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Advances in integrated management of Fusarium head blight through Canada's Pest Management Centre

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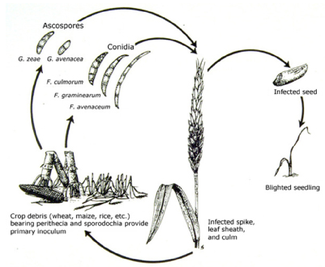
Fusarium head blight (FHB), caused by *Fusarium* spp. is a destructive and economically important disease of cereals across Canada. The disease can cause significant yield loss and reduction in the grade of grains due to contamination with mycotoxin such as DON. *F. graminearum* is the predominant species, particularly abundant in eastern Canada and Manitoba. Fully resistant wheat varieties are not yet available and FHB management relies mainly on the use of fungicides. Alternative control solutions and tools were needed to:

(i) manage the risk of pathogen resistance to fungicides,
(ii) minimize the environmental impact of pesticide load, and
(iii) improve the efficacy of all tools and achieve cost-effective FHB management.

Fusarium head blight symptoms on wheat heads



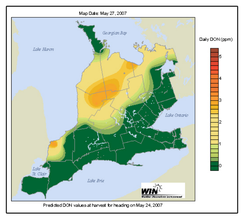
Fusarium head blight - Disease Cycle (Courtesy A. Schilder and G. Bergstrom)

The Pesticide Risk Reduction Program of AAFC's Pest Management Centre established a national working group of FHB experts and stakeholders to develop a strategy for sustainable FHB management. Solutions identified through consultations with this working group are being implemented by the Program through research and demonstration work. Ten projects supported since 2006 focus on a three pronged approach with outcomes ranging from improved ***decision support*** tools, development of a ***biocontrol*** product and validation of ***cultural control*** practices. Making new knowledge and solutions accessible to growers helps diversify the FHB control toolbox, enables practice of integrated management and minimizes reliance on fungicides.

Decision Support

Field validation trials conducted in wheat growing region of Ontario in 2006 - 2007 led to a more accurate, site-specific (ss) version of DONcast spray advisory system, originally developed in 2002[1]. Since 2008, the upgraded ssDONcast is delivered to growers through http://weathercentral.ca, providing field-specific predictions of DON levels in wheat grain at harvest and spray recommendations accordingly at the time of heading.

Weather monitoring instruments placed in a wheat field



Example of a regional ssDONcast generated map

Extensive field validation and demonstration trials were conducted from 2010 - 2013 across provinces of Saskatchewan, Manitoba, and Quebec to test the prediction accuracy and suitability to Canadian conditions of a variety of existing forecasting models. The tested models originated from various countries in three continents as described in the table below:

Model	Country of origin	Purpose: designed to predict	Tested in Provinces
DONcast (Hooker *et al.*, 2002)	Canada	DON levels in harvested grain	Ontario, Quebec
De Wolf (De Wolf *et al.*, 2003), (models A, B, I tested in QC)	USA	probability of epidemics (≥10% disease severity)	Saskatchewan, Manitoba, Quebec
Molineros (Molineros, 2007)	USA	disease incidence	Quebec
Moschini (Moschini *et al.*, 1996)	Argentina	disease incidence	Quebec
Rossi (Rossi *et al.*, 2003)	Italy	risk of infection and DON levels in harvested grain	Quebec

In Saskatchewan and Manitoba, the De Wolf model provided accurate predictions about 80% of the time and is available through http://weatherfarm.com.

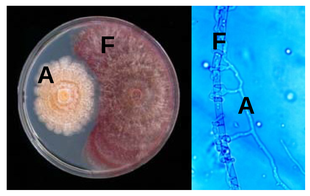
In Quebec, the model De Wolf B performed best with the highest (90%) accuracy in disease risk prediction and is available through http://www.agrometeo.org.

Current status

Decision support tools, scientifically validated for use in different parts of Canada, are now being delivered to growers, who are making more informed decisions on fungicide application.

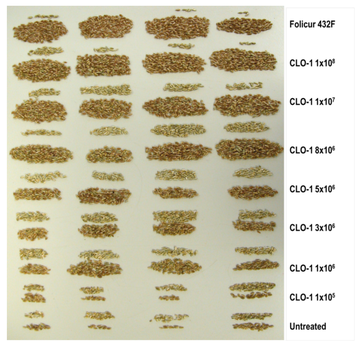
Biological Control

A novel Canadian native strain of the mycoparasitic fungus *Clonostachys roseae* (ACM941), discovered by AAFC's scientist, Dr. Allen Xue, is being developed as a biocontrol product for FHB. Laboratory, greenhouse and field tests conducted from 2007-2011 established the efficacy and optimized the formulation of ACM941 against FHB. These tests also generated some of the data necessary to meet regulatory requirements for registration of this biofungicide in Canada.

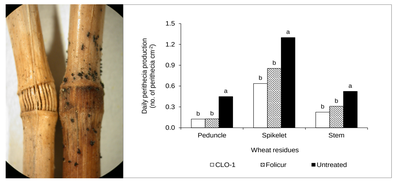


Strain ACM941 (A) reduces mycelial growth of *F. graminearum* (F) in dual-culture (left) due to its mycoparasitic effect (right)

In field trials ACM941 reduced FHB index by 30-46% and DON by 22-33%, providing a control comparable to the standard fungicide Folicur™. Moreover, ACM941 appears to be most effective on moderately resistant wheat cultivars[2].



ACM941 concentrations at or above 10^6 cfu mL^{-1} performed best in suppressing FHB



Perithecial production reduced by 72% on peduncle, 51% on spikelet, and 57% on stem of wheat residue

A fall application of ACM941 (referred to as CLO-1) in the field was also shown to significantly inhibit perithecial production of *Gibberella zeae* on naturally infected wheat stubble in the following growing season (left). These effects were comparable to those achieved by Folicur sprays[3].

Current Status

The Canadian company Adjuvants Plus Inc. was recently granted licensing rights to register and commercialize AAFC's patented strain ACM941 as a new biopesticide. The product will undergo regulatory assessment by Health Canada's Pest Management Regulatory Agency before approval for commercial use in Canada.

Cultural Control

On-farm field demonstration and surveys were conducted from 2010 to 2012 to assess the impact of irrigation management, fungicide spray timing and cropping methods on FHB control in irrigated wheat fields. The project raised grower awareness of the prevalence of *Fusarium* spp. and increasing threat from FHB to irrigated wheat crops in Southern Alberta.

While irrigated wheat crops showed higher FHB levels than dryland, trials demonstrated that reduced irrigation, particularly during flowering, combined with timed fungicide sprays can suppress disease without compromising yield. Various outreach activities[4] were used to inform growers about these findings, and other IPM approaches proven useful such as use of clean seed and consideration of FHB history in the area when making decisions about crop rotation and cultivar selection.

References

1. Using weather variables pre- and post-heading to predict deoxynivalenol content in winter wheat. Hooker, D. C. et *al*. 2002. *Plant Disease* 86:611-619.
2. Concentration and cultivar effects on efficacy of CLO-1 biofungicide in controlling Fusarium head blight of wheat. Xue, A.G. et *al*. 2014. *Biological Control* 73: 2-7
3. Efficacy of CLO-1 biofungicide in suppressing perithecial production by *Gibberella zeae* on crop residues. Xue, A.G. et *al*. 2014. *Can. J. Plant Pathol*. Vol. 36, No. 2: 161-169
4. Farming Smarter *Newsletter*, Fall 2012 Ed. http://www.agcanada.com/wp-content/uploads/2012/10/FS_Fall_2012.pdf

About the Pesticide Risk Reduction Program

This Federal Government Program aims to deliver viable agricultural pest management solutions which reduce pesticide risks in crop production. To learn more about the Program and other strategies, visit www.agr.gc.ca/pmc.

Acknowledgements

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