311.7 a	317.4 ab	325.8 a	271.7 cd	299.8 a-d
MS – head	304.7 a	318.4 ab	324.4 b	287. 8 c	321.3 a	334.2 a	310.1 a	316.1 ab	326.1 a	269.7 d	303.4 abc
MS – dual	303.0 a	320.7 a	324.9 ab	288.3 c	320.7 ab	333.8 a	310.5 a	317.1 ab	327.7 a	271.6 d	296.6 bcd
I – untr	303.8 a	318.4 ab	328.3 ab	294.4 b	318.7 a-d	335.6 a	314.5 a	319.6 ab	327.4 a	279.3 abc	294.0 bcd
I – flag	303.8 a	318.4 ab	328.4 ab	297.3 ab	319.3 abc	336.7 a	317.7 a	321.7 a	330.7 a	281.3 a	293.7 cd
I – head	302.9 a	322.8 a	328.1 ab	295.6 ab	321.2 a	336.4 a	315.6 a	318.5 ab	328.8 a	280.1 ab	305.0 ab
I – dual	304.7 a	320.8 a	329.4 a	299.1 a	320.3 ab	336.0 a	315.1 a	320.3 ab	329.7 a	279.6 ab	304.0 abc
MR – untr	300.7 a	315.6 ab	325.5 ab	287.8 c	314.0 d	333.0 a	311.3 a	317.2 ab	326.3 a	275.2 a-d	304.7 abc
MR – flag	304.0 a	318.0 ab	326.0 ab	289.6 c	314.7 cd	333.0 a	314.4 a	320.0 ab	328.5 a	269.2 d	296.7 bcd
MR – head	303.6 a	311.4 b	327.8 ab	289.0 c	317.2 a-d	333.5 a	311.6 a	319.7 ab	328.6 a	274.9 a-d	309.5 a
MR – dual	302.3 a	317.3 ab	328.1 ab	290.1 c	316.5 a-d	333.9 a	314.4 a	317.8 ab	328.3 a	274.0 a-d	298.6 a-d
S.E.M.	2.00	1.68	1.01	0.91	1.26	1.03[Z]	1.75 [Z]	1.47	0.99	1.67 [Z]	2.60

[Z] Overall average S.E.M. (values for individual treatments varied due to missing plots)

Table 13. Main effect means for variety and fungicide main effects on barley kernel weight at 11 sites in 2020-22. Main effect means within a site followed by the same letter do not significantly differ (Tukey, P < 0.05).

Main Effect	BR-21	BR-22	IH-20	IH-21	IH-22	ME-20	ME-21	ME-22	YK-20	YK-21	YK-22
Variety	---------- Kernel Weight (g/1000 seeds) ----------										
Bow (MS)	47.0 A	47.1 A	47.8 B	45.1 A	45.7 A	44.8 B	45.5 A	47.0 B	48.7 B	42.1 A	42.2 A
Synergy (I)	45.6 A	46.6 A	49.1 A	45.0 A	47.3 A	46.3 A	45.2 A	47.0 B	49.7 A	40.6 AB	40.6 B
Connect (MR)	46.7 A	46.8 A	49.3 A	45.1 A	47.6 A	46.1 A	46.2 A	49.3 A	49.9 A	39.2 B	42.8 A
S.E.M.	0.39	0.40	0.16	0.17	0.25	0.41 [Z]	0.35 [Z]	0.38	0.19	1.19	0.38
Fungicide											
Untreated	46.3 A	46.1 A	48.4 A	44.8 A	46.3 B	45.9 A	45.3 A	47.3 A	49.0 A	40.9 A	41.0 B
Flag	46.3 A	47.6 A	49.1 A	45.1 A	46.6 B	45.7 A	45.9 A	48.1 A	49.8 A	40.6 A	40.9 B
Head	46.4 A	46.8 A	48.7 A	44.9 A	47.6 A	46.0 A	45.6 A	47.8 A	49.2 A	41.4 A	43.4 A
Dual	46.7 A	46.7 A	48.8 A	45.4 A	47.0 AB	45.9 A	45.9 A	47.8 A	49.7 A	39.7 A	42.2 AB
S.E.M.	0.45	0.46	0.18	0.19	0.27	0.45 [Z]	0.40 [Z]	0.39	0.22	1.28	0.43

[Z] Overall average S.E.M. (values for individual treatments varied due to missing plots)

Table 14. Individual variety by fungicide treatment means for barley kernel weight at 11 sites in 2020-22. Means within a site followed by the same letter do not significantly differ (Tukey, P < 0.05).

Main Effect	BR-21	BR-22	IH-20	IH-21	IH-22	ME-20	ME-21	ME-22	YK-20	YK-21	YK-22
Variety - Fung	---------- Kernel Weight (g/1000 seeds) ----------										
MS – untr	47.0 a	46.8 a	47.3 c	44.8 a	44.8 d	44.7 a	45.2 a	46.4 c	48.6 b	41.4 a	40.3 bcd
MS – flag	46.0 a	47.7 a	48.1 bc	44.9 a	45.2 cd	44.5 a	45.0 a	47.1 bc	49.0 ab	43.3 a	42.2 abc
MS – head	47.6 a	46.4 a	48.1 bc	45.1 a	46.6 a-d	44.9 a	45.4 a	47.1 bc	48.6 b	41.8 a	43.8 a
MS – dual	47.4 a	47.5 a	47.9 bc	45.4 a	46.3 bcd	45.3 a	46.3 a	47.2 abc	48.8 ab	41.9 a	42.4 abc
I – untr	45.6 a	46.0 a	48.9 ab	44.6 a	46.8 abc	45.4 a	44.8 a	46.6 c	49.0 ab	40.6 a	39.6 cd
I – flag	45.5 a	47.1 a	49.7 a	45.0 a	47.3 ab	46.6 a	45.8 a	47.8 abc	50.5 a	41.4 a	38.6 d
I – head	44.7 a	47.1 a	48.5 abc	44.7 a	47.8 ab	46.6 a	45.3 a	46.4 c	49.2 ab	41.7 a	42.1 abc
I – dual	46.7 a	46.0 a	49.2 ab	45.6 a	47.5 ab	46.5 a	45.0 a	47.2 abc	49.9 ab	38.8 a	42.2 abc
MR – untr	46.4 a	45.6 a	48.9 ab	44.9 a	47.2 ab	45.8 a	45.8 a	48.9 abc	49.3 ab	40.6 a	43.2 ab
MR – flag	47.5 a	48.0 a	49.4 ab	45.4 a	47.4 ab	46.7 a	46.8 a	49.5 ab	49.9 ab	37.7 a	41.9 a-d
MR – head	46.8 a	47.0 a	49.6 ab	45.0 a	48.4 a	45.7 a	45.7 a	49.8 a	49.9 ab	40.7 a	44.3 a
MR – dual	46.1 a	46.6 a	49.2 ab	45.3 a	47.4 ab	46.3 a	46.3 a	49.0 abc	50.3 ab	38.2 a	42.0 abc
S.E.M.	0.79	0.80	0.31	0.33	0.40	0.66 [Z]	0.66 [Z]	0.59	0.38	1.80	0.69

[Z] Overall average S.E.M. (values for individual treatments varied due to missing plots)

Table 15. Main effect means for variety and fungicide main effects on percent plump barley kernels at 11 sites in 2020-22. Main effect means within a site followed by the same letter do not significantly differ (Tukey, P < 0.05).

Main Effect	BR-21	BR-22	IH-20	IH-21	IH-22	ME-20	ME-21	ME-22	YK-20	YK-21	YK-22
Variety	---------- Plump Kernels (%) ----------										
Bow (MS)	97.0 A	96.0 A	97.0 A	98.5 A	95.3 A	97.8 A	98.3 A	95.4 B	99.0 A	98.2 A	91.0 A
Synergy (I)	95.1 B	96.5 A	97.5 A	98.6 A	93.5 B	97.8 A	98.0 A	96.4 A	99.2 A	95.3 A	85.6 B
Connect (MR)	93.3 C	94.3 B	96.7 A	98.4 A	92.4 C	97.9 A	98.0 A	96.2 A	98.9 A	94.9 A	84.7 B
S.E.M.	0.45	0.36	0.27	0.14	0.23	0.30 [Z]	0.22 [Z]	0.22	0.16	0.94	1.06
Fungicide											
Untreated	95.2 A	95.1 A	96.8 A	98.3 A	92.9 B	97.4 A	98.1 A	95.9 A	98.9 A	96.9 A	86.0 AB
Flag	95.5 A	96.0 A	97.1 A	98.5 A	93.5 AB	98.2 A	98.3 A	96.4 A	99.0 A	95.4 A	84.9 B
Head	94.5 A	95.6 A	97.2 A	98.6 A	94.3 A	97.9 A	97.8 A	95.7 A	99.0 A	97.2 A	89.9 A
Dual	95.3 A	95.8 A	97.3 A	98.6 A	94.1 A	97.9 A	98.8 A	95.9 A	99.1 A	95.1 A	87.4 AB
S.E.M.	0.52	0.40	0.31	0.15	0.26	0.33 [Z]	0.24 [Z]	0.30	0.16	1.02	1.19

[Z] Overall average S.E.M. (values for individual treatments varied due to missing plots)

Table 16. Individual variety by fungicide treatment means for percent plump barley kernels at 11 sites in 2020-22. Means within a site followed by the same letter do not significantly differ (Tukey, P < 0.05).

Main Effect	BR-21	BR-22	IH-20	IH-21	IH-22	ME-20	ME-21	ME-22	YK-20	YK-21	YK-22
Variety - Fung	---------- Plump Kernels (%) ----------										
MS – untr	96.8 ab	95.5 ab	96.6 a	98.2 a	90.9 e	97.6 a	98.6 a	95.1 a	98.8 a	97.7 a	89.7 abc
MS – flag	96.7 ab	96.8 a	96.4 a	98.4 a	91.8 de	98.2 a	98.7 a	95.4 a	99.1 a	98.2 a	90.4 ab
MS – head	97.4 a	95.3 ab	97.0 a	98.7 a	93.6 a-d	97.8 a	97.8 a	95.9 a	99.0 a	98.7 a	93.3 a
MS – dual	96.9 ab	96.2 a	98.0 a	98.6 a	93.4 abc	97.7 a	98.7 a	95.2 a	98.9 a	98.2 a	90.5 ab
I – untr	95.8 ab	96.5 a	97.2 a	98.5 a	94.7 abc	96.9 a	97.9 a	96.7 a	99.1 a	96.4 a	83.5 bc
I – flag	95.4 ab	96.5 a	97.9 a	98.6 a	95.6 a	97.8 a	98.1 a	96.8 a	99.2 a	95.6 a	80.9 c
I – head	93.1 ab	96.7 a	97.8 a	98.6 a	95.4 ab	98.2 a	97.9 a	95.4 a	99.3 a	96.1 a	88.3 abc
I – dual	96.1 ab	96.4 a	97.2 a	98.6 a	95.4 cd	98.2 a	97.9 a	96.8 a	99.1 a	93.3 a	89.6 abc
MR – untr	92.9 b	93.3 b	96.5 a	98.2 a	93.0 cd	97.6 a	97.9 a	96.0 a	98.9 a	96.7 a	85.0 abc
MR – flag	94.4 ab	94.7 ab	96.9 a	98.5 a	93.2 cd	98.4 a	98.3 a	97.1 a	98.8 a	92.6 a	83.6 bc
MR – head	93.0 ab	94.7 ab	96.8 a	98.4 a	94.0 abc	97.7 a	97.6 a	95.9 a	98.8 a	96.6 a	88.2 abc
MR – dual	92.8 b	94.7 ab	96.8 a	98.5 a	93.7 a-d	97.8 a	98.2 a	95.8 a	99.1 a	93.7 a	82.2 bc
S.E.M.	0.91	0.60	0.54	0.20	0.43	0.53 [Z]	0.36 [Z]	0.47	0.22	1.47	1.96

[Z] Overall average S.E.M. (values for individual treatments varied due to missing plots)

Table 17. Main effect means for variety and fungicide main effects on percent THIN barley kernels at 11 sites in 2020-22. Main effect means within a site followed by the same letter do not significantly differ (Tukey, P < 0.05).

Main Effect	BR-21	BR-22	IH-20	IH-21	IH-22	ME-20	ME-21	ME-22	YK-20	YK-21	YK-22
Variety	---------- Thin Kernels (%) ----------										
Bow (MS)	0.3 B	0.6 B	0.3 AB	0.1 A	0.7 A	0.3	0.2 A	0.5 A	0.1 A	0.2 B	1.0 B
Synergy (I)	0.3 B	0.4 C	0.2 B	0.1 B	0.4 B	0.3	0.2 A	0.4 A	0.1 A	0.3 AB	1.6 A
Connect (MR)	0.5 A	0.8 A	0.3 A	0.1 B	0.6 A	0.3	0.2 A	0.4 A	0.1 A	0.3 A	1.7 A
S.E.M.	0.04	0.06	0.03	0.01	0.05	0.06 [Z]	0.03 [Z]	0.04	0.01	0.04	0.12
Fungicide											
Untreated	0.4 A	0.7 A	0.3 A	0.1 A	0.7 A	0.3	0.2 A	0.5 A	0.1 A	0.2 A	1.5 A
Flag	0.3 A	0.5 B	0.3 A	0.1 A	0.6 AB	0.3	0.2 A	0.4 A	0.1 A	0.3 A	1.8 A
Head	0.3 A	0.6 AB	0.2 A	0.1 A	0.5 AB	0.3	0.2 A	0.4 A	0.1 A	0.2 A	1.0 B
Dual	0.4 A	0.6 AB	0.3 A	0.1 A	0.5 B	0.3	0.1 A	0.4 A	0.1 A	0.3 A	1.4 AB
S.E.M.	0.05	0.07	0.030	0.02	0.05	0.07 [Z]	0.03 [Z]	0.05	0.01	0.04	0.14

[Z] Overall average S.E.M. (values for individual treatments varied due to missing plots)

Table 18. Individual variety by fungicide treatment means for percent thin barley kernels at 11 sites in 2020-22. Means within a site followed by the same letter do not significantly differ (Tukey, P < 0.05).

Main Effect	BR-21	BR-22	IH-20	IH-21	IH-22	ME-20	ME-21	ME-22	YK-20	YK-21	YK-22
Variety - Fung	---------- Thin Kernels (%) ----------										
MS – untr	0.4 a	0.9 ab	0.3 a	0.1 a	1.0 a	0.2 a	0.2 a	0.6 a	0.1 a	0.2 a	1.1 bc
MS – flag	0.3 a	0.4 de	0.3 a	0.1 a	0.7 ab	0.2 a	0.2 a	0.5 a	0.1 a	0.2 a	1.0 bc
MS – head	0.2 a	0.7 a-e	0.2 a	0.1 a	0.4 b	0.3 a	0.3 a	0.4 a	0.1 a	0.2 a	0.8 c
MS – dual	0.4 a	0.5 b-e	0.2 a	0.1 a	0.5 b	0.3 a	0.1 a	0.5 a	0.1 a	0.2 a	1.0 bc
I – untr	0.2 a	0.4 de	0.2 a	0.1 a	0.4 b	0.5 a	0.2 a	0.3 a	0.1 a	0.2 a	1.9 abc
I – flag	0.3 a	0.5 cde	0.2 a	0.1 a	0.4 b	0.4 a	0.2 a	0.3 a	0.1 a	0.3 a	2.3 a
I – head	0.4 a	0.3 e	0.2 a	0.1 a	0.4 b	0.3 a	0.1 a	0.4 a	0.1 a	0.2 a	1.1 bc
I – dual	0.3 a	0.5 b-e	0.2 a	0.1 a	0.4 b	0.2 a	0.2 a	0.3 a	0.1 a	0.4 a	1.1 bc
MR – untr	0.6 a	0.8 abc	0.4 a	0.1 a	0.6 b	0.3 a	0.2 a	0.5 a	0.1 a	0.2 a	1.7 abc
MR – flag	0.4 a	0.7 a-d	0.3 a	0.1 a	0.6 b	0.2 a	0.1 a	0.3 a	0.1 a	0.4 a	2.0 ab
MR – head	0.3 a	0.9 a	0.3 a	0.1 a	0.6 b	0.3 a	0.2 a	0.5 a	0.1 a	0.2 a	1.2 abc
MR – dual	0.6 a	0.7 a-d	0.3 a	0.1 a	0.6 b	0.3 a	0.2 a	0.4 a	0.1 a	0.3 a	2.0 ab
S.E.M.	0.09	0.10	0.05	0.02	0.08	0.09 [Z]	0.05 [Z]	0.08	0.02	0.06	0.24

[Z] Overall average S.E.M. (values for individual treatments varied due to missing plots)

Table 19. Main effect means for variety and fungicide main effects on deoxynivalenol (DON) content at 11 sites in 2020-22. DON was measured in parts per million to two decimal places. Main effect means within a site followed by the same letter do not significantly differ (Tukey, P < 0.05).

Main Effect	BR-21	BR-22	IH-20	IH-21	IH-22	ME-20	ME-21	ME-22	YK-20	YK-21	YK-22
Variety	---------- Deoxynivalenol - DON (ppm) ----------										
Bow (MS)	Nil	0.40 A	0.06 A	Nil	1.27 A	0.11 A	Nil	0.56 A	0.01 A	Nil	0.14 A
Synergy (I)	Nil	0.41 A	0.06 A	Nil	1.42 A	0.10 A	Nil	0.53 AB	0.00 A	Nil	0.14 A
Connect (MR)	Nil	0.41 A	0.03 A	Nil	1.30 A	0.08 A	Nil	0.48 B	0.00 A	Nil	0.08 A
S.E.M.	–	0.023	0.026	–	0.113	0.031	–	0.030	0.004	–	0.037
Fungicide											
Untreated	Nil	0.40 A	0.06 A	Nil	1.64 A	0.12 A	Nil	0.49 A	0.01 A	Nil	0.19 A
Flag	Nil	0.42 A	0.06 A	Nil	1.62 A	0.08 A	Nil	0.56 A	0.01 A	Nil	0.18 A
Head	Nil	0.41 A	0.02 A	Nil	1.06 B	0.13 A	Nil	0.53 A	0.00 A	Nil	0.04 B
Dual	Nil	0.38 A	0.05 A	Nil	1.01 B	0.05 A	Nil	0.51 A	0.00 A	Nil	0.07 B
S.E.M.	–	0.025	0.028	–	0.122	0.035 [Z]	–	0.032	0.005	–	0.040

[Z] Overall average S.E.M. (values for individual treatments varied due to missing plots)

Table 20. Individual variety by fungicide treatment means for deoxynivalenol (DON) content at 11 sites in 2020-22. DON was measured in parts per million to two decimal places. Means within a site followed by the same letter do not significantly differ (Tukey, P < 0.05).

Main Effect	BR-21	BR-22	IH-20	IH-21	IH-22	ME-20	ME-21	ME-22	YK-20	YK-21	YK-22
Variety - Fung	---------- Deoxynivalenol - DON (ppm) ----------										
MS – untr	Nil	0.40 a	0.14 a	Nil	1.59 ab	0.09 a	Nil	0.51 ab	0.03 a	Nil	0.20 a
MS – flag	Nil	0.43 a	0.04 a	Nil	1.46 ab	0.10 a	Nil	0.54 ab	0.00 a	Nil	0.18 a
MS – head	Nil	0.38 a	0.03 a	Nil	1.03 ab	0.16 a	Nil	0.60 ab	0.00 a	Nil	0.07 a
MS – dual	Nil	0.39 a	0.01 a	Nil	1.03 ab	0.09 a	Nil	0.57 ab	0.00 a	Nil	0.10 a
I – untr	Nil	0.43 a	0.04 a	Nil	1.82 a	0.18 a	Nil	0.49 ab	0.00 a	Nil	0.22 a
I – flag	Nil	0.39 a	0.03 a	Nil	1.64 ab	0.07 a	Nil	0.69 a	0.00 a	Nil	0.25 a
I – head	Nil	0.43 a	0.03 a	Nil	1.30 ab	0.14 a	Nil	0.46 b	0.01 a	Nil	0.01 a
I – dual	Nil	0.39 a	0.13 a	Nil	0.93 b	0.01 a	Nil	0.47 b	0.01 a	Nil	0.07 a
MR – untr	Nil	0.39 a	0.00 a	Nil	1.52 ab	0.11 a	Nil	0.47 b	0.00 a	Nil	0.15 a
MR – flag	Nil	0.45 a	0.11 a	Nil	1.76 a	0.07 a	Nil	0.44 b	0.02 a	Nil	0.13 a
MR – head	Nil	0.44 a	0.00 a	Nil	0.84 b	0.08 a	Nil	0.53 ab	0.00 a	Nil	0.03 a
MR – dual	Nil	0.36	0.00 a	Nil	1.08 ab	0.07 a	Nil	0.49 ab	0.00 a	Nil	0.03 a
S.E.M.	–	0.039	0.045	–	0.181	0.061 [Z]	–	0.047	0.008	–	0.059

[Z] Overall average S.E.M. (values for individual treatments varied due to missing plots)

Table 21. Overall tests of fixed effects for variety (VAR), fungicide (FUNG), and VAR x FUNG for barley leaf disease at 11 location-years. P-values less than or equal to 0.05 indicate that an effect was significant for the corresponding response variable. P-values below 0.1 are also worth noting.

Source	BR-21	BR-22	IH-20	IH-21	IH-22	ME-20	ME-21	ME-22	YK-20	YK-21	YK-22
	Flag Leaf Stage (T1) Total Leaf Disease (p-values)										
Variety (VAR)	–	0.630	0.670	0.388	0.670	0.069	0.880	0.516	0.518	0.933	0.620
	Early Heading Stage (T2) Total Leaf Disease (p-values)										
Variety (VAR)	–	0.027	–	–	0.739	–	–	–	–	–	0.055
	Early Dough Stage (T3) Total Leaf Disease (p-values)										
Variety (VAR)	0.027	<0.001	<0.001	0.962	0.003	0.017	0.362	0.022	0.026	0.723	<0.001
Fungicide (FUNG)	0.087	<0.001	0.893	<0.001	<0.001	0.298	0.152	<0.001	<0.001	0.095	<0.001
VAR x FUNG	0.918	<0.001	0.397	0.824	0.159	0.983	0.021	0.161	0.567	0.130	0.171

Table 22. Main effect means for variety main effects on flag leaf stage (T1) total disease levels at 11 sites in 2020-22. Main effect means within a site followed by the same letter do not significantly differ (Tukey, P < 0.05).

Main Effect	BR-21	BR-22	IH-20	IH-21	IH-22	ME-20	ME-21	ME-22	YK-20	YK-21	YK-22
Variety	Flag Leaf Stage (T1) Total Leaf Disease (% area affected)										
Bow (MS)	0.0	0.3 A	0.1 A	0.1 A	0.1 A	3.4 A	0.2 A	0.3 A	1.1 A	0.1 A	0.9 A
Synergy (I)	0.0	0.3 A	0.2 A	0.1 A	0.1 A	2.2 A	0.2 A	0.4 A	1.1 A	0.1 A	0.7 A
Connect (MR)	0.0	0.3 A	0.1 A	0.2 A	0.0 A	1.3 A	0.2 A	0.4 A	1.0 A	0.1 A	0.5 A
S.E.M.	–	0.02	0.08	0.05	0.03	0.68	0.04	0.10	0.06	0.05	0.23

Table 23. Main effect means for variety main effects on early heading stage (T2) total disease levels at 11 sites in 2020-22. Main effect means within a site followed by the same letter do not significantly differ (Tukey, P < 0.05).

Main Effect	BR-21	BR-22	IH-20	IH-21	IH-22	ME-20	ME-21	ME-22	YK-20[Z]	YK-21	YK-22
Variety	---------- Early Heading Stage (T2) Total Leaf Disease (% area affected) ----------										
Bow (MS)	–	1.0 A	–	–	0.2 A	–	–	–	–	–	1.4 A
Synergy (I)	–	0.6 B	–	–	0.2 A	–	–	–	–	–	1.0 AB
Connect (MR)	–	0.7 B	–	–	0.2 A	–	–	–	–	–	0.8 B
S.E.M.	–	0.07	–	–	0.07	–	–	–	–	–	0.18

Table 24. Main effect means for variety and fungicide main effects on total leaf area affected by disease at 11 sites in 2020-22. Main effect means within a site followed by the same letter do not significantly differ (Tukey, P < 0.05).

Main Effect	BR-21	BR-22	IH-20	IH-21	IH-22	ME-20	ME-21	ME-22	YK-20	YK-21	YK-22
Variety	---------- Early Dough Stage (T3) Total Leaf Disease (% area affected) ----------										
Bow (MS)	0.2 A	1.6 A	1.9 B	0.3 A	0.7 A	5.2 A	0.4 A	1.8 AB	2.2 A	0.1 A	3.0 A
Synergy (I)	0.0 B	0.7 B	3.1 A	0.3 A	0.3 B	3.8 AB	0.5 A	1.2 B	1.7 B	0.1 A	1.8 B
Connect (MR)	0.1 AB	0.9 B	4.0 A	0.3 A	0.4 B	3.2 B	0.6 A	2.0 A	1.9 AB	0.2 A	2.0 B
S.E.M.	0.04	0.12	0.30	0.05	0.10	0.65	0.09	0.25	0.15	0.03	0.26
Fungicide											
Untreated	0.2 A	1.8 A	2.9 A	0.5 A	0.8 A	4.8 A	0.6 A	3.1 A	3.3 A	0.1 A	3.5 A
Flag	0.1 A	0.8 B	3.0 A	0.2 B	0.4 B	4.3 A	0.4 A	1.1 B	1.3 BC	0.1 A	2.2 B
Head	0.1 A	0.8 B	3.0 A	0.2 B	0.2 B	3.6 A	0.5 A	1.4 B	1.8 B	0.2 A	2.0 B
Dual	0.1 A	0.8 B	3.2 A	0.2 B	0.3 B	3.5 A	0.4 A	1.0 B	1.2 C	0.1 A	1.4 B
S.E.M.	0.04	0.14	0.35	0.06	0.11	0.70	0.100	0.28	0.17	0.04	0.28

Table 25. Individual variety by fungicide treatment means for total leaf area affected by disease at 11 sites in 2020-22. Means within a site followed by the same letter do not significantly differ (Tukey, P < 0.05).

Main Effect	BR-21	BR-22	IH-20	IH-21	IH-22	ME-20	ME-21	ME-22	YK-20	YK-21	YK-22
Variety - Fung	---------- Final Total Leaf Disease (% area affected) ----------										
MS – untr	0.3 a	3.3 a	1.6 b	0.6 a	1.4 a	5.8 a	0.5 ab	2.9 ab	4.0 a	0.2 a	4.8 a
MS – flag	0.1 a	1.0 b	1.6 b	0.2 ab	0.7 ab	5.5 a	0.5 ab	1.3 bc	1.5 cd	0.1 a	3.4 ab
MS – head	0.1 a	1.1 b	1.7 b	0.2 ab	0.3 b	4.4 a	0.3 ab	1.6 bc	2.1 bcd	0.2 a	2.3 bcd
MS – dual	0.2 a	1.1 b	2.8 ab	0.1 b	0.4 b	5.0 a	0.5 ab	1.2 bc	1.3 d	0.1 a	1.6 bcd
I – untr	0.1 a	0.7 b	3.2 ab	0.4 ab	0.5 b	4.9 a	0.5 ab	2.1 bc	2.8 abc	0.2 a	2.8 bcd
I – flag	0.0 a	0.7 b	3.8 ab	0.3 ab	0.3 b	4.0 a	0.4 ab	0.9 bc	1.2 d	0.0 a	1.5 cd
I – head	0.0 a	0.7 b	2.7 ab	0.2 ab	0.1 b	3.6 a	0.5 ab	1.1 bc	1.7 cd	0.2 a	1.9 bcd
I – dual	0.0 a	0.6 b	2.9 ab	0.2 ab	0.2 b	2.7 a	0.5 ab	0.6 c	1.1 d	0.1 a	1.1 d
MR – untr	0.2 a	1.3 b	4.1 ab	0.5 ab	0.6 ab	3.7 a	1.0 a	4.4 a	3.3 ab	0.1 a	3.0 abc
MR – flag	0.1 a	0.7 b	3.5 ab	0.2 ab	0.3 b	3.5 a	0.3 b	1.1 bc	1.3 d	0.2 a	1.8 bcd
MR – head	0.1 a	0.7 b	4.6 a	0.2 ab	0.3 b	2.9 a	0.9 ab	1.4 bc	1.7 cd	0.3 a	1.8 bcd
MR – dual	0.1 a	0.8 b	4.1 ab	0.2 ab	0.4 b	2.8 a	0.3 b	1.2 bc	1.3 d	0.1 a	1.5 cd
S.E.M.	0.08	0.23	0.59	0.10	0.17	1.03	0.15	0.44	0.27	0.07	0.42