

2021 (Year 2) 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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1. Project Title: Contrasting Fungicide Applications and Genetic Fusarium Head Blight Resistance for Enhanced Yield and Quality of Barley

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. Protocols were finalized in the late winter/early spring with the first field trials established at Indian Head, Yorkton, and Melfort in the spring of 2020. Our intent was to also conduct a trial at Brandon in 2020 but it was delayed due to COVID-19 restrictions at that location. For the 2021 growing season, trials were conducted at Indian Head, Yorkton, Melfort, and Brandon – as originally intended. Field trials at a fifth location, Lacombe Alberta, are scheduled to come online in the spring of 2022; however, we are still anticipating that COVID-19 related disruptions at this location (i.e, postponement of cancelled trials in

2020 to 2021/2022) and capacity limitations may impact their ability to conduct the field trials as originally intended.

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 damage at Melfort) or minor misunderstandings of data collection requirements (i.e., plant counts not completed for all plots at Yorkton). In 2021, the field trials went 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 2021), low and extremely variable yields combined with relatively poor grain quality. This could result in some data being removed from the final, combined analyses but was not due to any error on the part of collaborators and such weather related challenges are beyond our control. 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. Collaborating organizations completed the plant density and grain yield measurements 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 the leaf disease assessments. Leaf disease assessments and DON analyses are not yet available for the 2021 growing season; however, all currently available response data has been statistically analyzed and summarized. These preliminary analyses are intended to allow preliminary 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 Day in 2021, attended by approximately 85 participants.

Similar to last year, this project is still considered to be behind schedule relative to the original timelines. If AAFC-Lacombe is unable to host a location as originally planned, we may have to extend field trials for an additional growing season at select sites in order to make up the shortfall. Further to this, we anticipate that an additional year may be required for final data analyses and report preparation; however, this does not come with any additional funding requirements. The challenge with respect to the original reporting timelines is that there is often a substantial delay between in-house grain quality assessments (i.e., test weight, TKW, plumps and thins, and the laboratory analyses (i.e., DON). The detailed leaf disease ratings are also often not completed early enough for this data to be analyzed, summarized, and interpreted prior to the original reporting deadlines. It is currently difficult for the PI to dedicate sufficient time to data analyses and report preparation during the field season; therefore, we believe it would be preferable to postpone the final report (if necessary) rather than rushing the process or working with incomplete data.

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 is provided in Schedule 1 of the Appendices and the first field trials were initiated that spring. Again, due to COVID-19 restrictions, field trials were not initiated at the AAFC-Brandon location in 2020 and may not be able to proceed at AAFC Lacombe as originally intended. Trials were completed at Indian Head, Melfort, and Yorkton in both

2020 and 2021 and at Brandon in 2021. 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 reported 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 and 3 of the Appendices for 2020 and 2021, respectively. The target seeding rate at all sites was 300 viable seeds/m², adjusted for seed size and percent germination. All locations used the same seed source. Seed-applied fungicides were permitted at the discretion of site-managers but not required. 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 damaged 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.

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/m². These measurements were not completed for all plots at Yorkton 2020 but were in 2021 and 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. The third leaf from the head was collected for the flag-leaf stage ratings while the penultimate (2nd leaf from head) was collected at the later 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, net-form blotch, and other leaf diseases. At this time (March 2022), these results are available for 2020 but not 2021. 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. 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. Again, the DON data from 2021 are not yet available at this time.

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. In 2021, the response data were analysed using the Mixed procedure of SAS with variety (VAR), fungicide (FUNG), VAR x FUNG effects considered fixed and replicate effects treated as random. In 2021, the generalized linear mixed model (GLIMMIX) procedure was used in place of the Mixed procedure; however, fixed and random effects were unchanged and these procedures produce identical results which are directly comparable for the purposes of this report. Unless there were explicit reasons for doing so (i.e., drift damage at Melfort), no individual data points have been deleted at this stage of the project.

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 2021-March 2022 reporting period. Please refer to the 2020-21 interim report for progress in the first year of the project.

Seed for the 2021 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 2021; however, severe drought resulted in low yields and variable data. Yorkton 2021 was the most drought affected site and may be removed from the final, combined analyses. The dry conditions also resulted in negligible disease pressure for all four locations; however, while not ideal for our purposes, this in itself does not make the data invalid as it is still representative of the environmental conditions encountered.

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. DON results from 2021 are not yet available but should be before the middle of April. IHARF forwarded the leaf samples to AAFC Lacombe who (at the time of writing) had just recently completed the 2021 ratings. The results for these assessments from 2021 are not included in this report as the data analyses and summarization of results were completed before they were available; however, visual inspection of this data indicates that leaf disease was very low at all sites in 2021 – generally below 1% for net blotch, scald, and miscellaneous leaf spot diseases combined. A minimum of 10 leaves were assessed for each plot in all cases. As originally proposed, the initial assessments (prior to any fungicide application) were only completed for the control plots while the latter (late milk/early dough stage) were completed for all plots. The initial ratings are

intended to provide information on leaf disease pressure at the time of the flag-leaf fungicide applications while the latter were to assess treatment effects on final leaf disease.

All available data from the 2021 season were analysed using basic statistical procedures and 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.

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 seven location-years with specific details of these trials and the work completed discussed in previous sections. All available data to date, from both years of the project, is provided in the Appendices and will be briefly discussed in the current section. Again, selected agronomic information and dates of operations are provided in Tables 1 and 2 of the Appendices for 2020 and 2021, respectively. Tables 3 and 4 of the Appendices included mean monthly temperatures and cumulative precipitation, respectively, for all of the sites. Results from the overall tests of fixed effects for all response variables except leaf disease ratings at all seven sites are provided in Table 6. Corresponding main effect and individual treatment means for each of these response variables are provided in Tables 7-19. Overall tests of fixed effects and main effect means for the detailed leaf disease ratings from 2020 are provided in Tables 20, 21, and 22 for Indian Head, Yorkton, and Melfort, respectively. Individual treatment means for the leaf disease ratings are not provided at this time as no significant interactions were detected.

Plant Emergence (Table 7)

These measurements were completed prior to the application of any fungicide treatments, therefore, only variety effects were included in the model. While seed rates were adjusted for seed size and percent germination, differences between varieties still occurred at 5/7 locations. In 2020, emergence for AAC Synergy (I) was slightly lower than for the other two varieties at Indian Head but not Yorkton or Melfort. In 2021, all four locations observed lower plant populations for CDC Bow (MS). This was primarily attributed to differences in seed quality and seemingly poorer seed vigour for this variety. At some locations (i.e. Indian Head and Brandon 2021) emergence in general was poorer than expected, possibly due to relatively poor seedbed conditions and, in the case of Indian Head, seed being placed deeper than optimal. It is possible that populations for some of these sites increased as the season progressed; however, plant counts must generally be completed prior to tillering or they become increasingly difficult to complete accurately.

Leaf Disease (Tables 20-22)

Only results from 2020 have been statistically analysed and summarized at this time. Results for scald and net blotch were always extremely low, ranging from 0 to <1%. The pathogens isolated were mostly, saprophytic organisms. The AAFC Lacombe pathology lab speculated that much of the observed damage was likely caused by non-biotic factors (i.e., wind and sun damage) and, subsequently, saprophytic organisms such as *Alternaria* spp. moved into the dead tissue. While occasional treatment effects were detected, absolute disease levels were always sufficiently low that they, in themselves, would not justify foliar fungicide applications. At Indian Head 2020, slightly less alternaria (other) and total disease was observed in the MS variety (CDC Bow) but no fungicide effects were detected. At Yorkton 2020, the variety effects differed from Indian Head but were too small to be important; however, there was a slight reduction in alternaria (other) and total disease observed with the fungicide treated plots, particularly with the flag leaf and dual applications. At Melfort 2020, slightly higher leaf disease was observed with CDC Bow; however, no fungicide effects were detected. The variety effects on leaf disease at Melfort 2020

were consistent with Yorkton 2020 but not Indian Head 2020. Similar to the other locations, alternaria was the dominant pathogen at Melfort; however, trace levels of scald were also observed.

Preliminary observations from 2021 suggest that, again, all leaf diseases are at trace levels and unlikely to suggest a need for a foliar fungicide application in themselves.

Grain Yield (Tables 8 and 9)

Grain yields were affected by variety at 6/7 sites, fungicide at 0/7 sites, and no interactions were detected. Varietal differences in yield were not specifically of interest for this project, but generally showed amongst the highest yields with AAC Synergy (I) and, for 4/7 locations, lower yields with CDC Bow (MS). In 2021 specifically, 3 of 4 locations showed significantly lower yields with CDC Bow (I) and this may have been due, at least in part, to poorer seed quality. The lack of a benefit to fungicide applications was not unexpected given the lack of disease. The lack a VAR x FUNG interaction indicates that this (lack of a) response was consistent for all three varieties, regardless of location. As previously alluded to, yields at Yorkton 2021 were highly variable and it is recommended that data from this location-year be excluded from any final, combined analyses. Inspection of individual plot data for Yorkton 2021 suggests that yield variability did not show any specific patterns associated with treatment or replicate and cannot be improved by simply removing a few outliers.

Test Weight (Tables 10 and 11)

Test weight was affected by variety at 6/7 sites and fungicide at 1/7 sites but no interactions were detected. Similar to yield, differences between varieties were not, in themselves, of interest unless they could be attributed to differences in disease. In all cases where varietal differences were observed, test weights were amongst the highest with Synergy (I) and lowest with CDC Bow (MR). Test weights with CDC Connect (MR) were usually intermediate. Focussing on fungicide effects on test weight, Indian Head 2021 was the only responsive site. At this location, the range in tests weights was small from a practical perspective (290.0-292.5 g/0.5 L or 48.3-48.8 lb/A bu) but did show significant improvements with the dual fungicide application and, to a lesser extent, the flag-leaf stage application. The lack of interaction indicates that this response did not significantly differ across varieties.

Thousand Kernel Weight (Tables 12 and 13)

Thousand kernel weight was affected by variety at 4/7 sites while fungicide effects were significant at 1/7 and no interactions were detected. Kernel weight was lowest with CDC Bow at 3/4 sites where the variety effect was significant and with CDC Connect at 1/4; however, the outlier was Yorkton 2021 which was identified as having questionable data quality. Yorkton 2020 was the only site where the F-test for fungicide was significant; however, differences between means were too small to be considered significant according to the Tukey's multiple comparisons test. The trend was for slightly heavier seeds with the treatments that received fungicide at the flag-leaf stage.

Plump Kernels (Tables 14 and 15)

Percent plump kernels were affected by variety at 2/7 locations but not by fungicide in any cases and no interactions were detected. The responsive sites were Yorkton and Brandon, both in 2021. In the case of Yorkton, CDC Bow (MS) had a higher percentage of plump seeds than the other varieties (98.3% versus 94.9-95.3%). At Brandon, CDC Bow (MS) had the most plump seeds (97%), followed by AAC Synergy (I; 95.1%), and finally, AAC Connect (MR; 93.3%). Again, varietal differences in themselves were not specifically of interest and the lack of fungicide effects or interactions indicates that this variable was not impacted in a meaningful manner for any of the 7 site-years completed to date.

Thin Kernels (Tables 16 and 17)

Percent thin kernels were affected by variety at 4/7 sites and fungicide at 1/7; however, no interactions were detected. Of the responsive sites, CDC Connect (MR) had the most thin kernels in 3/4 cases and, for one location, CDC Bow (MS) had the most thin kernels. The outlier was Indian Head 2021 and the higher proportion of thin kernels with CDC Bow at this site-year may have been due to the poorer emergence

and vigour observed for this variety. In all cases, percent thin kernels were below 0.5% and well below the thresholds which might lead to rejection by maltsters. Yorkton 2021 was the sole location where the fungicide effect was significant ($P = 0.050$); however, differences between individual treatment means were too small to be considered significant according to the Tukey's separations and no meaningful trends were observed. Again, this site was identified as being highly variable and will likely be removed from future, combined analyses. The lack of any VAR x FUNG interactions indicates that the general lack of fungicide effects on percent thin kernels was consistent across varieties.

Deoxynivalenol – DON (Tables 18 and 19)

Deoxynivalenol (DON) accumulation was not affected by either variety nor fungicide treatment on their own for any individual locations, but the VAR x FUNG interaction was significant at Yorkton 2020 and marginally significant at Indian Head 2020 ($P = 0.082$). Under the dry conditions, DON was low for all treatments at all locations, averaging 0.005 ppm at Yorkton, 0.047 ppm at Indian Head, and 0.096 ppm at Melfort. 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, even DON levels of 0.5-1.0 ppm may be considered acceptable. Under the low disease pressure, no consistent trends for treatment effects on DON were identified. The VAR x FUNG interaction at Yorkton was primarily attributed to low variability (with many 0.00 ppm values) and some inconsistencies amongst fungicide treatments for individual varieties; however, there was nothing to suggest that DON levels were higher, or that the fungicide response was more consistent, for any given variety. Overall, we speculate that FHB pressure in 2020 was too low for us to detect either meaningful variety differences or consistent fungicide benefits. This does not mean that the results from 2020 are not useful or important. It simply means that, in the absence of the disease, fungicides are unlikely to provide measurable benefits for yield or quality and genetic resistance to FHB is unlikely to impact DON levels. While we remain hopeful that we will acquire results for a wider range of conditions, including heavier disease pressure, as we move forward with the project, this is not expected to have been the case in 2021 under the wide-spread dry conditions. Again, results for DON in 2021 are not yet available at this time.

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 and the plots at Indian Head 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). We will continue to promote this project in 2022 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 2020 Season – Does Not Include Randomization / Field Map****#20-2613: FUNGICIDE APPLICATIONS & GENETIC FHB RESISTANCE FOR ENHANCED YIELD & QUALITY OF BARLEY (YR 1)**

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, Yorkton & Lacombe (starting in 2022)

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/m², 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 should be avoided

if possible. 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:** A minimum of 10 individual leaves per plot for should be collected in all cases. 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 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 two separate times.
 - a. T1) Early Flag Leaf stage:** 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). These ratings will focus on the 3rd leaf from the head.
 - b. T2) 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).
 - 3) Grain Yield:** Corrected for dockage and to 13.5% seed moisture content
- NOTE: All quality measurements to be completed by IHARF. Forward 1 kg cleaned seed per plot (minimum) to: IHARF, #1 Government Rd, Indian Head, SK, S0G 2K0, Attn: Chris Holzapfel.*
- 4) Test Weight:** Standard CGC methodology, recorded in g/0.5 l
 - 5) Kernel Weight:** Count and weigh a minimum of 1000 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. Seed Solutions Laboratory (Swift Current) is the preferred choice, for consistency
 - b. IHARF to retain any leftover grain (approximately 500 g) as a temporary archive, until the project has concluded

Schedule 2 – Results Tables for the 2020-21 Field Trials**Table 1. Specifications for seed used in 2020 and 2021 field trials. All locations used the same seed source within any given year.**

Attribute	CDC Bow (20)	AAC Synergy (20)	AAC Connect (20)	CDC Bow (21)	AAC Synergy (21)	AAC Connect (21)
Germination	97%	97%	97%	88%	99%	99%
Thousand Kernel Weight (g/1000 seeds)	51 g	52 g	52 g	51.5 g	47.0 g	55.6 g

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)
Seed Treatment	None	None	5 g prothioconazole + 2 g metalaxyl/100 kg seed
Seeding Date	May-14-2020	May-7-2020	May 22-2020
Row Spacing	30 cm	30 cm	30 cm
Fertility (kg N-P ₂ O ₅ -K ₂ O-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	23 g azoxystrobin/ha + 38.6 g propiconazole/ha + 30 g benzovindiflupyr (Jul-3-2020)	23 g azoxystrobin/ha + 38.6 g propiconazole/ha + 30 g benzovindiflupyr (Jul-1-2020)	23 g azoxystrobin/ha + 38.6 g propiconazole/ha + 30 g benzovindiflupyr (Jul-11-2020)
Head Fungicide	100 g prothioconazole/ha + 100 g tebuconazole/ha (Jul-19-2020)	100 g prothioconazole/ha + 100 g tebuconazole/ha (Jul-13-2020)	100 g prothioconazole/ha + 100 g tebuconazole/ha (Jul-24-2020)
T2 – Leaf Disease	Jul-30-2020	Jul-27-2020	Aug-5-2020
Pre-harvest Herbicide	None	894 g glyphosate/ha ² (Aug 5-2020)	None
Harvest Date	Aug-19-2020	Aug-20-2020	Sep-28-2020

² 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
Seed Treatment	None	None	None	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 ₂ O ₅ - K ₂ O-S/ha)	115-35-18-18	67-34-0-0	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)	129 g fluroxypyr/ha + 90 g clopyralid/ha + 503 g MCPA ester (Jun-8-2021) 62 g pinoxaden/ha (Jun-22-2021)	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	23 g azoxystrobin/ha + 38.6 g propiconazole/ha + 30 g benzovindiflupyr (Jul-2-2021)	23 g azoxystrobin/ha + 38.6 g propiconazole/ha + 30 g benzovindiflupyr (Jun-28-2021)	23 g azoxystrobin/ha + 38.6 g propiconazole/ha + 30 g benzovindiflupyr (Jul-5-2021)	23 g azoxystrobin/ha + 38.6 g propiconazole/ha + 30 g benzovindiflupyr (Jun-17-2021)
Head Fungicide	100 g prothioconazole/ha + 100 g tebuconazole/ha (Jul-16-2021)	100 g prothioconazole/ha + 100 g tebuconazole/ha (Jul-14-2021)	100 g prothioconazole/ha + 100 g tebuconazole/ha (Jul-13-2022)	100 g prothioconazole/ha + 100 g tebuconazole/ha (Jul-5-2022)
T2 – 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. Mean monthly temperatures along with long-term (1981-2010) averages for the 2020 and 2021 growing seasons at Indian Head (SK), Melfort (SK), Yorkton (SK), and Brandon (MB, 2021 only).

Location	Year	April	May	June	July	August	Average
		----- Mean Temperature (°C) -----					
Indian Head	2020	0.3	10.7	15.6	18.4	17.9	12.6 (95%)
	2021	3.3	9.0	17.7	20.3	17.1	13.5 (102%)
	Long-term	4.2	10.8	15.8	18.2	17.4	13.3
Melfort	2020	-2.9	10.1	14.3	18.2	17.6	11.5 (90%)
	2021	3.2	9.6	18.2	20.1	16.9	13.6 (107%)
	Long-term	2.8	10.7	15.9	17.5	16.8	15.2
Yorkton	2020	0.0	10.5	16.4	19.9	18.3	13.0 (102%)
	2021	3.5	8.9	19.1	21	17.3	14.0 (109%)
	Long-term	3.2	10.4	15.5	17.9	17.1	12.8%
Brandon	2021	3.4	9.9	18.8	20.5	17.5	14.0 (100%)
	Long-term	4.5	11.4	16.6	19.2	18.2	14.0

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

Location	Year	April	May	June	July	August	Total
		----- Cumulative Precipitation (mm) -----					
Indian Head	2020	22.0	27.3	23.5	37.7	24.9	135 (51%)
	2021	25.6	81.6	62.9	51.2	99.4	321 (120%)
	Long-term	22.6	51.7	77.4	63.8	51.2	267
Melfort	2020	11.1	26.7	103.7	52.4	18.5	212 (84%)
	2021	9.1	31.4	37.6	0.2	69.3	148 (58%)
	Long-term	26.7	42.9	54.3	76.7	52.4	253
Yorkton	2020	6.2	16.7	33.6	80.1	49.3	186 (63%)
	2021	10.2	24.6	18.1	35.2	69.7	158 (54%)
	Long-term	21.6	51.3	80.1	78.2	62.2	293
Brandon	2021	8.3	25.8	101.2	0.2	156.8	292 (99%)
	Long-term	24.9	56.5	79.6	68.2	65.5	295

Table 6. Overall tests of fixed effects for variety (VAR), fungicide (FUNG), and VAR x FUNG for selected barley response variables at seven 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	IH-20	YK-20 ^z	MF-20 ^y	IH-21	YK-21	ME-21	BR-21
----- Emergence (p-values) -----							
Variety (VAR)	<0.001	0.321	0.239	<0.001	<0.001	0.003	0.003
----- Yield (p-values) -----							
Variety (VAR)	<0.001	0.010	0.213	<0.001	0.036	0.001	<0.001
Fungicide (FUNG)	0.144	0.250	0.759	0.373	0.945	0.715	0.864
VAR x FUNG	0.746	0.504	0.964	0.512	0.655	0.020	0.616
----- Test Weight (p-values) -----							
Variety (VAR)	<0.001	0.005	0.002	<0.001	<0.001	0.002	0.480
Fungicide (FUNG)	0.258	0.187	0.957	0.003	0.625	0.352	0.701
VAR x FUNG	0.657	0.387	0.974	0.211	0.257	0.944	0.592
----- Thousand Kernel Weight (p-values) -----							
Variety (VAR)	<0.001	<0.001	0.005	0.782	0.040	0.115	0.065
Fungicide (FUNG)	0.099	0.045	0.436	0.140	0.581	0.585	0.926
VAR x FUNG	0.258	0.483	0.841	0.896	0.596	0.757	0.423
----- Plump Kernels (p-values) -----							
Variety (VAR)	0.113	0.136	0.976	0.357	0.002	0.210	<0.001
Fungicide (FUNG)	0.627	0.841	0.413	0.178	0.139	0.214	0.623
VAR x FUNG	0.488	0.725	0.805	0.851	0.482	0.762	0.375
----- Thin Kernels (p-values) -----							
Variety (VAR)	0.032	0.594	0.355	0.001	0.026	0.769	0.006
Fungicide (FUNG)	0.337	0.733	0.689	0.972	0.050	0.311	0.535
VAR x FUNG	0.877	0.862	0.409	0.805	0.333	0.605	0.240
----- Deoxynivalenol (p-values) -----							
Variety (VAR)	0.559	0.650	0.819	–	–	–	–
Fungicide (FUNG)	0.642	0.483	0.343	–	–	–	–
VAR x FUNG	0.082	0.046	0.802	–	–	–	–

^z Emergence data not collected for all plots at Yorkton-2021; ^y Ten (of 48) plots had to be discarded at this location due to damage caused by spray drift

Table 7 Main effect means for barley variety effects on plant density at seven sites in 2020 and 2021. The target seed rate for all varieties was 300 viable seeds/m². Main effect means within a location followed by the same letter do not significantly differ (Tukey's range test, P < 0.05).

Main Effect	IH-20	YK-20 ^z	MF-20 ^y	IH-21	YK-21	ME-21	BR-21
Variety	----- Emergence (plants/m ²) -----						
Bow (MS)	222.3 A	270.4 A	231.4 A	134.0 B	207.2 B	199.1 B	126.9 B
Synergy (I)	194.6 B	278.2 A	213.5 A	161.0 A	238.8 A	221.3 AB	159.0 A
Connect (MR)	218.4 A	281.4 A	217.4 A	184.1 A	252.8 A	233.8 A	148.7 A
S.E.M.	6.73	8.35	10.06 ^y	7.50	4.71	7.6	6.1

^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 8. Main effect (variety and fungicide treatment) means for barley grain yield at seven sites in 2020 and 2021. Main effect means within a location followed by the same letter do not significantly differ (Tukey's range test, $P < 0.05$).

Main Effect	IH-20	YK-20	MF-20 ^y	IH-21	YK-21	ME-21	BR-21
<u>Variety</u>	----- Grain Yield (kg/ha) -----						
Bow (MS)	4986 B	2610 B	3394 A	3156 B	1948 A	2000 B	3950 B
Synergy (I)	5609 A	3074 A	3691 A	3965 A	1733 AB	2728 A	5653 A
Connect (MR)	5429 A	2624 B	3630 A	3954 A	1207 B	2484 A	5288 A
S.E.M.	123.9	124.7	138.0 ^z	120.6	252.3	225.7	141.7
<u>Fungicide</u>							
Untreated Control	5378 A	2744 A	3487 A	3635 A	1636 A	2553 A	4986 A
Flag	5444 A	2998 A	3691 A	3720 A	1575 A	2340 A	4895 A
Head	5258 A	2647 A	3604 A	3735 A	1741 A	2382 A	4920 A
Dual	5286 A	2688 A	3505 A	3677 A	1564 A	2340 A	5054 A
S.E.M.	127.7	140.9	155.0 ^z	122.6	277.1	237.7	158.8

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

Table 9. Individual treatment means (variety by fungicide treatment) for barley grain yield at seven sites in 2020 and 2021. Means within a location followed by the same letter do not significantly differ (Tukey's range test, $P < 0.05$).

Treatment	IH-20	YK-20	MF-20 ^z	IH-21	YK-21	ME-21	BR-21
Variety - Fung	----- Grain Yield (kg/ha) -----						
MS - untr	4989 bcd	2800 ab	3203 a	3015 B	1763 a	2252 ab	3960 CD
MS – flag	5188 a-d	2692 ab	3569 a	3194 B	1668 a	2112 ab	3749 D
MS – head	4830 d	2459 b	3438 a	3251 B	2066 a	1463 b	4235 BCD
MS – dual	4938 cd	2489 b	3365 a	3165 B	2294 a	2172.1 ab	3855 CD
I - untr	5682 a	2900 ab	3772 a	3984 A	1644 a	3183 a	5767 A
I – flag	5662 a	3629 a	3625 a	3979 A	1987 a	2484 ab	5575 A
I – head	5611 a	2849 ab	3749 a	4025 A	1665 a	3123 a	5490 A
I – dual	5481 ab	2920 ab	3618 a	3871 A	1635 a	2121 ab	5780 A
MR - untr	5464 abc	2533 ab	3484 a	3906 A	1501 a	2225 ab	5231 A
MR – flag	5483 ab	2674 ab	3879 a	3987 A	1070 a	2425 ab	5362 A
MR – head	5333 a-d	2633 ab	3624 a	3930 A	1493 a	2559 ab	5035 ABC
MR – dual	5439 abc	2656 ab	3532 a	3994 A	763 a	2727 ab	5525 A
S.E.M.	154.7	233.2	250.4	137.2	426.5	318.0	257.5

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

Table 10. Main effect (variety and fungicide treatment) means for barley test weight at seven sites in 2020 and 2021. Main effect means within a location followed by the same letter do not significantly differ (Tukey's range test, $P < 0.05$).

Main Effect	IH-20	YK-20	MF-20 ^z	IH-21	YK-21	ME-21	BR-21
<u>Variety</u>	----- Test Weight (g/0.5 L) -----						
Bow (MS)	324.6 B	326.7 B	334.2 B	287.9 B	271.5 B	310.8 B	302.1 A
Synergy (I)	328.5 A	329.1 A	336.2 A	296.6 A	280.0 A	315.7 A	303.8 A
Connect (MR)	326.8 A	327.9 AB	333.4 B	289.1 B	273.3 B	312.9 AB	302.7 A
S.E.M.	0.50	0.50	0.62 ^z	0.61	0.91	0.74	0.91
<u>Fungicide</u>							
Untreated Control	325.8 A	326.9 A	334.3 A	290.0 B	275.8 A	312.2 A	302.0 A
Flag	326.7 A	328.3 A	334.8 A	291.5 AB	274.0 A	314.6 A	302.2 A
Head	326.7 A	327.9 A	334.7 A	290.8 B	274.9 A	312.4 A	303.7 A
Dual	327.5 A	328.6 A	334.6 A	292.5 A	275.0 A	313.3 A	303.3 A
S.E.M.	0.58	0.58	0.68 ^z	0.65	1.01	0.90	1.09

^z Average S.E.M. (individual values varied due to missing values)

Table 11. Individual treatment means (variety by fungicide treatment) for barley test weight at seven sites in 2020 and 2021. Means within a location followed by the same letter do not significantly differ (Tukey's range test, $P < 0.05$).

Treatment	IH-20	YK-20	MF-20 ^z	IH-21	YK-21	ME-21	BR-21
Variety - Fung	----- Test Weight (g/0.5 L) -----						
MS - untr	323.5 b	326.9 a	334.3 a	287.7 c	273.1 bcd	310.8 a	301.6 a
MS – flag	325.7 ab	325.8 a	334.6 a	287.8 c	271.7 cd	311.7 a	298.9 a
MS – head	324.4 b	326.1 a	334.2 a	287.8 c	269.7 d	310.1 a	304.7 a
MS – dual	324.9 ab	327.7 a	333.8 a	288.3 c	271.6 d	310.5 a	303.0 a
I - untr	328.3 ab	327.4 a	335.6 a	294.4 b	279.3 abc	314.5 a	303.8 a
I – flag	328.4 ab	330.7 a	336.7 a	297.3 ab	281.3 a	317.7 a	303.8 a
I – head	328.1 ab	328.8 a	336.4 a	295.6 ab	280.1 ab	315.6 a	302.9 a
I – dual	329.4 a	329.7 a	336.0 a	299.1 a	279.6 ab	315.1 a	304.7 a
MR - untr	325.5 ab	326.3 a	333.0 a	287.8 c	275.2 abcd	311.3 a	300.7 a
MR – flag	326.0 ab	328.5 a	333.0 a	289.6 c	269.2 d	314.4 a	304.0 a
MR – head	327.8 ab	328.6 a	333.5 a	289.0 c	274.9 abcd	311.6 a	303.6 a
MR – dual	328.1 ab	328.3 a	333.9 a	290.1 c	274.0 abcd	314.4 a	302.3 a
S.E.M.	1.01	0.99	1.03 ^z	0.91	1.61	1.73	2.00

^z Average S.E.M. (individual values varied due to missing values)

Table 12. Main effect (variety and fungicide treatment) means for barley kernel weight at seven sites in 2020 and 2021. Main effect means within a location followed by the same letter do not significantly differ (Tukey’s range test, $P < 0.05$).

Main Effect	IH-20	YK-20	MF-20 ^z	IH-21	YK-21	ME-21	BR-21
<u>Variety</u>	----- Kernel Weight (g/1000 seeds) -----						
Bow (MS)	47.8 B	48.7 B	44.8 B	45.1 A	42.1 A	45.5 A	47.0 A
Synergy (I)	49.1 A	49.7 A	46.3 A	45.0 A	40.6 AB	45.2 A	45.6 A
Connect (MR)	49.3 A	49.9 A	46.1 A	45.1 A	39.2 B	46.2 A	46.7 A
S.E.M.	0.16	0.19	0.41 ^z	0.16	1.19	0.34	0.35
<u>Fungicide</u>							
Untreated Control	48.4 A	49.0 A	45.9 A	44.8 A	40.9 A	45.3 A	46.3 A
Flag	49.1 A	49.8 A	45.7 A	45.1 A	40.6 A	45.9 A	46.3 A
Head	48.7 A	49.2 A	46.0 A	44.9 A	41.4 A	45.6 A	46.4 A
Dual	48.8 A	49.7 A	45.9 A	45.4 A	39.7 A	45.9 A	46.7 A
S.E.M.	0.18	0.22	0.45 ^z	0.18	1.28	0.40	0.42

^z Average S.E.M. (individual values varied due to missing values)

Table 13. Individual treatment means (variety by fungicide treatment) for barley kernel weight at seven sites in 2020 and 2021. Means within a location followed by the same letter do not significantly differ (Tukey’s range test, $P < 0.05$).

Treatment	IH-20	YK-20	MF-20 ^z	IH-21	YK-21	ME-21	BR-21
Variety - Fung	----- Kernel Weight (g/1000 seeds) -----						
MS - untr	47.3 c	48.6 b	44.7 a	44.8 a	41.4 a	45.2 a	47.0 a
MS – flag	48.1 bc	49.0 ab	44.5 a	44.9 a	43.3 a	45.0 a	46.0 a
MS – head	48.1 bc	48.6 b	44.9 a	45.1 a	41.8 a	45.4 a	47.6 a
MS – dual	47.9 bc	48.8 ab	45.3 a	45.4 a	41.9 a	46.3 a	47.4 a
I - untr	48.9 ab	49.0 ab	45.4 a	44.6 a	40.6 a	44.8 a	45.6 a
I – flag	49.7 a	50.5 a	46.6 a	45.0 a	41.4 a	45.8 a	45.5 a
I – head	48.5 abc	49.2 ab	46.6 a	44.7 a	41.7 a	45.3 a	44.7 a
I – dual	49.2 ab	49.9 ab	46.5 a	45.6 a	38.8 a	45.0 a	46.7 a
MR - untr	48.9 ab	49.3 ab	45.8 a	44.9 a	40.6 a	45.8 a	46.4 a
MR – flag	49.4 ab	49.9 ab	46.7 a	45.4 a	37.7 a	46.8 a	47.5 a
MR – head	49.6 a	49.9 ab	45.7 a	45.0 a	40.7 a	45.7 a	46.8 a
MR – dual	49.2 ab	50.3 ab	46.3 a	45.3 a	38.2 a	46.3 a	46.1 a
S.E.M.	0.31	0.38	0.66 ^z	0.33	1.80	0.66	0.79

^z Average S.E.M. (individual values varied due to missing values)

Table 14. Main effect (variety and fungicide treatment) means for percent plump barley kernels at seven sites in 2020 and 2021. Main effect means within a location followed by the same letter do not significantly differ (Tukey’s range test, $P < 0.05$).

Main Effect	IH-20	YK-20 ^z	MF-20 ^y	IH-21	YK-21	ME-21	BR-21
<u>Variety</u>	----- Plump Kernels (g/100 g) -----						
Bow (MS)	97.0 A	99.0 A	97.8 A	98.5 A	98.2 A	98.3 A	97.0 A
Synergy (I)	97.5 A	99.2 A	97.8 A	98.6 A	95.3 A	98.0 A	95.1 B
Connect (MR)	96.7 A	98.9 A	97.9 A	98.4 A	94.9 A	98.0 A	93.3 C
S.E.M.	0.27	0.16	0.30 ^z	0.14	0.94	0.22	0.40
<u>Fungicide</u>							
Untreated Control	96.8 A	98.9 A	97.4 A	98.3 A	96.9 A	98.1 A	95.2 A
Flag	97.1 A	99.0 A	98.2 A	98.5 A	95.4 A	98.3 A	95.5 A
Head	97.2 A	99.0 A	97.9 A	98.6 A	97.2 A	97.8 A	94.5 A
Dual	97.3 A	99.1 A	97.9 A	98.6 A	95.1 A	98.8 A	95.3 A
S.E.M.	0.31	0.16	0.33 ^z	0.15	1.02	0.24	0.48

Table 15. Individual treatment means (variety by fungicide treatment) for percent plump barley kernels at seven sites in 2020 and 2021. Means within a location followed by the same letter do not significantly differ (Tukey’s range test, $P < 0.05$).

Treatment	IH-20	YK-20 ^z	MF-20 ^y	IH-21	YK-21	ME-21	BR-21
Variety - Fung	----- Plump Kernels (g/100 g) -----						
MS - untr	96.6 a	98.8 a	97.6 a	98.2 a	97.7 a	98.6 a	96.8 a
MS – flag	96.4 a	99.1 a	98.2 a	98.4 a	98.2 a	98.7 a	96.7 a
MS – head	97.0 a	99.0 a	97.8 a	98.7 a	98.7 a	97.8 a	97.4 a
MS – dual	98.0 a	98.9 a	97.7 a	98.6 a	98.2 a	98.7 a	96.9 a
I - untr	97.2 a	99.1 a	96.9 a	98.5 a	96.4 a	97.9 a	95.8 a
I – flag	97.9 a	99.2 a	97.8 a	98.6 a	95.6 a	98.1 a	95.4 a
I – head	97.8 a	99.3 a	98.2 a	98.6 a	96.1 a	97.9 a	93.1 a
I – dual	97.2 a	99.1 a	98.2 a	98.6 a	93.3 a	97.9 a	96.1 a
MR - untr	96.5 a	98.9 a	97.6 a	98.2 a	96.7 a	97.9 a	92.9 a
MR – flag	96.9 a	98.8 a	98.4 a	98.5 a	92.6 a	98.3 a	94.4 a
MR – head	96.8 a	98.8 a	97.7 a	98.4 a	96.6 a	97.6 a	93.0 a
MR – dual	96.8 a	99.1 a	97.8 a	98.5 a	93.7 a	98.2 a	92.8 a
S.E.M.	0.54	0.22	0.53 ^z	0.20	1.47	0.36	0.91

Table 16. Main effect (variety and fungicide treatment) means for percent plump barley kernels at seven sites in 2020 and 2021. Main effect means within a location followed by the same letter do not significantly differ (Tukey's range test, $P < 0.05$).

Main Effect	IH-20	YK-20 ^z	MF-20 ^y	IH-21	YK-21	ME-21	BR-21
<u>Variety</u>	----- Thin Kernels (g/100 g) -----						
Bow (MS)	0.25 AB	0.08 A	0.26 A	0.13 A	0.16 B	0.21 A	0.30 B
Synergy (I)	0.20 B	0.06 A	0.34 A	0.08 B	0.25 AB	0.18 A	0.29 B
Connect (MR)	0.29 A	0.08 A	0.28 A	0.07 B	0.27 A	0.19 A	0.49 A
S.E.M.	0.028	0.011	0.060 ^z	0.014	0.041	0.025	0.044
<u>Fungicide</u>							
Untreated Control	0.29 A	0.08 A	0.34 A	0.10 A	0.17 A	0.22 A	0.40 A
Flag	0.25 A	0.06 A	0.28 A	0.09 A	0.27 A	0.18 A	0.32 A
Head	0.23 A	0.08 A	0.27 A	0.09 A	0.19 A	0.22 A	0.32 A
Dual	0.27 A	0.07 A	0.27 A	0.09 A	0.29 A	0.15 A	0.40 A
S.E.M.	0.030	0.012	0.065 ^z	0.015	0.044	0.030	0.05

Table 17. Individual treatment means (variety by fungicide treatment) for percent plump barley kernels at seven sites in 2020 and 2021. Means within a location followed by the same letter do not significantly differ (Tukey’s range test, $P < 0.05$).

Treatment	IH-20	YK-20 ^z	MF-20 ^y	IH-21	YK-21	ME-21	BR-21
Variety - Fung	----- Thin Kernels (g/100 g) -----						
MS - untr	0.30 a	0.08 a	0.24 a	0.14 a	0.18 a	0.21 a	0.37 a
MS – flag	0.28 a	0.07 a	0.22 a	0.13 a	0.15 a	0.23 a	0.26 a
MS – head	0.24 a	0.08 a	0.28 a	0.13 a	0.16 a	0.27 a	0.21 a
MS – dual	0.20 a	0.08 a	0.28 a	0.10 a	0.16 a	0.115 a	0.37 a
I - untr	0.21 a	0.07 a	0.48 a	0.07 a	0.18 a	0.245 a	0.22 a
I – flag	0.19 a	0.05 a	0.41 a	0.07 a	0.28 a	0.158 a	0.27 a
I – head	0.19 a	0.06 a	0.25 a	0.08 a	0.20 a	0.148 a	0.42 a
I – dual	0.21 a	0.08 a	0.22 a	0.09 a	0.36 a	0.160 a	0.27 a
MR - untr	0.36 a	0.08 a	0.31 a	0.07 a	0.16 a	0.215 a	0.61 a
MR – flag	0.27 a	0.07 a	0.22 a	0.07 a	0.38 a	0.138 a	0.45 a
MR – head	0.26 a	0.10 a	0.29 a	0.07 a	0.22 a	0.238 a	0.34 a
MR – dual	0.27 a	0.06 a	0.30 a	0.08 a	0.33 a	0.166 a	0.55 a
S.E.M.	0.049	0.021	0.093 ^z	0.023	0.064	0.054	0.089

Table 18. Main effect (variety and fungicide treatment) means for deoxynivalenol (DON; ppm) in barley harvest samples from seven sites in 2020 and 2021. Main effect means within a location followed by the same letter do not significantly differ (Tukey's range test, $P < 0.05$).

Main Effect	IH-20	YK-20 ^z	MF-20 ^y	IH-21	YK-21	ME-21	BR-21
<u>Variety</u>	----- Deoxynivalenol - DON (ppm) -----						
Bow (MS)	0.056 A	0.008 A	0.108 A	–	–	–	–
Synergy (I)	0.056 A	0.003 A	0.098 A	–	–	–	–
Connect (MR)	0.028 A	0.004 A	0.081 A	–	–	–	–
S.E.M.	0.0255	0.0039	0.0306 ^z	–	–	–	–
<u>Fungicide</u>							
Untreated Control	0.061 A	0.011 A	0.125 A	–	–	–	–
Flag	0.058 A	0.006 A	0.078 A	–	–	–	–
Head	0.020 A	0.003 A	0.126 A	–	–	–	–
Dual	0.048 A	0.002 A	0.054 A	–	–	–	–
S.E.M.	0.0283	0.0045	0.0351	–	–	–	–

Table 19. Individual treatment means (variety by fungicide treatment) for deoxynivalenol (DON; ppm) in barley harvest samples from seven sites in 2020 and 2021. Means within a location followed by the same letter do not significantly differ (Tukey’s range test, $P < 0.05$).

Treatment	IH-20	YK-20 ^z	MF-20 ^y	IH-21	YK-21	ME-21	BR-21
Variety - Fung	----- Deoxynivalenol - DON (ppm) -----						
MS - untr	0.143 a	0.033 a	0.085 a	–	–	–	–
MS – flag	0.040 a	0.000 a	0.100 a	–	–	–	–
MS – head	0.030 a	0.000 a	0.158 a	–	–	–	–
MS – dual	0.013 a	0.000 a	0.090 a	–	–	–	–
I - untr	0.040 a	0.000 a	0.177 a	–	–	–	–
I – flag	0.025 a	0.000 a	0.070 a	–	–	–	–
I – head	0.030 a	0.008 a	0.140 a	–	–	–	–
I – dual	0.128 a	0.005 a	0.005 a	–	–	–	–
MR - untr	0.000 a	0.000 a	0.113 a	–	–	–	–
MR – flag	0.108 a	0.018 a	0.065 a	–	–	–	–
MR – head	0.000 a	0.000 a	0.080 a	–	–	–	–
MR – dual	0.003 a	0.000 a	0.068 a	–	–	–	–
S.E.M.	0.0449	0.0079	0.0605	–	–	–	–

Table 20 Main effect means for barley variety effects on leaf disease at Indian Head in 2020. Main effect means within a column followed by the same letter do not significantly differ (Tukey’s range test, P < 0.05).

Source/ Main Effect	T1 ^z -Scald	T1_Net Blotch	T1_Other	T1_Total	T2 ^y -Scald	T2_Net Blotch	T2_Other	T2_Total
<u>Tests of Fixed Effects</u>								
	----- Leaf Area Affected (%) -----							
VAR	0.422	–	0.809	0.681	0.582	–	<0.001	<0.001
FUNG	–	–	–	–	0.540	–	0.921	0.893
VAR x FUNG	–	–	–	–	0.292	–	0.415	0.397
	----- Leaf Area Affected (%) -----							
Bow (MS)	0.00 A	0	0.08 A	0.08 A	0.04 A	–	1.88 B	1.91 B
Synergy (I)	0.05 A	0	0.10 A	0.15 A	0.00 A	–	3.10 A	3.10 A
Connect (MR)	0.00 A	0	0.05 A	0.05 A	0.04 A	–	4.00 A	4.04 A
S.E.M.	0.029	–	0.057	0.079	0.035	–	0.291	0.304
<u>Fungicide</u>								
Untreated	–	–	–	–	0.00 A	–	2.93 A	2.93 A
Flag	–	–	–	–	0.05 A	–	2.90 A	2.95 A
Head	–	–	–	–	0.00 A	–	2.95 A	2.95 A
Dual	–	–	–	–	0.00 A	–	3.19 A	3.24 A
S.E.M.	–	–	–	–	0.038	–	0.336	0.347

^z T1 timing was flag-leaf emergence with 3rd leaf from head rated (10 per plot)

^y T2 timing was late-milk / early-dough with penultimate leaf rated (10 per plot)

NOTE: All values for initial and final net blotch ratings were zero

Table 21 Main effect means for barley variety effects on leaf disease Yorkton in 2020. Main effect means within a column followed by the same letter do not significantly differ (Tukey’s range test, P < 0.05).

Source/ Main Effect	T1 ^z -Scald	T1_Net Blotch	T1_Other	T1_Total	T2 ^y -Scald	T2_Net Blotch	T2_Other	T2_Total
<u>Tests of Fixed Effects</u>								
	----- Leaf Area Affected (%) -----							
VAR	–	–	0.597	0.597	0.129	0.379	0.044	0.026
FUNG	–	–	–	–	0.181	0.405	<0.001	<0.001
VAR x FUNG	–	–	–	–	0.205	0.442	0.351	0.567
	----- Leaf Area Affected (%) -----							
Bow (MS)	0	0	1.08 A	1.08 A	0.07 A	0.00 A	2.14 A	2.21 A
Synergy (I)	0	0	1.13 A	1.13 A	0.03 A	0.00 A	1.66 B	1.69 B
Connect (MR)	0	0	1.03 A	1.03 A	0.00 A	0.01 A	1.88 AB	1.89 AB
S.E.M.	–	–	0.058	0.058	0.028	0.007	0.142	0.149
<u>Fungicide</u>								
Untreated	–	–	–	–	0.03 A	0.00 A	3.32 A	3.34 A
Flag	–	–	–	–	0.03 A	0.00 A	1.30 BC	1.33 BC
Head	–	–	–	–	0.00 A	0.00 A	1.82 B	1.82 B
Dual	–	–	–	–	0.08 A	0.02 A	1.14 C	1.24 C
S.E.M.	–	–	–	–	0.031	0.008	0.161	0.167

^z T1 timing was flag-leaf emergence with 3rd leaf from head rated (10 per plot)

^y T2 timing was late-milk / early-dough with penultimate leaf rated (10 per plot)

NOTE: All values for initial and scald and net blotch ratings were zero

Table 22 Main effect means for barley variety effects on leaf disease Melfort in 2020. Main effect means within a column followed by the same letter do not significantly differ (Tukey’s range test, P < 0.05).

Source/ Main Effect	T1 ^z -Scald	T1_Net Blotch	T1_Other	T1_Total	T2 ^y -Scald	T2_Net Blotch	T2_Other	T2_Total
<u>Tests of Fixed Effects</u>								
	----- Leaf Area Affected (%) -----							
VAR	0.071	–	0.099	0.069	0.008	–	0.247	0.017
FUNG	–	–	–	–	0.856	–	0.334	0.298
VAR x FUNG	–	–	–	–	0.919	–	0.925	0.983
	----- Leaf Area Affected (%) -----							
Bow (MS)	0.55 A	0	2.85 A	3.40 A	1.08 A	0	4.09 A	5.16 A
Synergy (I)	0.28 A	0	1.88 A	2.15 A	0.08 B	0	3.69 A	3.78 AB
Connect (MR)	0.13 A	0	1.15 A	1.28 A	0.06 B	0	3.16 A	3.23 B
S.E.M.	0.195	–	0.52	0.677	0.245	–	0.525	0.646
<u>Fungicide</u>								
Untreated	–	–	–	–	0.53 A	–	4.27 A	4.79 A
Flag	–	–	–	–	0.53 A	–	3.78 A	4.31 A
Head	–	–	–	–	0.27 A	–	3.37 A	3.63 A
Dual	–	–	–	–	0.30 A	–	3.18 A	3.48 A
S.E.M.	–	–	–	–	0.283	–	0.570	0.670

^z T1 timing was flag-leaf emergence with 3rd leaf from head rated (10 per plot)

^y T2 timing was late-milk / early-dough with penultimate leaf rated (10 per plot)

NOTE: All values for initial and final net blotch ratings were zero