IMPROVING MALTING BARLEY YIELD & QUALITY IN NORTHERN CLIMATES

2019 ANNUAL REPORT

NORTHERN ONTARIO FARM INNOVATION ALLIANCE

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Introduction

The beer economy contributes $13.68 billion to Canada's GDP and, as of 2016, supported 149,000 Canadian jobs. Ontario has over 200 craft beer breweries and the Ontario Craft Brewers Association predicts upwards of 500 breweries in Ontario over the next decade. In recent years, craft beer has been the fastest growing segment within the LCBO's beer category, with annual increases of 20-30%. With this growth in craft beer, there is an increased demand for regionally produced malt.

Currently, most of the malting barley is produced in Western Canada, with Ontario importing over 300,000 tonnes per year. However, with increased demand for Ontario malt, there is strong market potential for Ontario-grown malting barley. The climate in Northern Ontario is somewhat like that of Western Canada and offers a promising opportunity to support further growth in malting barley production. However, to meet the standards for brewing, malting barley must be grown with appropriate management practices that can be intensive. The risk for farmers is that they won't know if they've met malt quality until post-harvest testing is completed. Research on variety evaluations and nutrient management techniques will support Ontario growers in accessing these markets.

The Northern Ontario Farm Innovation Alliance is coordinating a three-year research project (2018-2021) on "Improving Malting Barley Yield and Quality in Northern Climates", in partnership with the Grain Farmers of Ontario and the Canadian Agricultural Partnership (through the Agricultural Adaptation Council). This is a pan-northern research trial evaluating malting barley varieties and best management practices in different regions across Northern Ontario. The research outcomes will help Ontario's grain farmers grow malting barley to maximum yield and quality, targeting the domestic market and adding a potential new crop to farmers' rotations.

Research Trials

Trials are being conducted at the New Liskeard Agricultural Research Station (NLARS) in New Liskeard, the Lakehead University Agricultural Research Station (LUARS) in Thunder Bay, and the Emo Agricultural Research Station (EARS) in Emo. On-farm trials are being coordinated by the Rural Agri-Innovation Network (RAIN) in Algoma studying dual-purpose malting barley varieties (i.e. can be used for either feed or malt).

The work at the three research stations is assessing:

1. Ten high-yielding varieties of malting barley, including Bentley, AAC Synergy, CDC Bow, CDC Kindersley, CDC Fraser, AAC Connect, Lowe, Newdale, Copeland and OAC 21 for yields and quality.
2. Nitrogen and sulphur management strategies to improve yields while maintaining protein content to acceptable levels. Nitrogen has a major impact on protein levels in the crop, while sulfur levels have been declining in Ontario soils. Both nutrients are likely to increase yields, but the downside is adverse effects on the overall malt quality of the barley. Therefore, varying rates of these nutrients are being tested to determine the best nutrient management plan for malting barley in Northern Ontario. Seven different rates of nitrogen using urea and ESN and three rates of sulfur using gypsum are being tested. These nutrient tests are being done on CDC Bow.

Additionally, dual-purpose varieties are being assessed on-farm in Algoma as these can be used for both malt and feed and would help mitigate risk for farmers if conditions are not conducive to growing high quality malting barley.

Results

The results from the three stations have been summarized below. Aggregate samples were also sent to Canada Malt for quality testing. Barley quality analysis determined whether the samples were suitable for malt production – if they were, they underwent additional analysis to assess malt quality.

Barley Quality

The following include some of the variables that are important for barley quality:

- Protein – barley protein within the range of 11-12.5% can be used by maltsters to meet many brewers' needs. Barley with high protein levels results in lower extracts and slows down water uptake during steeping, which can affect final malt quality. Low protein levels lack the enzymes necessary to modify the barley kernel and to break down the starch during brewing.
- Moisture – barley over 13.5% moisture does not store well. It can be dried but must be done very carefully as excessive heat can damage germination in the kernels.
- Peeled & Broken – limit of 5% or less for properly threshed barley. Barley is commonly rejected for malting if there are too many peeled and broken kernels, mostly caused by improper combine adjustments.
- Plump – barley with greater than 80% plumpness is desirable as plump kernels contain higher levels of starch, which will produce more beer from a given weight of malt.
- Germination energy – barley with greater than 95% germination is acceptable for malting. If this threshold isn't reached, the barley won't have enough energy to be efficient during the malting process.

Variety Trial

The highest grain yielding variety averaged across the three research stations was AAC Connect (see figure 1). The highest yielding variety at EARS was CDC Bow, at NLARS was AAC Connect, and at LUARS was CDC Lowe. In 2018, the highest yielding variety at all three stations had been AAC Synergy.

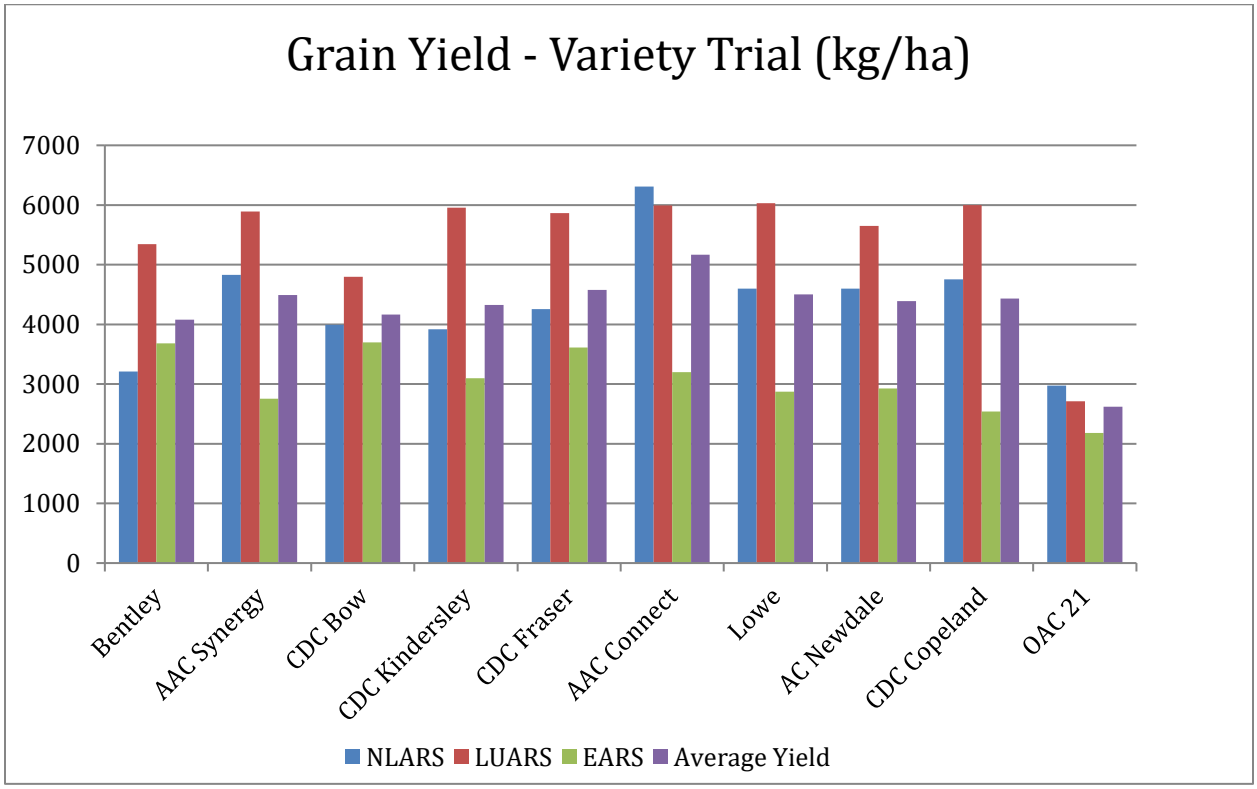

Figure 1. Comparison of grain yields from the ten malting barley varieties across the three research stations.

At NLARS, only CDC Copeland, CDC Fraser, OAC 21 and AC Newdale varieties had a sufficient yield to be tested for other metrics. Those four varieties were all well within the acceptable threshold for moisture. CDC Copeland and Fraser fell below the lower limit for protein content of 11%. CDC Copeland had a protein content of 10.75%, while CDC Fraser had a protein content of 9.33%. OAC 21 and AC Newdale were above the upper limit for protein content of 12.5%. OAC 21 had a protein content of 14.24% while AC Newdale had a content of 13.66%.

At EARS, none of the varieties were sufficient to be able to be tested for protein or quality.

At LUARS, Bentley, AAC Synergy, AAC Connect, AC Newdale, CDC Copeland, and OAC 21 were all tested. All varieties were well within the acceptable protein range. AC Newdale, CDC Copeland, and OAC 21 were above the limit, with contents of 12.53%, 13.44% and 15.08% respectively.

Nitrogen & Sulphur Management Trial

Malt quality is extremely sensitive to nitrogen fertility. In many cases, the best quality is achieved by adding little or no nitrogen. However, this can be difficult to reconcile as nitrogen also drives yield. Therefore, it is important to find a balance between yield and quality. Protein levels can indicate appropriate levels on nitrogen – if protein levels are high, nitrogen applications should be reduced. This general relationship between nitrogen, protein and yield can be seen in the graph below and will be further explored in the final report at the end of the three years of this trial. The only station with sufficient data to be tested for nitrogen and sulphur was NLARS, and its results can be seen below (figure 2).

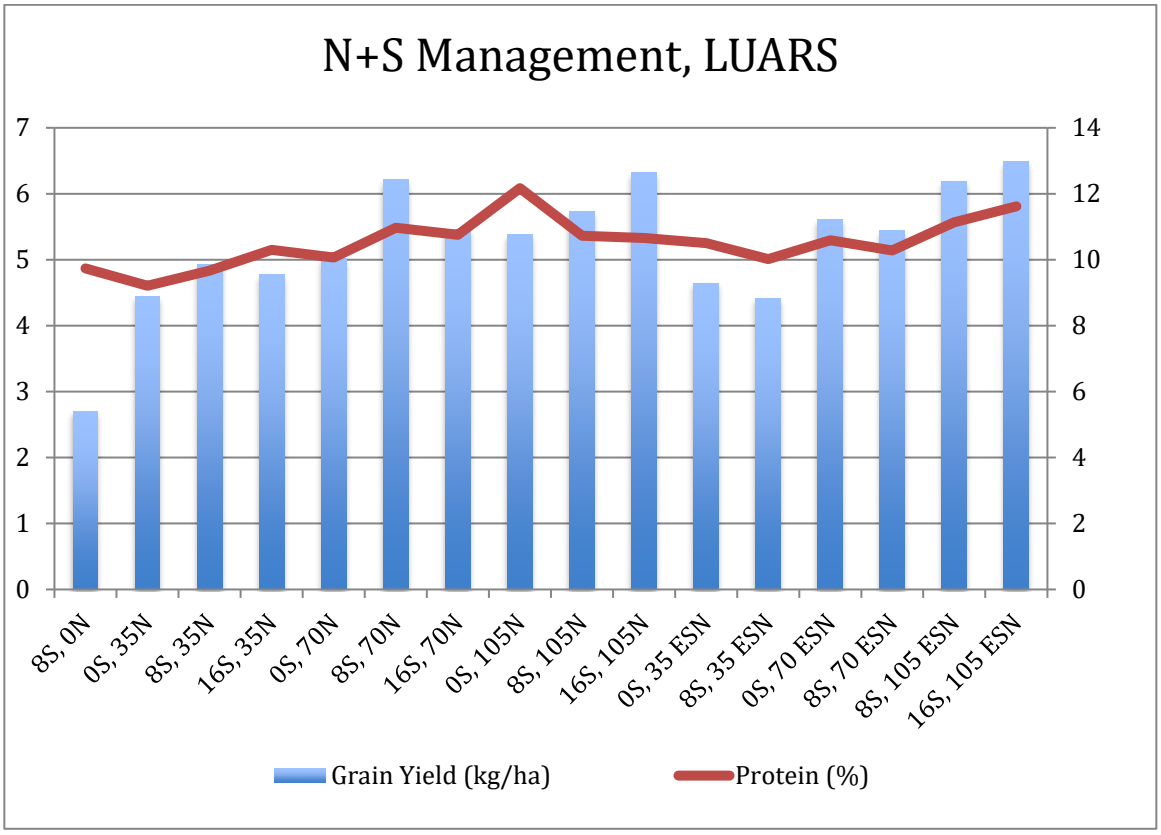

Figure 2. Comparison of nitrogen and sulphur treatments on malting barley yield and protein content at LUARS.

Malt Quality

Quality samples that tested within acceptable protein ranges underwent further testing for malt quality, identifying traits necessary for brewing different kinds of beer. These traits include:

- Moisture content – the closer a malt is to 1.5%, the less it risks mold growth and it loses less flavour and aroma over time. The upper limit for acceptable moisture in any malt is 6% and coloured malts should never be over 4% MC.
- % DBGF –this measurement indicates the maximum soluble yield possible for malt, the higher the percentage, the more soluble the material and the less husk and protein. Anything lower than 78% is considered substandard.
- % DBCG – indicates the amount of yield a brewer can target, based upon the degree of starch modification that the grain underwent during malting. These values typically need to be reduced by 5% - 15% to reflect actual yields obtained in a brewhouse since they are less efficient than the lab.

At NLARS, Copeland, Fraser, OAC 21 and Newdale varieties ranged between 4.2 and 5.1%, below the limit of 6%, but far from the ideal 1.5%. At LUARS, Bentley, Synergy, Connect, Copeland and OAC 21 all scored within the acceptable limit, with measurements ranging between 4.9 and 5.2%.

At NLARS, only Fraser scored above the acceptable DBGF% limit of 78%, with 78.9%. The other varieties fell below the limit, though AC Newdale was very close at 77.9%. LUARS had more varieties in the acceptable range, with Bentley, Synergy, Connect and Newdale scoring between 81.4 and 79.6%. Copeland and OAC 21 were below the threshold with 77.9% and 73.0%, respectively. All of the different nitrogen and sulphur management levels at LUARS resulted in DBGF% levels above the 78% limit, with scores from 81.9 to 83%.

Fraser had the highest %DBCG at NLARS, with 77.8%, while Copeland had the lowest, with 73%. OAC 21 and Newdale fell between those scores with 75.1% and 75.3%, respectively. Connect had the highest %DBCG at LUARS with 79.6%, while OAC 21 had the lowest, with 69.8%. The rest of the varieties fell between those scores.

On-Farm Trials

The on-farm aspect of this project is being coordinated by the Rural Agri-Innovation network on two farms based in the Algoma district. Three varieties were tested on each farm: AC Metcalfe, AAC Synergy and AC Newdale. As mentioned earlier, these three varieties are dual-purpose, in that they can be used for malting if they meet necessary thresholds or they can be used as livestock feed if they do not meet malt requirements. This is intended to reduce the risk to the farmer by acting as a backup plan in case the growing conditions are not conducive to malting and the crop grown does not meet malt quality.

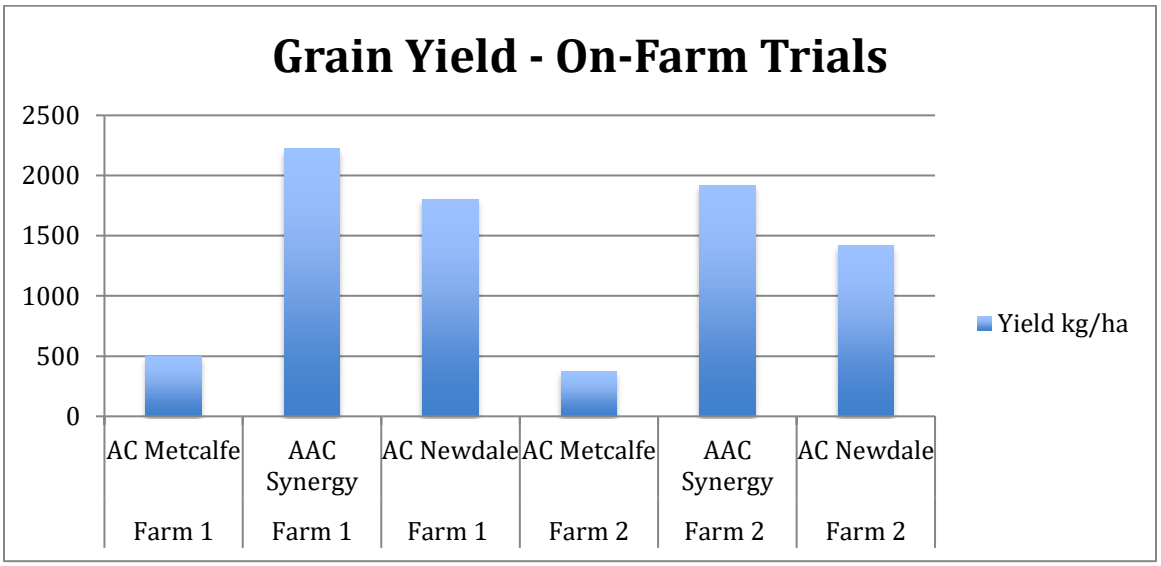

Figure 3. A comparison of the yields of three varieties of barley grown in the two on-farm trials.

Figure 3 clearly shows that there are distinct and repeatable yield differences in the three varieties in the on-farm trials. Across the two farms, AAC Synergy was the highest yielding with an average of 2069.46 kg/ha. AC Newdale followed with an average yield of 1612.32 kg/ha, while AC Metcalfe trailed significantly with an average yield of 432.42 kg/ha.

Samples from these trials were also tested for malt quality. The moisture content of the samples ranged from 4.4% to 4.8%, within the acceptable upper limit of 6%, but far from the 1.5% ideal value. Only two of the samples tested above the 78% minimum limit for DBGF%: AC Newdale (Farm 2), with 80%, and AAC Synergy (Farm 1), with 79.9%. The other samples ranged from 76.3% to 77.7%. The DBCG% of the samples ranged from AAC Synergy (Farm 1) at 78.1%, to AAC Synergy (Farm 2) at 73.8%. The other samples scored within this range.

Two sampels tested below the 11% lower limit for protein. AAC Synergy (Farm 1) scored 10.73%, and AC Newdale (Farm 2) scored 10.87%. The other samples were above the acceptable limit, with AC Metcalfe (Farm 1) scoring the highest at 13.43%.

Considerations Moving Forward

Similar to what we saw in 2018, the 2019 data was significantly impacted by weather. A cool, wet spring caused delays in planting and washouts of seedlings in some plots. A hot, dry summer followed, leading to higher protein levels due to greater intake of nitrogen by the crop. Finally, a wet harvest impacted the quality of malting barley from some locations. Notably, the Rainy River district, where EARS is located, had record levels of rainfall, which damaged many crops and hampered the harvest season.

Early planting and high yields usually result in lower percentage protein levels. Excessive rates of nitrogen fertilizer will increase protein levels, but the application of nitrogen, based on soil tests, to obtain optimum yields will normally only have a minor effect on the protein content of the grain. Good production practices that increase yield will generally tend to reduce protein levels.

The farmer, maltster and brewer each have different considerations with regards to malt barley. The farmer needs to consider Deoxynivalenol (DON) and protein and chitting needs to be low after harvest. The maltster is concerned about low beta-glucans and protein, while the brewer needs low colour, high extract and low protein.

Timing is essential for a good harvest of malt barley. Extremely high values for chitting or pre-harvest sprouting (anything over 5%) are enough to impact the entire harvest. Due to the high-level enzymes in malt barley compared to feed barley, it is common in Eastern Canada to take the barley off at 18-20% moisture and use forced air in the grain bin to get the moisture down. It has been said that “nothing good happens after physiological maturity”. High chitting numbers can correlate with high numbers of peeled and broken kernels, mildew, etc.

Beta-glucans are going to be an issue for Eastern Canada. The levels from preliminary results are very high, and most varieties in the first two years illustrated this. This is largely governed by the grain filling period, and there is little that can be done by the farmer, other than to try and grow varieties that genetically have lower levels of beta-glucans.

These trials will be repeated for a third time in 2020, after which an overall data summary, economic analysis, and best practices report will be produced.

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