

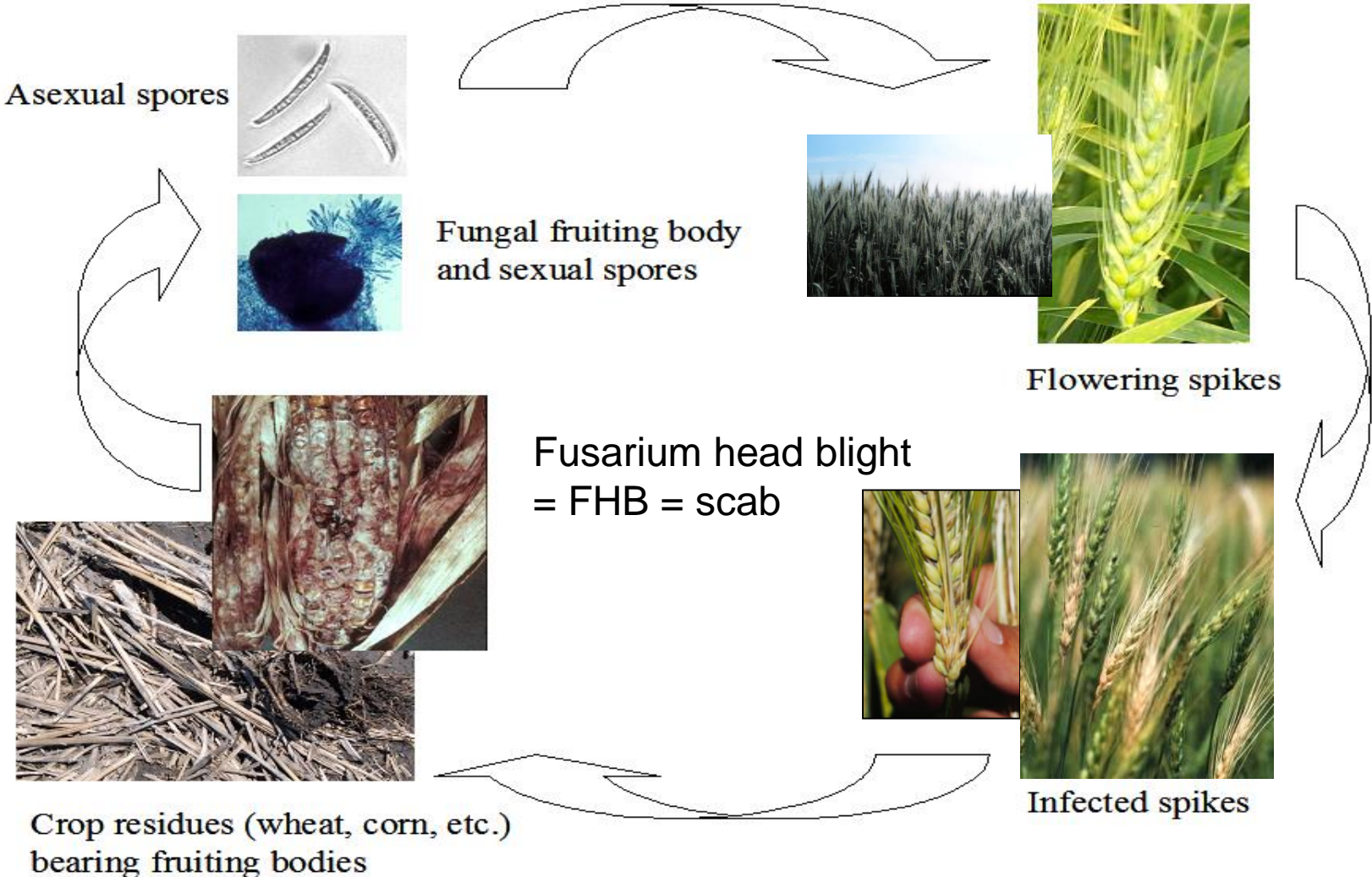
# FHB Management in Wheat and Barley

Marcia McMullen

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North Dakota State University, Fargo, ND  
[marcia.mcmullen@ndsu.edu](mailto:marcia.mcmullen@ndsu.edu)



# Fusarium species overwinter on wheat, barley, corn residue



## **FHB development favored by:**

- Wet weather at wheat flowering; barley at heading
- Saturated soils; prolonged dews
- Moderate temperatures
- Short rotations between susceptible crops; planting into colonized crop residue
- Susceptible cultivars

# Losses due to this disease

Yield

Test Weight

Seed Quality

Baking Quality

Food and Feed Quality

Market Price



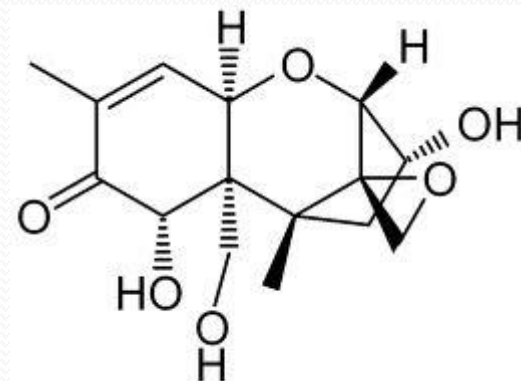
**DON (vomitoxin)**



**= Disruption of grain industry**



- **DON** = deoxynivalenol = vomitoxin
- DON is a fungal by-product produced when *Fusarium graminearum* infects grain
- One of many potential mold toxins caused by *Fusarium* species



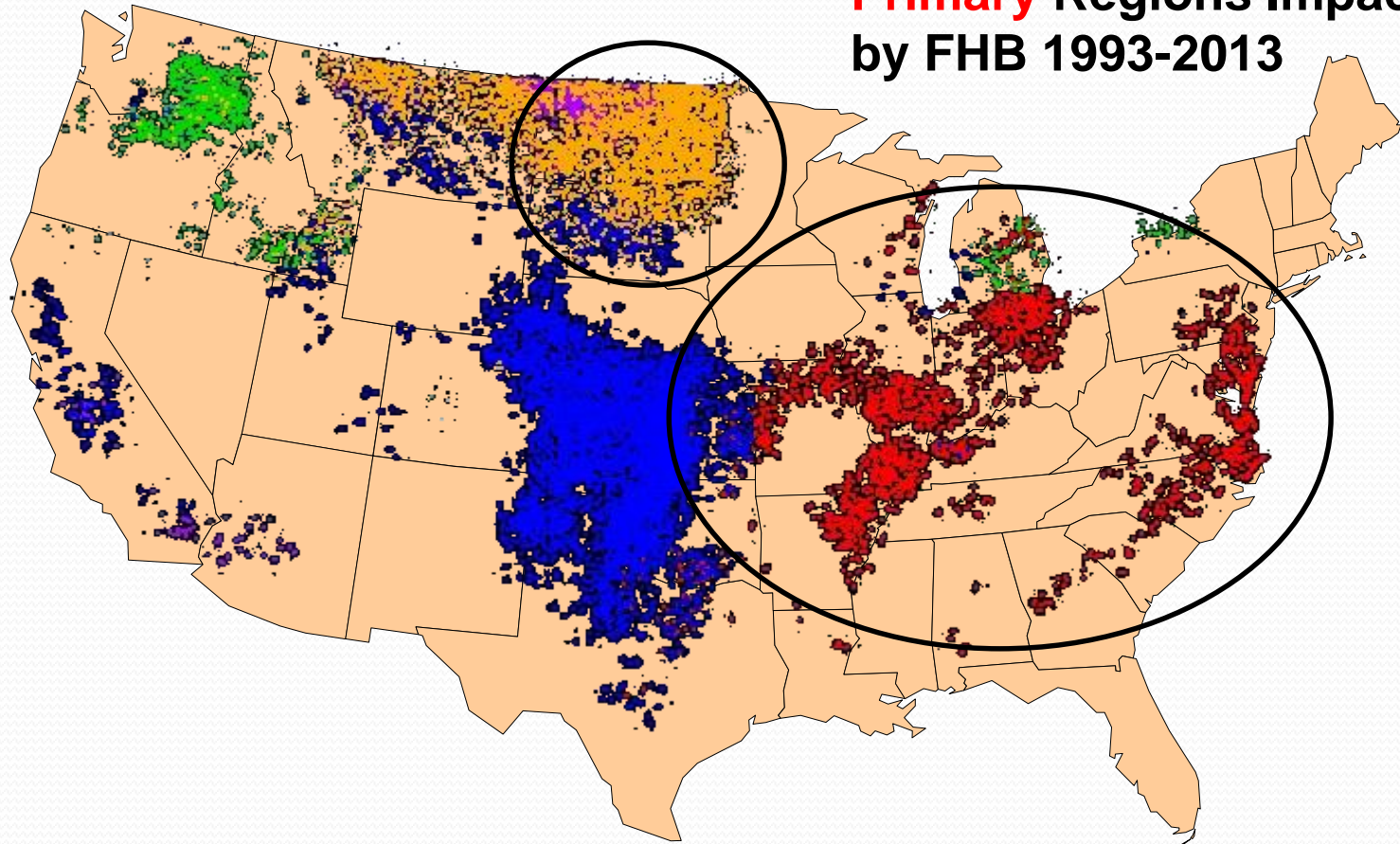
# DON May Cause:

- Feed refusal, poor animal weight gain
- Vomiting in pigs; (ruminants least affected)
- Digestive, inhalation problems
- Chronic immunological, other long term effects
- Gushing in beer
- Poor bread making qualities



# U.S. Wheat Production Areas and FHB

**Primary** Regions Impacted  
by FHB 1993-2013



 Hard Red Winter

 Hard Red Spring

 White

 Soft Red Winter

 Durum

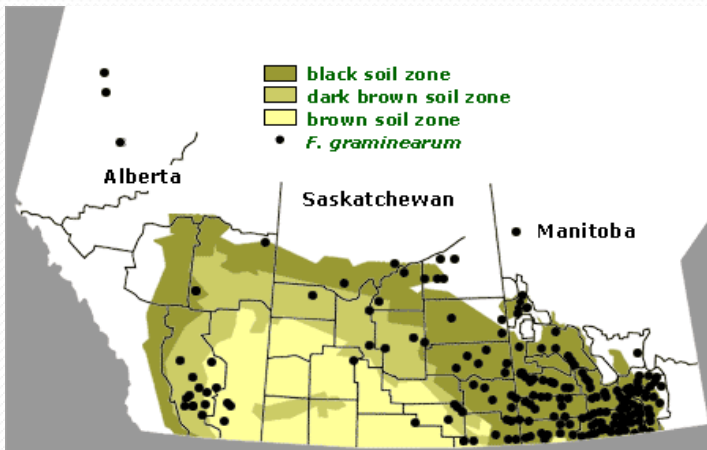


Areas impacted traditionally corresponded to wetter areas of US and Canada



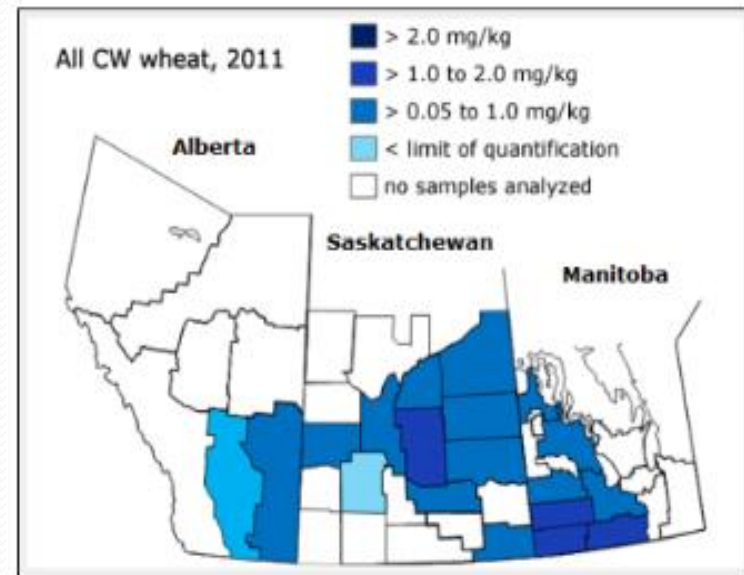


# FHB and DON in Western Canada



- Distribution of *Fusarium graminearum* and soil zones in Western Canada in 2003 (R. Clear, CGC)

## DON levels



Average concentrations of DON (mg/kg) in all CW wheat collected in Prairie crop districts during the 2011 Harvest Sample Program

Average concentrations of DON between 1 and 2 mg/kg were highest in samples from crop districts in southwestern Manitoba and central Saskatchewan.

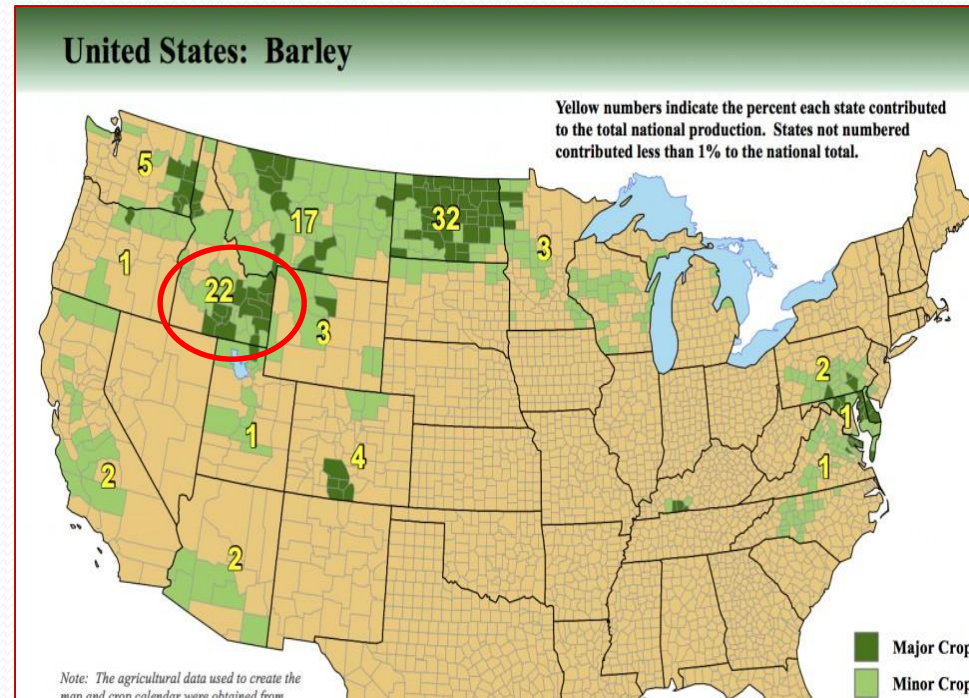
Source: Canadian Grain Commission

<http://www.grainscanada.gc.ca/str-rst/fusarium/fhbmc-feccg-en.htm>

# Irrigation and/or Corn introduction brings increased risk



Picture Sources:  
Idaho Farm  
Bureau and  
Idaho Farmer  
Magazine



FHB recently common in Idaho with increased **corn** production for dairy

# Research/Outreach Responses to Epidemics

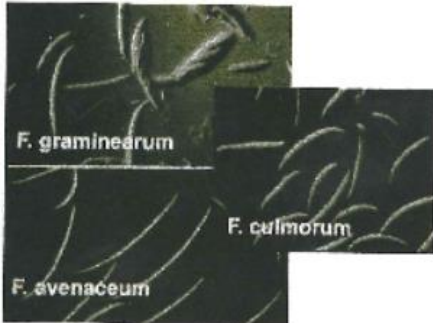
- Regional efforts began in 1993 in US and Canada
- **US Wheat and Barley Scab Initiative (USWBSI) established in 1998**
- Canadian National Workshops





# Proceedings of the 1996 Regional Fusarium/Scab Forum

October 1996, Winnipeg, Manitoba



## Topics of Sessions

- Breeding
- Genetics
- Pathogen Biology and Epidemiology
- Mycotoxin Accumulation and Detection
- Disease Management





7th Canadian Workshop  
on Fusarium Head Blight

7<sup>e</sup> Colloque canadien  
sur la fusariose

# 7th Canadian Workshop on Fusarium Head Blight

November 27-30, 2011  
Winnipeg, Manitoba, Canada

Delta Winnipeg Hotel

## • Research Topic Sessions •

Resistance Breeding	Genomics & Genetics	Pathogen Dynamics
Mycotoxins	Epidemiology & Management	Industry & Consumer Issues

## • Plenary Session • Invited Oral Presentations • Poster Presentations •

### To Receive Future Notices

For registration and hotel details as well as a preliminary agenda, contact the workshop registrar

[Brent.McCallum@agr.gc.ca](mailto:Brent.McCallum@agr.gc.ca)

with the subject line "CWFHB more info"

### Questions?

For additional information contact the co-chairs of the organizing committee

[Andy.Tekauz@agr.gc.ca](mailto:Andy.Tekauz@agr.gc.ca)  
(204) 983-0944

[Jeannie.Gilbert@agr.gc.ca](mailto:Jeannie.Gilbert@agr.gc.ca)  
(204) 983-0891

[www.cwfhb.org](http://www.cwfhb.org)

## Topics of Sessions

- Breeding
- Genetics
- Pathogen dynamics
- Mycotoxins
- Epidemiology, Management
- Industry, Consumer Issues

# Extensive Field, Greenhouse and Laboratory Research







**SCAB SMART**  
MANAGEMENT



# US Wheat and Barley Scab Initiative

[www.scabusa.org](http://www.scabusa.org)

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[Variety Resistance](#)

[Scab Forecasting](#)

[Fungicides](#)

[Crop Rotation](#)

**Other Management Strategies:** [Residue Management](#), [Planting Date](#), [Harvest Practices](#), [Seed Treatment](#)

*All information provided is based on successful strategies identified by extensive research supported by the US Wheat and Barley Scab Initiative with funding provided by USDA-ARS.*



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# Variety Resistance

## Genetic Variation:

Several pathways in wheat

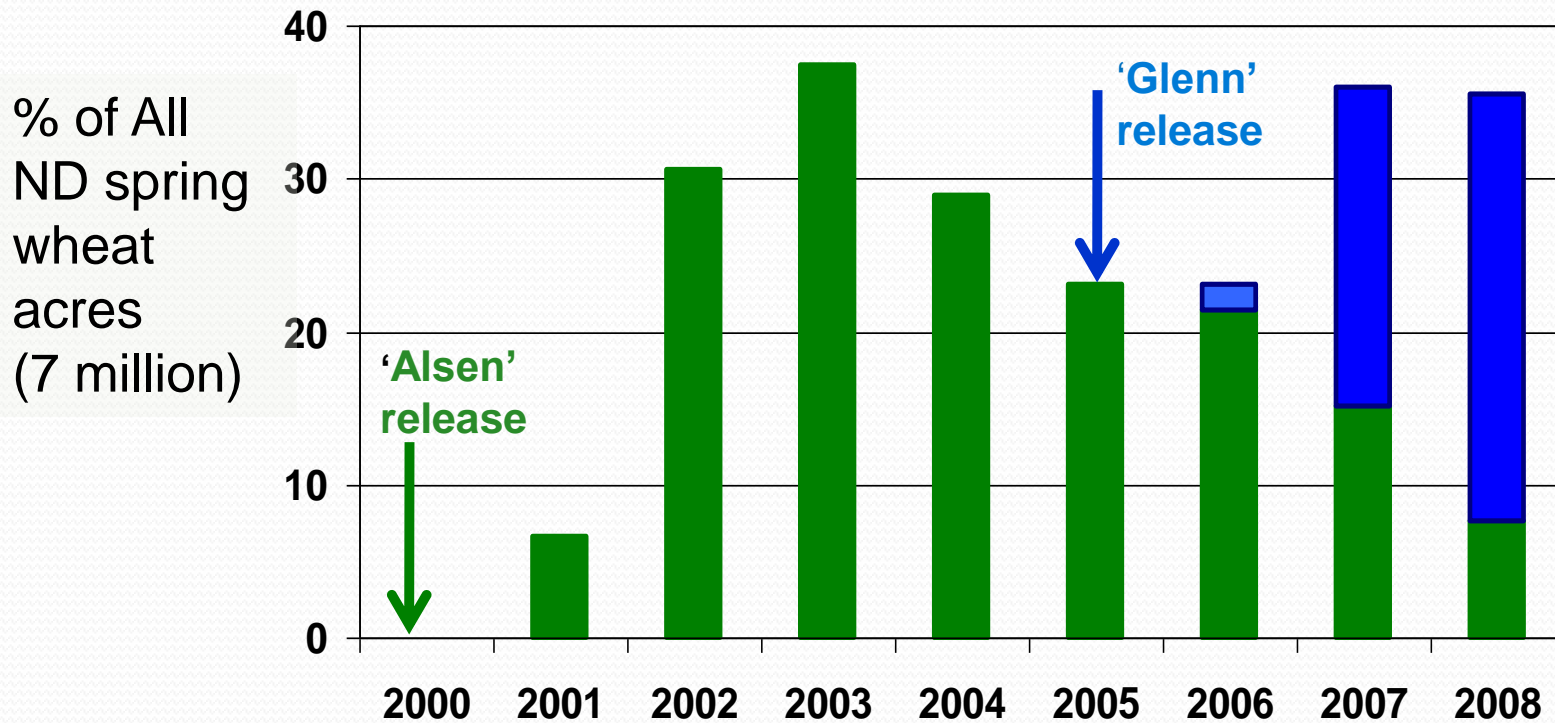
- Fhb1 locus on chromosome or others
  - \* Sumai #3, Ning 7840, others from China
- Native Resistance in certain lines or found in “alien” species

**\*Most breeders use multiple avenues**



# ND Farmers Accepted New FHB Resistant Varieties (+ Sumai 3)

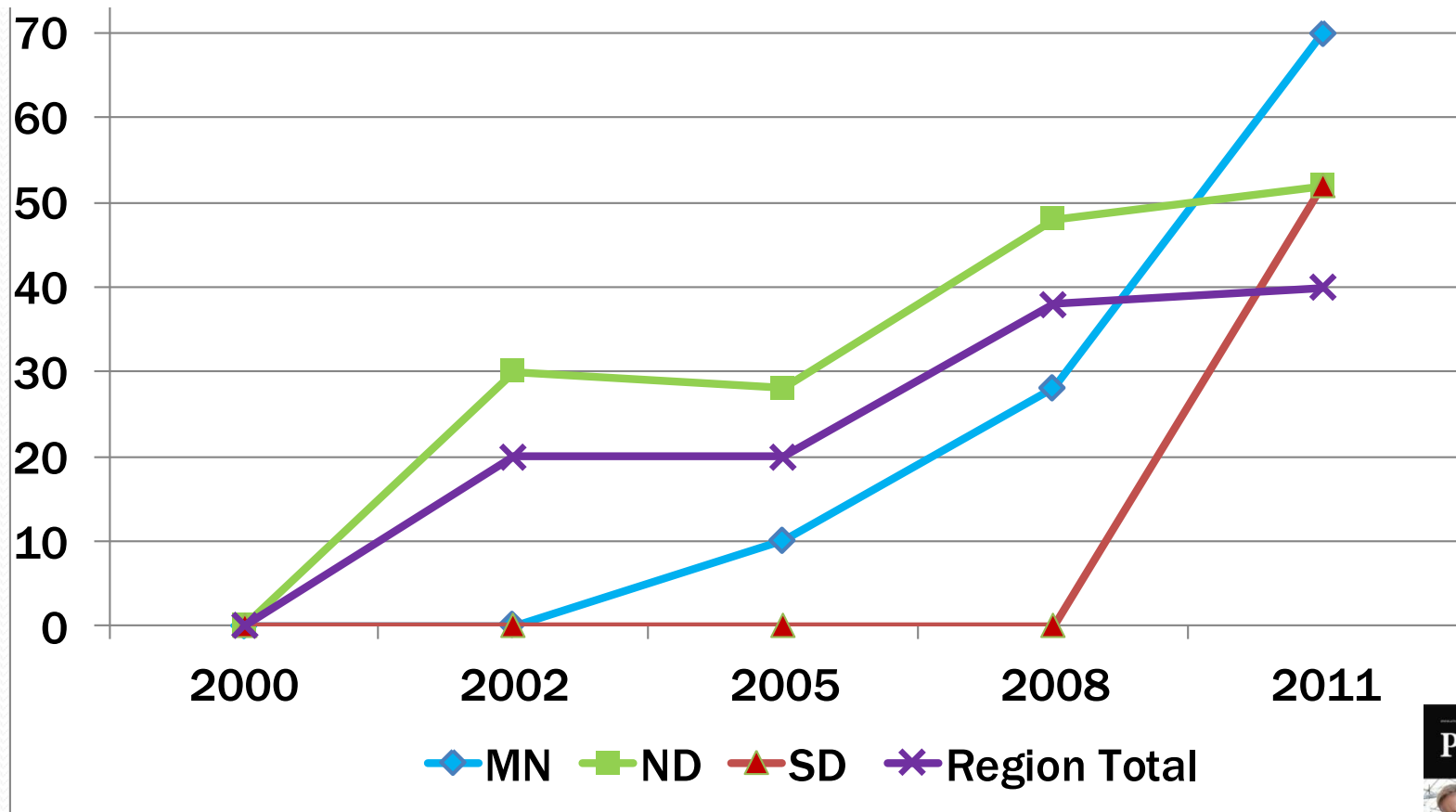
Alsen (1st FHB MR release-2000); Glenn (2<sup>nd</sup> FHB MR release- '05)



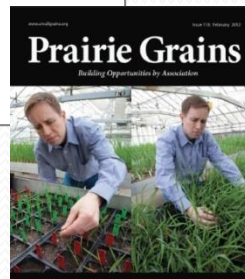
\*FHB resistance breeding and disease screening efforts supported by funding from US Wheat Barley Scab Initiative

# Adoption of MR Varieties

% Wheat Acres In Minnesota, North and South Dakota Seeded to Cultivars with MR Rating For FHB



(J. Anderson, K. Glover, and M. Mergoum, 2011 USWBSI Scab Forum Proc.)



# CWRS Varieties and FHB

- Those with G (best rating for FHB)
  - Carberry
  - AAC Brandon
  - Cardale
  - Coleman
  - CDC VR Morris
  - CDC Plentiful
- CWRS with G rating cont.
  - SY433
  - CDC Titanium
  - Waskada
  - WR8589CL
  - 5606HR CL

Source: "Varieties of Grain Crops, 2015",  
2015 SaskSeed Guide

# Most Commonly Grown CWRS Varieties 2013

## All of Western CA

- AC Harvest tops (1.5 million acres) but VP rating for FHB
- Carberry second (1.2 million acres, G)
- Lillian 3<sup>rd</sup> (1.1 million acres, VP)

## Individual Provinces

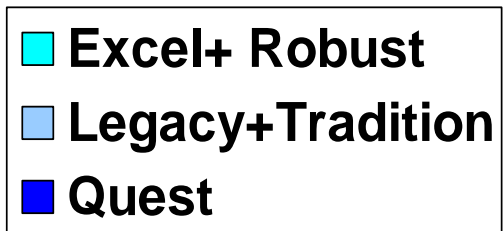
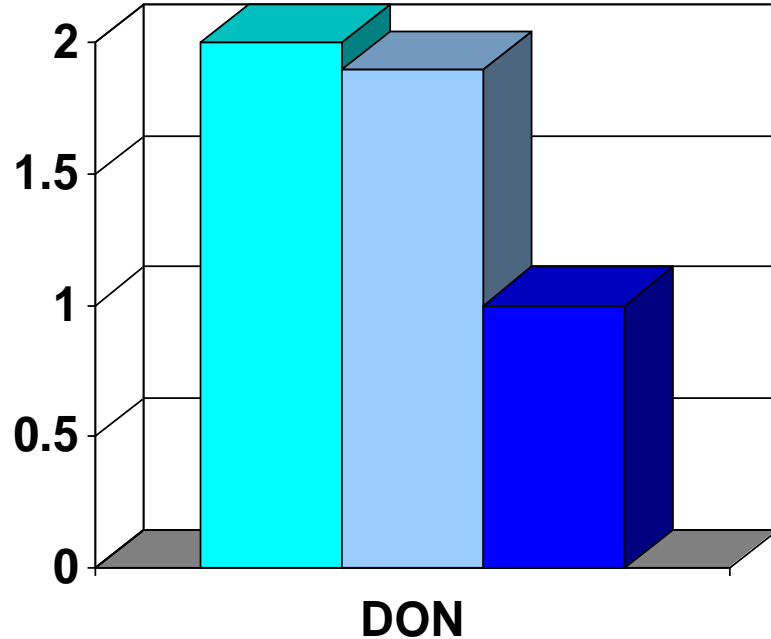
- Carberry was first in Manitoba
- Unity tops in Saskatchewan (has F (fair) FHB rating)
- AC Harvest tops in Alberta

Source: "The Western Producer"

<http://www.producer.com/2014/03/ac-harvest-top-choice-for-wheat-growers>



# Barley 6-row Barley



LSD = 0 .39

In Canada: Harrington and CDC Platinum Star 2-rows rated G as is CDC Polar Star 2-row malting variety

Source: SaskSeed Guide

**Quest**; released by U. of MN, 2010; Source: 2 row line from China called Zhedar 1 + Swiss line Chevron



# Challenges in Breeding/Genetics

- Size of programs: FHB, DON resistance + **all** other desired traits
- Producer acceptance if quality and yield aren't always equal
- Finding and incorporating more resistance
- Success and acceptance of transgenics
- Trained scientists



home

grain class of interest

management strategy

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# FUSARIUM HEAD BLIGHT Prediction Center



ND Commentary *last update 2014-06-26 Andrew Friskop,*

Recent rain events and moderate temperatures has increased scab risk across North Dakota. During the last three days, areas with greatest scab risk have been in central, north-central, and south-central ND. However, several small areas of high scab risk is apparent throughout the state. Depending on the location, winter wheat fields are near or past flowering and most growers applied fungicides due to elevated scab risks. Uneven flowering times and wet conditions hindered timely fungicide applications in some winter wheat fields. Early planted barley and spring wheat is starting to head and growers are making fungicide applications when appropriate. Free moisture events and moderate to warm temperatures are expected in the next few days. Growers will be monitoring the situation with respect to their location.

- Introduction
- Model Basics
- User Guide
- Fusarium
- Developers
- Login

### 1. Choose a State

State:

### 2. Choose a Model

Wheat:

Susceptibility:

[Link to Spring Wheat Variety Information](#)

### 3. Weather Forecast Mode

Forecast (hrs):

Assessment Date:

### Advanced: Save Model and Location

Name:

Saved Locs:

### Legend

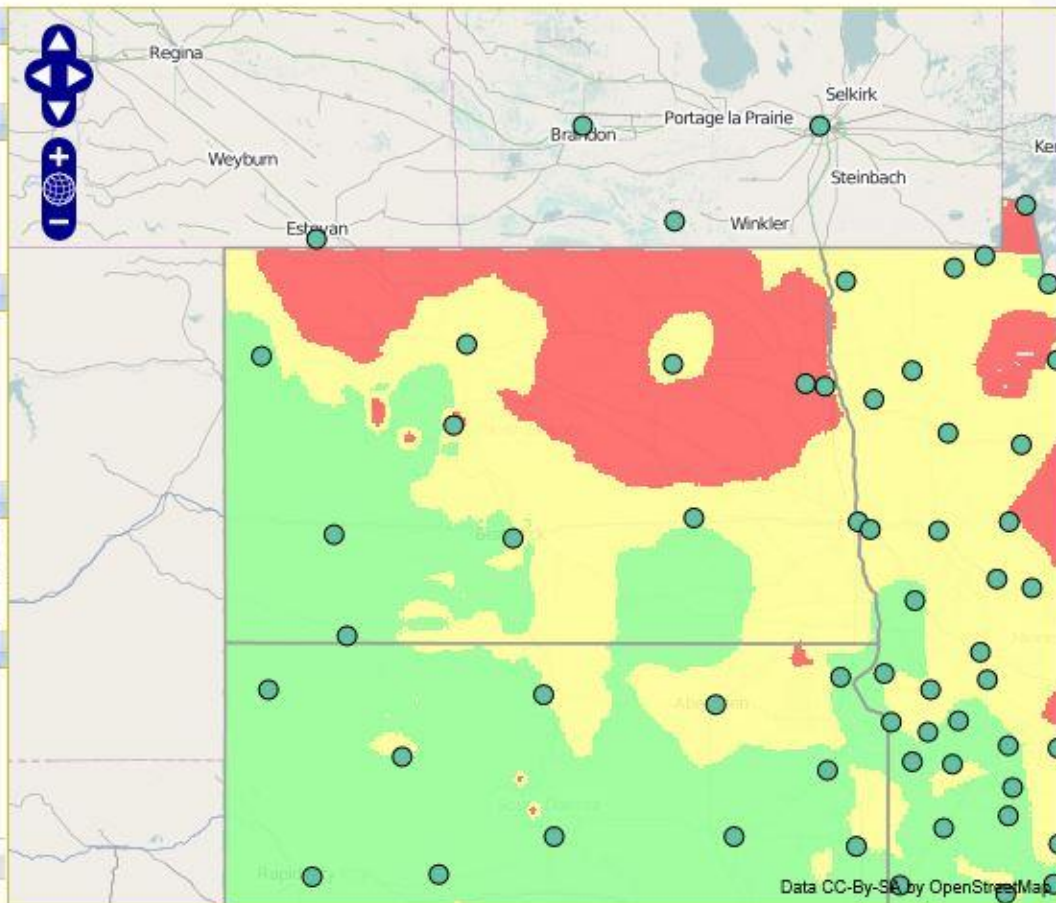
#### Blight Risk

- High
- Medium
- Low
- No Data

#### Weather Stations

- FAA
- AgNet
- Inactive (for model)

Risk Map Opacity

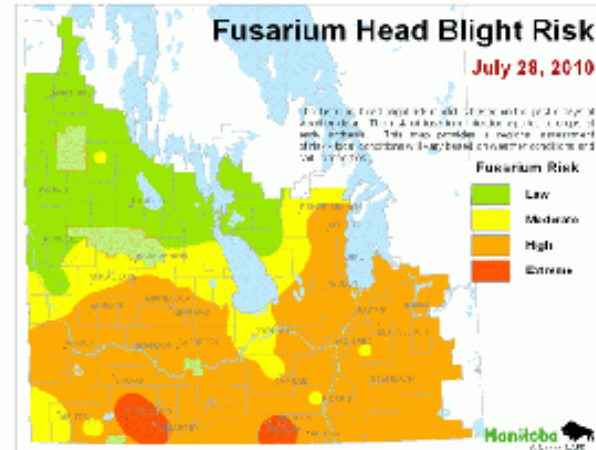




# DONcast®



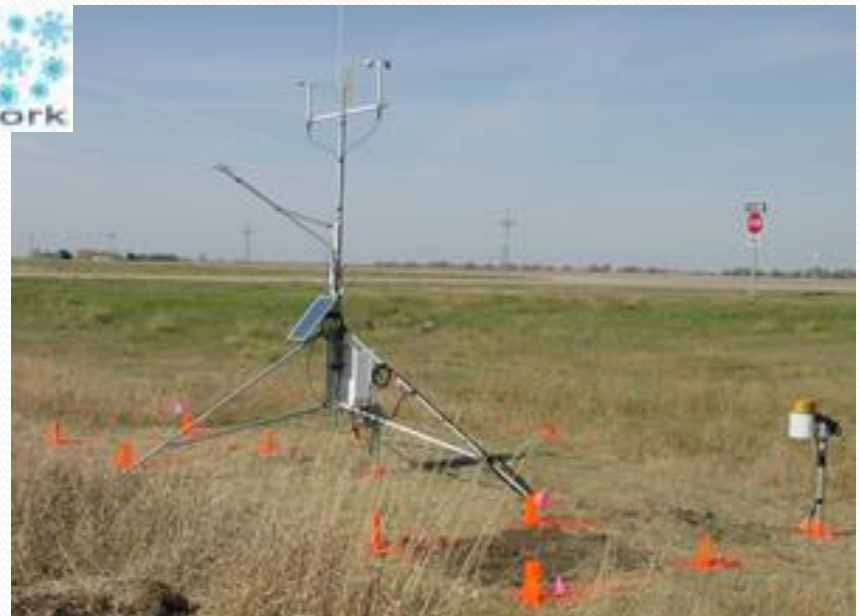
In Ontario



Fusarium Head Blight Risk Forecast, Manitoba



NDAWN  
in ND



# SCAB SMART MANAGEMENT

## Fungicides for all Grain Classes

Fungicides may reduce scab and the associated mycotoxin called DON (deoxynivalenol) when applied at the correct time, rate, and with optimal application techniques. [Scab Forecasting Models](#) also provide risk information to determine the need for fungicides.

[Fungicide Products Registered](#)

[Fungicide Timing](#)

[Best Application Techniques](#)



# Fungicides and FHB

- For fungicides to be effective:
  - Safe products with fairly short Pre-harvest intervals (PHIs)
  - High efficacy in reducing FHB and DON
  - Optimum rates and timing of application
  - Optimum application techniques

# Best Fungicides Available for Use in Managing FHB/DON in Saskatchewan.

## Triazoles

- \* Prothioconazole (Proline)
- \* Metconazole (Caramba)
- \* Prothioconazole \_ Tebuconazole (Prosaro)
- \* Propiconazole (e.g., Tilt)
- \* Tebuconazole (e.g., Folicur)

**Strobilurins – not labeled for managing FHB**  
since efficacy marginal and DON levels frequently elevated following trt.



# 2015 Saskatchewan Guide to Crop Protection Products



## 2015 GUIDE TO CROP PROTECTION

weeds, plant diseases, insects

Introduction

Weed Control

Foliar Fungicides

Seed Treatments

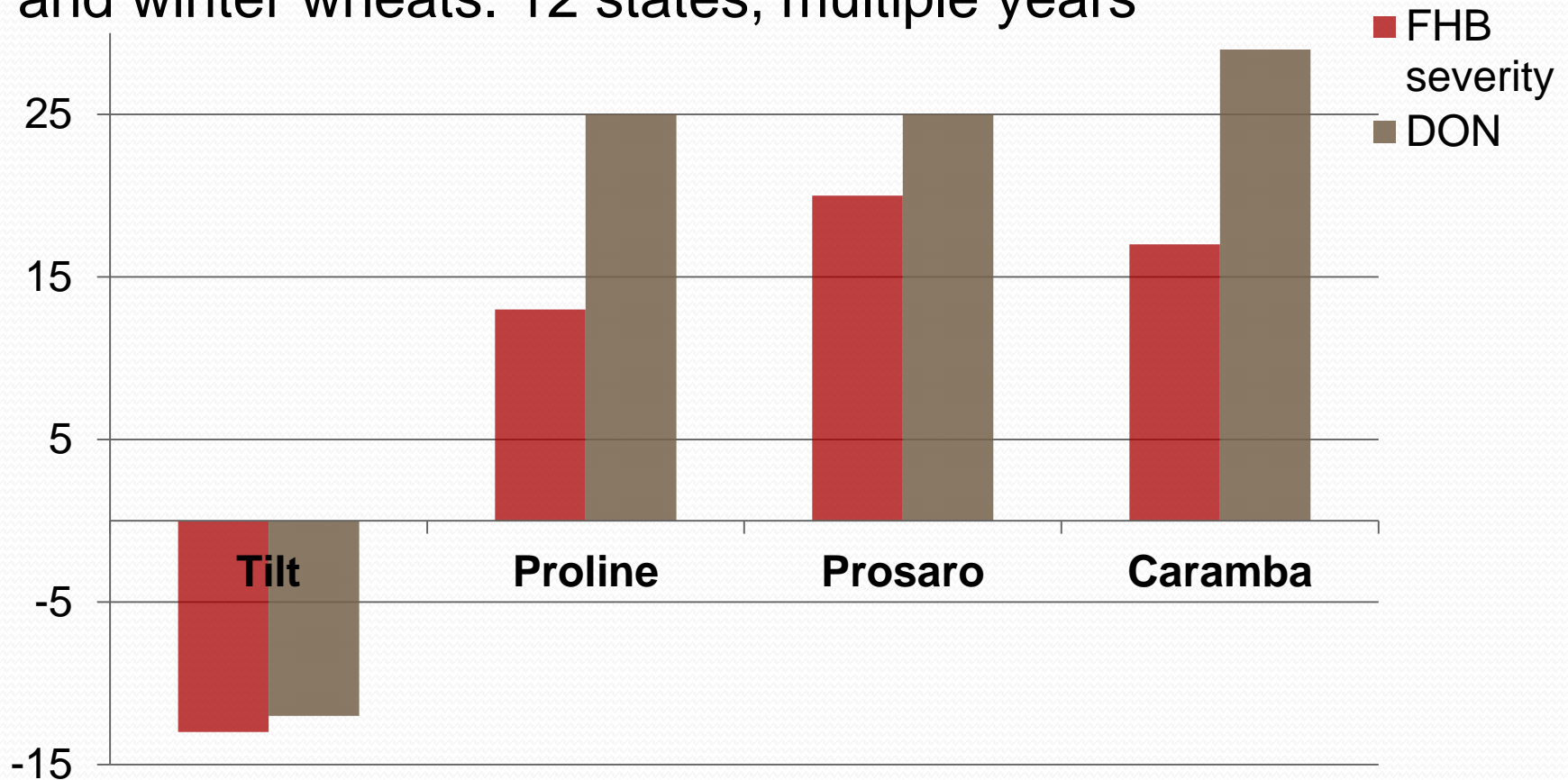
Insect Control



This publication is only a guide intended for the use of Saskatchewan growers. Always refer to the product label for application details and precautions. If information in this publication conflicts with the label, use label directions.

# Most Effective Fungicides compared to Folicur (tebuconazole)

% Reduction in Disease **relative to use of Folicur** on spring and winter wheats. 12 states, multiple years



From Paul et al., Phytopathology 98:999-1011(2008)

# Haven't achieved control equal to that achieved for some pesticides

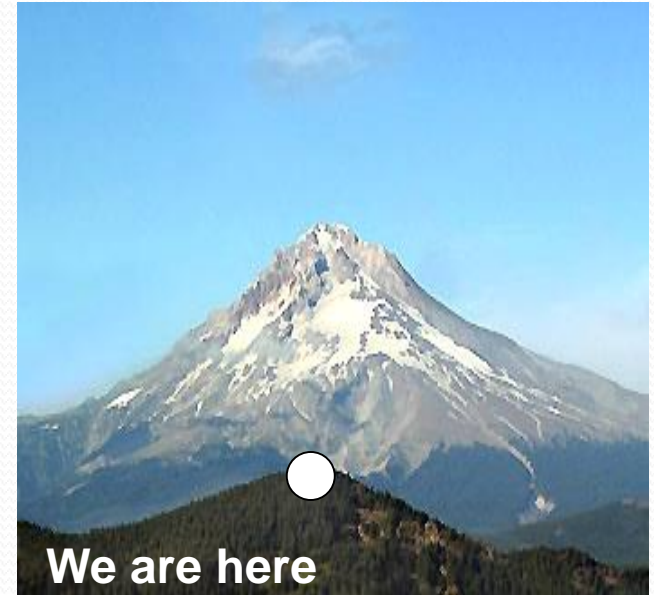
Over many states and years,  
% reductions:

**Prosaro** = 52% in FHB; 42% in DON

**Proline** = 48% in FHB; 43% in DON

**Caramba** = 50% in FHB; 45% in DON

Data: Paul et al., *Phytopathology* 99:999-1011(2008);  
Slide from C. Bradley and M. McMullen



<http://www.copyright-free-photos.org.uk/mountains/>

# Fungicide Timing Requirements

Wheat, early flowering best, anthers in middle visible on main stems, good for ~ 4-5 days after flowering begins

- Before flowering = too early
- After flowers start to drop, late

**Barley: early head emergence; if head fully out for a 3-5 days - usually too late**





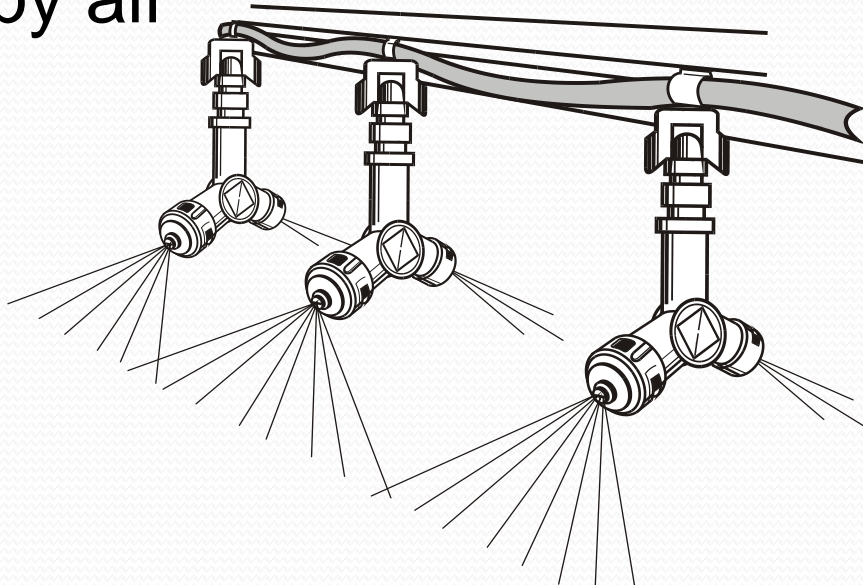
# Additional Requirements for Effective Fungicide Use

- Good Coverage on grain head
- **Timing X Coverage X Efficacy = Level of Control**

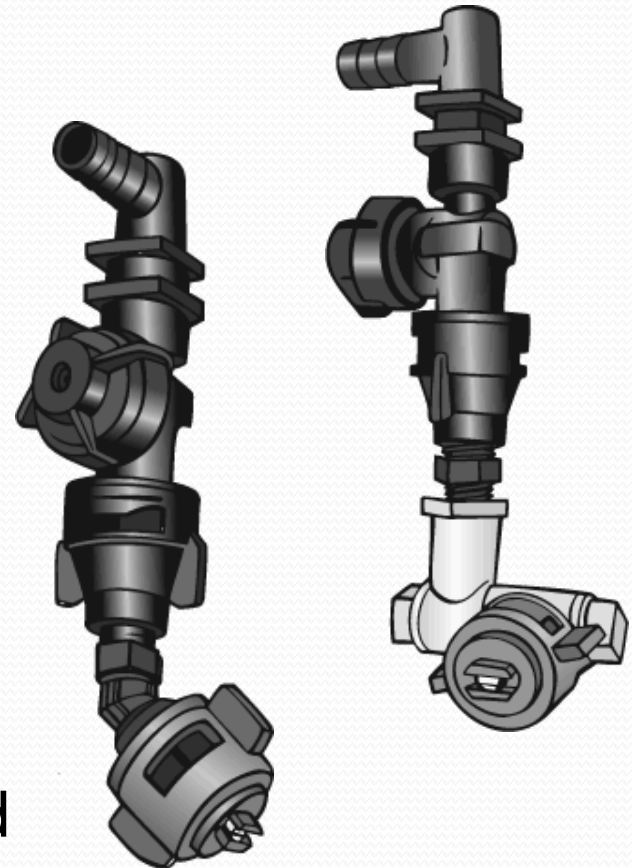
Real World: Narrow window of opportunity



**Current ND Recommendations:** 10 gpa minimum by ground; single backward nozzle; 5 gpa by air



At normal tractor speed (10 mph+), a single forward nozzle gives almost as much coverage and disease control as forward/backward nozzles used at slower speeds



# *F. graminearum* and resistance to triazole fungicides?

- Fungicide Resistance Action Committee (FRAC) – “triazoles at medium risk of fungi developing resistance to them”
- Several cases of resistance to triazoles
  - *Septoria* on wheat in Europe
  - Tebuconazole resistant *F. g.* isolate reported in NY wheat in 2013 (P. Spolti, et. al. Plant Dis. 98:607-613)



## SCAB SMART MANAGEMENT

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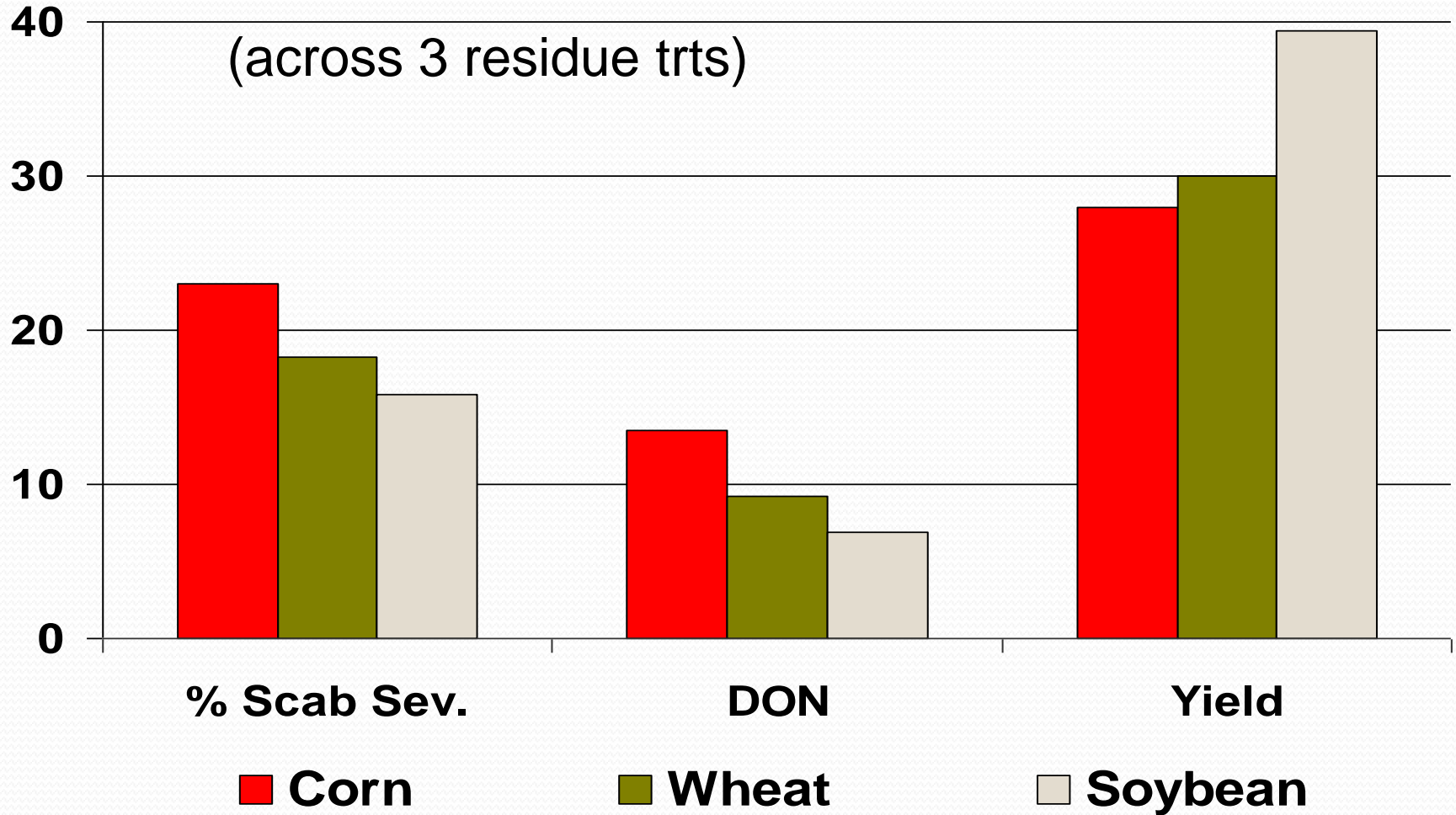
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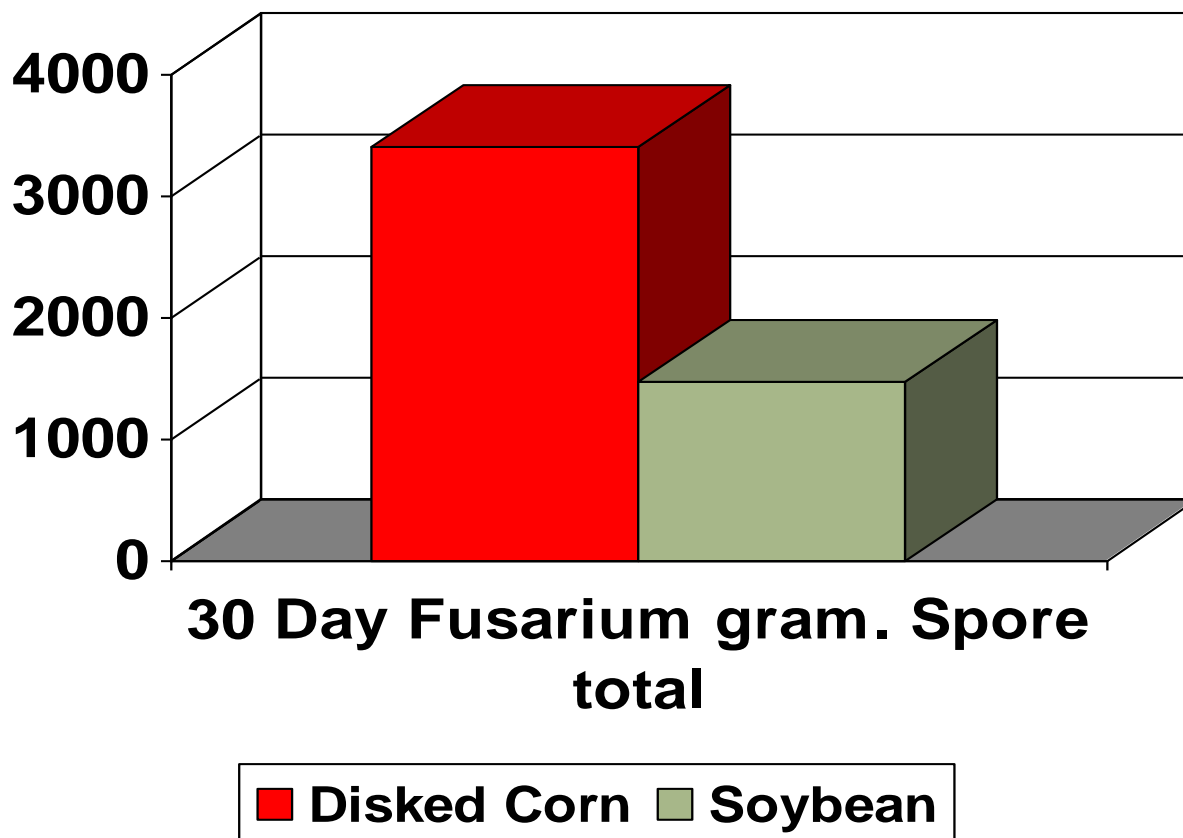
# Rotation Effect on Wheat Scab

3 year study at Morris, MN (Dill-Macky & Jones, '99)



# Crop Rotation Effects: Indiana

## Inoculum quantity



Picture from Fred Kolb, Univ. of Illinois



# Survey: MN and ND Wheat Growers

## Integrated Management of FHB

- Grow resistant varieties 81%
- Use good crop rotation 76%
- Apply recommended fungicide 68%
- Spray when weather FHB conducive 30%

Most used an **integrated** approach of a combination of methods listed above

\* Source: 2010. J. Ransom, G. McKee, M. McMullen, 2010 USWBSI National Forum Proceedings

home

grain class of interest

management strategy

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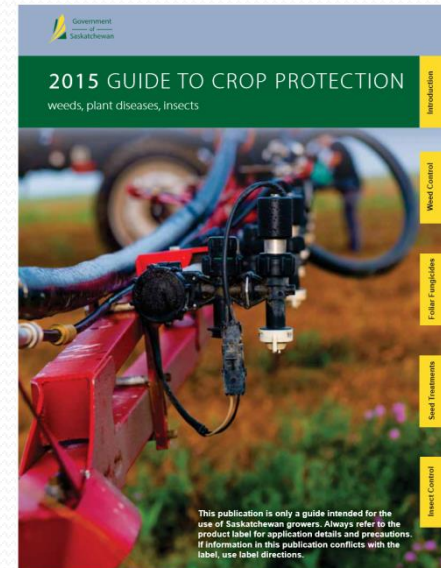
# Seed Treatments

- Seed treatments improve germination of FHB infected seed but do not bring “dead” seed back to life
- Seed treatments may or may not kill *Fusarium* fungus on seed completely
- Best seed treatments: ones that contain **multiple** modes of action fungicides - that not only reduce *Fusarium* (triazoles) but also manage other seed borne diseases such as smuts, root rots.



# Seed Treatments

- Examples of Products registered in Saskatchewan:
  - Raxil products containing tebuconazole
  - Charter product containing triticonazole
  - Vibrance products containing difenoconazole
  - Cruiser Maxx Cereals products containing difenconazole



# Other Good Sources of Information



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**CROP PRODUCTION NEWS #8 - OCTOBER 6, 2014**

## FYI on FHB (Fusarium Head Blight in 2014)

By: Faye Dokken-Bouchard, PAg, Provincial Specialist, Plant Disease

Ministry staff have received many reports of Fusarium head blight (FHB) and observations made in the field are confirming the possibility of a bad year for the disease. FHB is also known as scab. FHB can affect various cereal crops and forage grasses, but some are hit harder than others.

From least damage to most damage, they are ranked as follows:



Fusarium head blight is caused by one or more *Fusarium* species, a common pathogen and saprophyte found on seed and crop residue. The most important species is *Fusarium graminearum*, as it is aggressive as a pathogen and is also responsible for the production of toxin called deoxynivalenol or DON in the grain. DON can reduce feed intake by livestock and adversely affect the baking quality of wheat and the malting and brewing qualities of malt barley. Therefore, infection results in a grade and end-use quality reduction, but it also reduces yield.

Symptoms include premature bleaching of one or more of the spikelets on the head (see Photo 1) and can result in the formation of fusarium damaged kernels (FDK) or tombstone kernels, which are typically shrivelled, lightweight, and white or pink in colour. When tombstone kernels are lost during combining or seed cleaning, yield is reduced. More importantly, grade losses occur when the percentage of the remaining damaged kernels in a sample exceeds grading tolerances.

The Canadian Grain Commission allows only very low levels of FDK in food and feed grains and zero levels in malting barley. The tolerances were set to account for the presence of potentially harmful fungal toxins, called mycotoxins, produced in diseased grain (see Figure 1). Health Canada regulates the maximum levels for various chemical contaminants in food, including DON.



Photo 1. Bleaching of spikelets caused by FHB infection on durum.

Canada Western Wheat Type	Max FDK #1 Grade	Max FDK #2 Grade	Max FDK #3 Grade	Max FDK for #4/feed	Max FDK #5 Grade
Red Spring, Red Winter, Hard Red Spring	0.25%	0.8%	1.5%	4%	-
Amber Durum	0.5%	0.5%	2%	2%	4%
Soft White Spring	1.5%	1.5%	1.5%	4%	

## CROPS

# Identifying the proper crop stage to control fusarium head blight



by **Rory Cranston, AAgr**  
 Irrigation Agrolgist  
 Regional Services Branch  
 and



by **Sean Miller, PAg**  
 Integrated Pest Management Agrolgist  
 Crops and Irrigation Branch

Saskatchewan producers are becoming more aware, knowledgeable and active when it comes to controlling diseases in their crops. However, one difficulty most producers still face is properly timing a fungicide application to get the optimum level of control.

The importance of timing is critical as most fungicides will only prevent disease development on a plant - not cure it. Apply a fungicide too late and disease will already be established in your crop, apply too early and the fungicide's effectiveness can end while there is still significant risk of disease.

Determining the best time to spray can be difficult. Proper staging can be elusive with unpredictable weather conditions. For example, a hot summer in Saskatchewan can cause a crop to develop extremely fast, with the optimum stage passing in less than a day. The variations in Saskatchewan climate from year-to-year affect development enough to make it impossible to have a fixed date for fungicide application. In addition, if weather conditions are not favourable for disease development, it can eliminate the need for a fungicide application.

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- DISEASE**

## Fusarium Head Blight

August 2007

Fusarium head blight (FHB), also known as scab, is a fungal disease of small grain cereals that has become of increasing international importance in recent years. FHB can affect wheat, barley, oats, rye, corn, triticale, canary seed and some forage grasses. In Saskatchewan, durum, spring wheat, and barley are most affected by this disease. FHB is caused by several species of the fungal pathogen, *Fusarium*. The most important species is *Fusarium graminearum*, since it can result in the most yield loss and is responsible for the production of toxin in the grain.

FHB results in a reduction in yield, grade and end-use quality. Further losses to producers have occurred because of restricted crop rotations, limited variety selection, cost of control measures, as well as reduced marketing opportunities. It is important that producers are familiar with this potentially

FHB development in their crops  
 conditions during flowering.  
 FHB can result in the formation of  
 weight, and white or pink in  
 mels".

Blight (FHB) in wheat. If weather conditions are favourable for disease development, the proper time to apply is when 75 per cent of the wheat heads are fully emerged to when 50 per cent of the heads on the main stems have visible anthers (see figure 1). These stages usually occur near the middle of July, and at most will last three days. The current recommended wheat seeding rate of 1.6 bushels per acre encourages tillering, which will increase the variation of flowering and increase difficulty when staging the crop. Increased seeding rates will reduce tillering and flowering variation, making it easier to select the proper stage for fungicide application.

### FOR MORE INFORMATION

- Call the Agriculture Knowledge Centre at 1-866-457-2377, or
- Contact your nearest Regional Office.



nt infection on durum wheat. Note ets within the infected heads.

### Figure 1. FHB application timing on wheat





A wide-angle photograph of a vast, flat field of golden wheat stretching to the horizon. The sky is a clear, bright blue, filled with numerous fluffy white cumulus clouds. The horizon line is low, showing a thin strip of green trees and a few distant structures. The overall scene is bright and open, suggesting a rural or agricultural setting.

**Questions?**