Latest Research Results

organic SCIENCE CLUSTER 3

Biological control and management of Fusarium head blight and associated diseases in organic grain production

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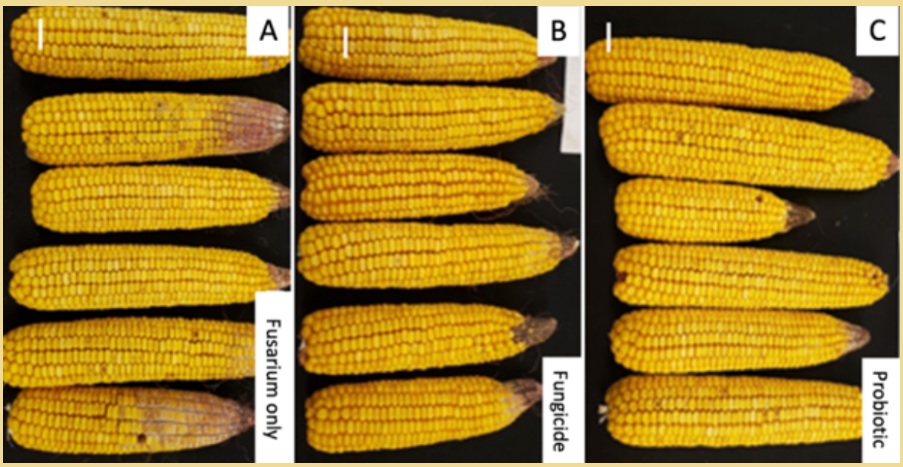
Problem Statement:

The fungal pathogen *Fusarium graminearum* (Fg) can reduce the income of Canadian grain farmers by causing the disease Fusarium Head Blight (FHB) in wheat and barley, and Gibberella ear rot in corn. Outbreaks of these diseases are expected to worsen due to climate change, which could transform them into global pandemics for these two critical crops which underpin human and livestock nutrition. Fg deposits mycotoxins in the grain including DON (deoxynivalenol) that can cause reduced weight gain in livestock and suppress immunity. There has been progress in breeding corn and wheat for improved disease resistance, and improvements in conventional fungicides, but, even together, they do not provide complete disease/mycotoxin control, especially during outbreaks. Thus, even conventional farmers need a third solution to add to their mitigation strategies. We hypothesized that probiotic bacteria could be useful, as they are theoretically compatible with fungicides including organic fungicides. There have been attempts to use anti-Fusarium probiotic microbes but none have been successful commercially, due to poor effectiveness. In wheat, Fg spreads between developing grains through the stem (rachis) that connects them; in corn, it spreads from the environment into the grain via silks, the threads at the tips of corn cobs. We hypothesized that the rachis (primary focus) as well as silks (secondary focus) of some wild, ancient or selected wheat and corn possess probiotics that are pre-adapted to these Fusarium entry points, and could be effective sources of anti-Fg bacteria. We hypothesized that these bacteria could be used as late-season sprays.

Objectives:

To discover safe new probiotics from wheat rachis tissues and corn silks, and test them for their ability to suppress FHB in winter wheat, GER in corn, and associated DON mycotoxin using greenhouse and field trials.



Effectiveness of a probiotic spray for corn silks under field conditions in terms of reducing Gibberella ear rot disease compared to a common commercial fungicide (J. Gregory and M.N. Raizada, University of Guelph).

Methods:

Bacteria were isolated from modern, wild and ancient relatives of corn and wheat, specifically from silks and rachis, respectively. Hundreds of bacteria were screened for their ability to suppress Fg in vitro, then evaluated for their safety to humans and livestock. Safe bacteria were selectively tested in replicated greenhouse and field trials, in parallel to mycotoxin testing of the grain.

Results and Conclusions:

We were able to isolate ~300 bacteria and fungi from the grain head rachis of wild, ancient and heirloom wheat, along with hundreds isolated from corn silks, which were screened in vitro for their ability to suppress *Fusarium graminearum*. In the lab, >90 of these strains suppressed Fusarium. After selecting for probiotics that were safe for humans and livestock, a subset proceeded to greenhouse and field trials. We showed that the best rachis probiotics could suppress Fusarium-derived mycotoxins by up to 90% in corn, and 70% in wheat, under controlled greenhouse conditions. Under field conditions, we identified 4 probiotic strains that after spraying onto corn silks could reduce DON mycotoxin by ~20-30%, improve thousand kernel weight by 4-20%, and improve absolute grain yield by 10-25% compared to negative controls. However, we observed year to year variability in the effectiveness of the probiotics. For winter wheat exported to the U.S., the acceptable threshold for DON mycotoxin for humans is 1 ppm. Here, we showed that a combination of a non-organic fungicide and one of the probiotics could prevent infected grain from exceeding this threshold, whereas fungicide alone could not; a result which suggests that an integrated approach should be used, consisting of a probiotic with a conventional or organic fungicide.

Future Research Needed:

The next research step is to breed the anti-Fusarium strains for improved anti-Fusarium potency and especially for improved stability under field conditions which suffer from variable environmental conditions that affect probiotics, which are alive, unlike chemical fungicides.

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