Activity 12

A Collaborative Approach to Genomic Selection in Winter Wheat to Accelerate Improvement of Complex Traits

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This research activity, led by Michel McElroy of the Centre de recherche sur les grains inc (CÉROM) in St-Mathieu-de-Beloeil, QC. is developing genomic modelling tools that will enhance the efficiency of winter wheat breeding programs in Eastern Canada and increase the effectiveness of the material exchange among them. This research is a new initiative, and it builds and strengthens the researcher's existing breeding programs, some of which were funded through previous cluster research.

Genomic selection is a breeding technique where important plant traits like yield are predicted by mathematical models developed from genetic information and agronomic measurements taken in the field. It's similar to marker-assisted selection but instead of using one marker for a trait, thousands of markers developed from the genetic information we know about a plant are used to predict a trait. When these models are accurate, breeding programs can increase their efficiency in developing new and better varieties by identifying good variety candidates early in their breeding program, before field testing begins. This approach is also used to predict the best possible parent combinations to use for crosses.

Accurate prediction models require a lot of good data. In the current research activity this is achieved through the collaboration among four research programs in Eastern Canada: CÉROM, Agriculture and Agri-Food Canada (AAFC) Ottawa Research and Development Centre (RDC), the University of Guelph and the University of Guelph Ridgetown Campus. These well-established research centres have teamed up to share resources to test a selection of candidate varieties with desirable traits and breeding material at several sites across Eastern Canada. Data is collected

KEY TAKEAWAYS

- **New genomic modelling tools are being developed that will enhance the efficiency of winter wheat breeding programs in Eastern Canada and increase the effectiveness of material exchange among them**
- **Research is well underway**
- **Genomic selection is a breeding technique where important plant traits like yield are predicted by mathematical models developed from genetic information and agronomic measurements taken in the field**
- **Data is collected manually in the field of the desirable traits with the field measurements then coupled with the genomic information of candidate varieties being used to develop predictive models that can estimate a trait or a response for breeding material**
- **Good data was collected in 2023 field season despite environmental and harvest challenges**
  - Analysis of the data from the 2023 field experiments is well underway with investigators evaluating the marker data which has provided information into the important genes that influence traits

Winter wheat fusarium nursery trials at CÉROM St-Mathieu-de-Beloeil, QC. in 2023.

Winter wheat agronomic trials at CÉROM in St-Mathieu-de-Beloeil, QC. in 2024. PHOTOS: CÉROM

manually in the field on the desirable traits, for example yield, plant height, or lodging tolerance. Then, these field measurements are coupled with the genomic information of the candidate varieties to develop predictive models that can estimate a trait or a response for breeding material that wasn't used to develop the model. It's also important the model is validated using measurements that weren't used to build the model, this way the researchers can ensure the model is accurate or requires improvement.

So far, field experiments have been conducted in Beloeil, QC. (CÉROM), Ottawa, ON. (AAFC Ottawa), Elora, ON. (University of Guelph) and Tupperville, ON. (University of Guelph, Ridgetown Campus). One year of field work has been completed, including agronomic and Fusarium head blight trials, and single markers have been run on the candidate varieties to determine what single genes have the greatest effect on the sought after traits are present in the breeding material. Analysis of the data from the 2023 field experiments are well underway and the investigators are evaluating the marker data which has provided information into the important genes that influence traits like plant height, winter survival, disease tolerance, and seed quality.

This genetic information is valuable to have while interpreting results from the field, and later, when the predictive model is developed. Further to this, it's important information to have when breeding material is exchanged among breeding programs. For example, if there's a gene for disease tolerance that hasn't been found in McElroy's breeding program but is present in a collaborator's, they can exchange breeding material which will make both breeding programs stronger and ultimately develop better varieties for farmers in Eastern Canada.

The 2023 field season had some challenges including several big rainstorms that resulted in lodging and harvest difficulties. However, this also gave the researchers an opportunity to evaluate their material in conditions that farmers deal with too and it was a good opportunity for them to evaluate lodging tolerance.