UNIVERSITY OF SASKATCHEWAN

Fusarium head blight of cereals: improving management of this difficult disease

Soils and Crops Workshop, March 10th, 2020

Randy Kutcher, Plant Pathologist
Crop Development Centre, University of Saskatchewan

What is Fusarium Head Blight (FHB)?

- An infectious disease of cereals, corn, grasses and some other crops
- Also called scab or tombstone on cereal grains
- Occurs worldwide and from coast to coast in Canada

FHB symptoms, wheat

- bleaching of the whole head or individual spikelets
- may be salmon pink - orange spore masses on the spikelet and glumes.

A. Friskop, North Dakota State University
https://www.ag.ndsu.edu/publications/crops/fusarium-head-blight-scab-of-small-grains

FHB symptoms, wheat

- tombstone / scab
- shrivelled, light-weight kernels, chalky white colour
- the earlier during anthesis infection occurs the greater the effect

Canadian Grain Commission
www.grainscanada.gc.ca

FHB symptoms, barley

- individual spikelets or whole heads affected
- infected spikelets or kernels may be pink, orange or black
- kernels shrunken and thin, often more difficult to identify in barley than in wheat

Courtesy A. Tekauz

Corn approaches one million acres on Prairies

Cool weather resulted in disappointing yields for producers this year, but they don't appear to be giving up on the crop

BY ROBERT ARNASON
WINNIPEG BUREAU

SASKATOON — Monsanto made a bold announcement about corn in June 2013, promising to invest $100 million in breeding programs to develop corn hybrids suitable for Western Canada.

The company's ambition was massive as it set a goal of eight to 10 million acres of corn on the Prairies by 2025.

That's not going to happen, but Monsanto executives were right about one thing.

Corn is moving west, and there could soon be a million acres on the Prairies.

This year, prairie farmers seeded 928,000 acres of corn, including silage, grazing and grain corn. That's up 54 percent from 2015, when there were 600,000 acres.

With more hybrids on the market, more farmers believe corn is a realistic option, even in areas hundreds of kilometres from Manitoba's Red River Valley, which is Western Canada's traditional corn-growing region.

"There's a lot of hype; the most hype we've had in the area for corn was (this) year," said Matt Gosling, an agronomist and founder of Premium Ag, a consulting service in Strathmore, Alta.

Farmers around Strathmore are

Grain corn acres increased in 2019, despite the recent setback with yields. This crop was photographed near Roblin, Man., in August. | ROBIN BOOKER PHOTO

Manitoba in September, stalling crop development and grain fill. Some producers have recorded test weights of 40 pounds per bushel, much lower than the normal 56 lb. per bu.

That's making it difficult, if not impossible, for producers to sell the crop because buyers won't

GRAIN CORN ACRES ON THE PRAIRIES

	2015	2019
Alberta	40,000	29,000
Saskatchewan	N/A	17,500
Manitoba	275,000	417,000

SILAGE AND GRAZING CORN

	2015	2019
Alberta	135,000	292,000
Saskatchewan	35,000	105,000
Manitoba	115,000	127,000

Source: Statistics Canada, Manitoba Agricultural Services Corp. | WP GRAPHIC

MORGAN COTT
MANITOBA CORN GROWERS ASSOCIATION

Cott's Saskatoon presentation focused on the agronomic basics of growing corn — selecting the right hybrid, fertilizer, pests and disease.

One critical piece for new growers is choosing more than one hybrid.

Cott said they should select one that is safe to grow, based on the heat units in their region, and maybe another hybrid that needs more heat units to see if it is suited to their region.

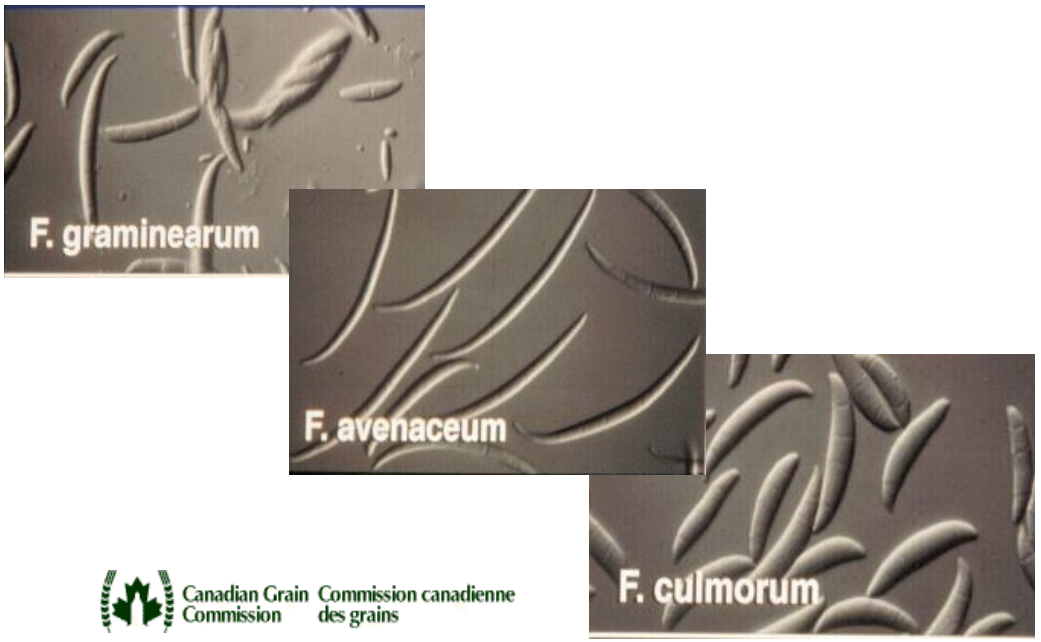
"Definitely (growers) should have more than one on their farm."

Producers should also consider a split application of nitrogen. The total nitrogen requirement for corn is about one lb. per bu. of desired yield, but the crop needs most of its nitrogen four to six weeks after emergence.

Consequently, many Manitoba corn growers are applying 50 to 60

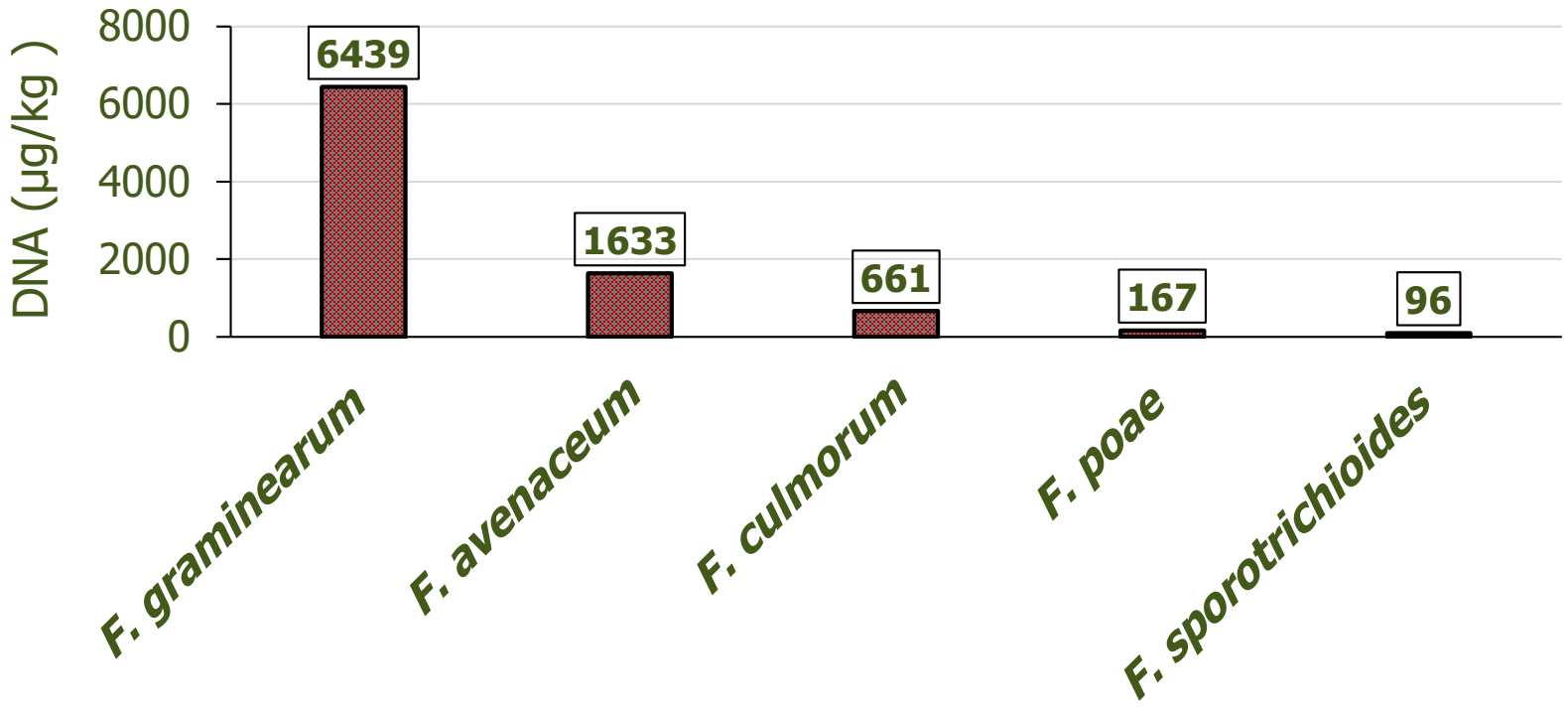
What causes Fusarium Head Blight (FHB)?

- Caused by a number of *Fusarium* species that can also cause seed decay, seedling blight, and stem and root rot
- *F. graminearum*
  F. avenaceum
  F. culmorum
  F. poae
  F. sporotrichioides



Canadian Grain Commission / Commission canadienne des grains

DNA of *Fusarium* spp. (µg) per kg dry weight of wheat (Saskatchewan)

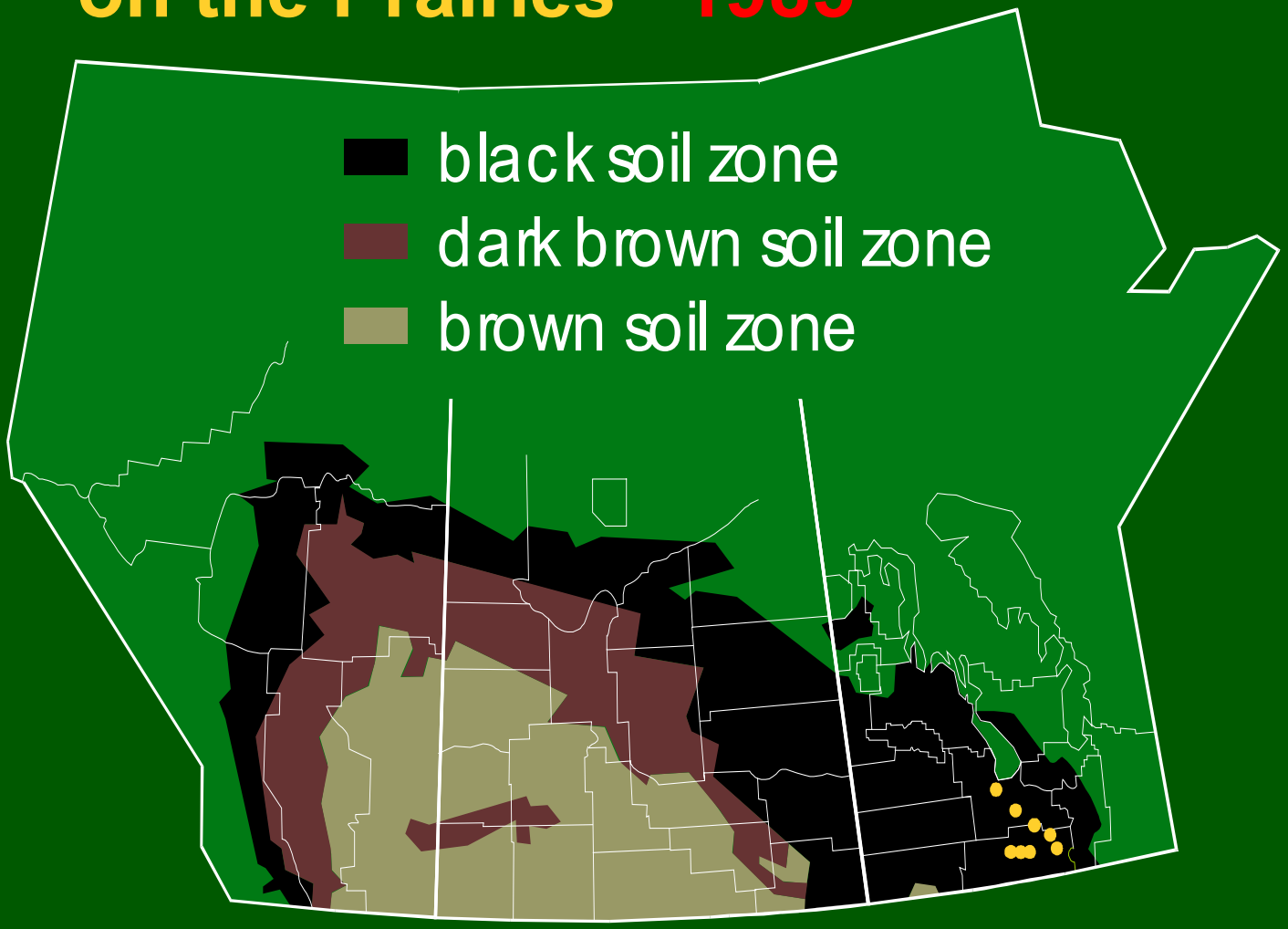


Mean of 144 samples from growers' crop samples, 2014-2016; G. Singh

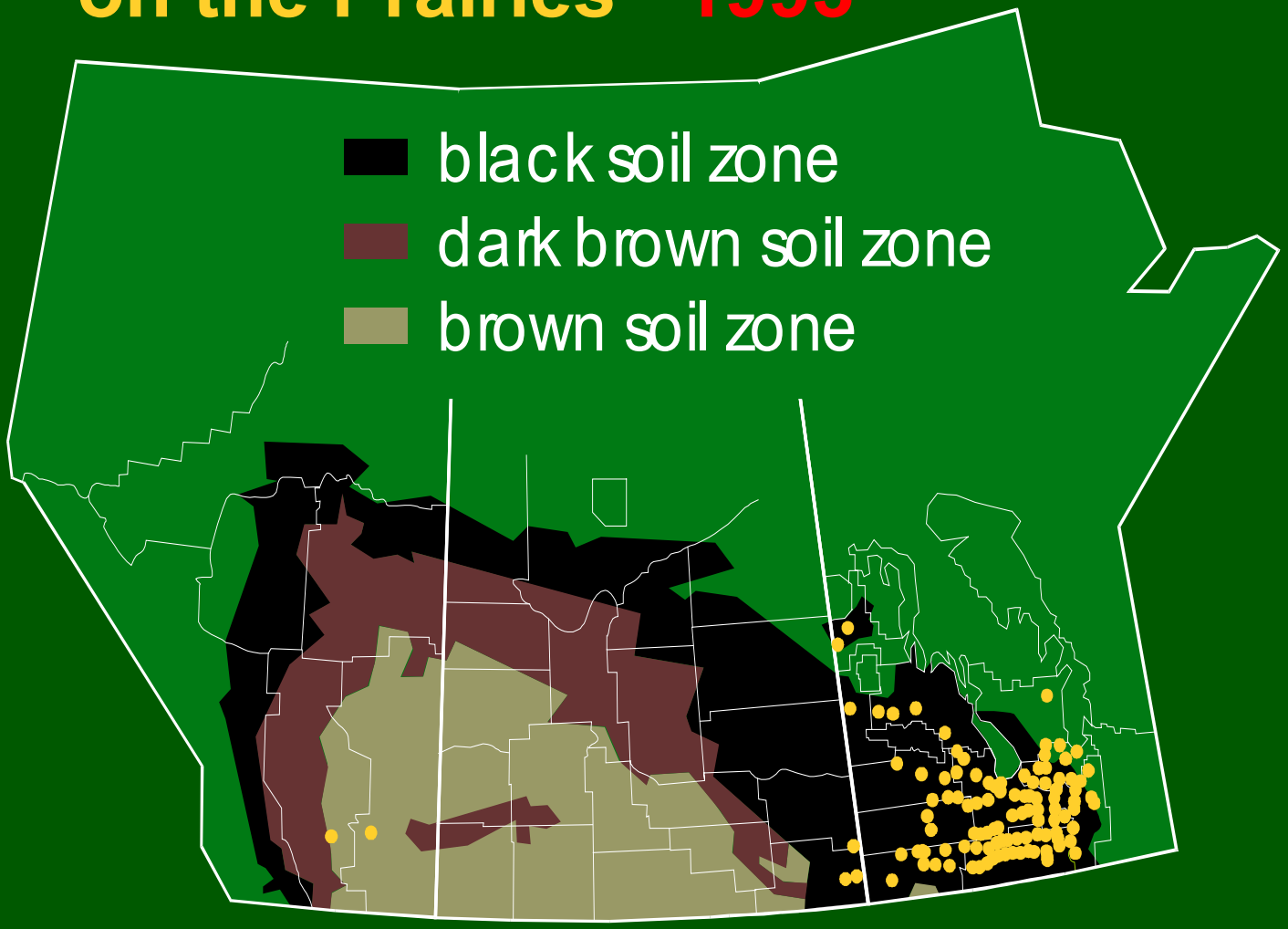
History in Canada

- **1923** - reported in Manitoba,
- **1984** - localized outbreak in Red River Valley, and under irrigation in Idaho,
- **1993** - record rainfall associated with high *F. graminearum* in MB, ND & MN, observed in durum in SE SK,
- **1996** - 3rd worst year in MB, SW MB a problem area, *F. graminearum* found at high levels in SE SK.

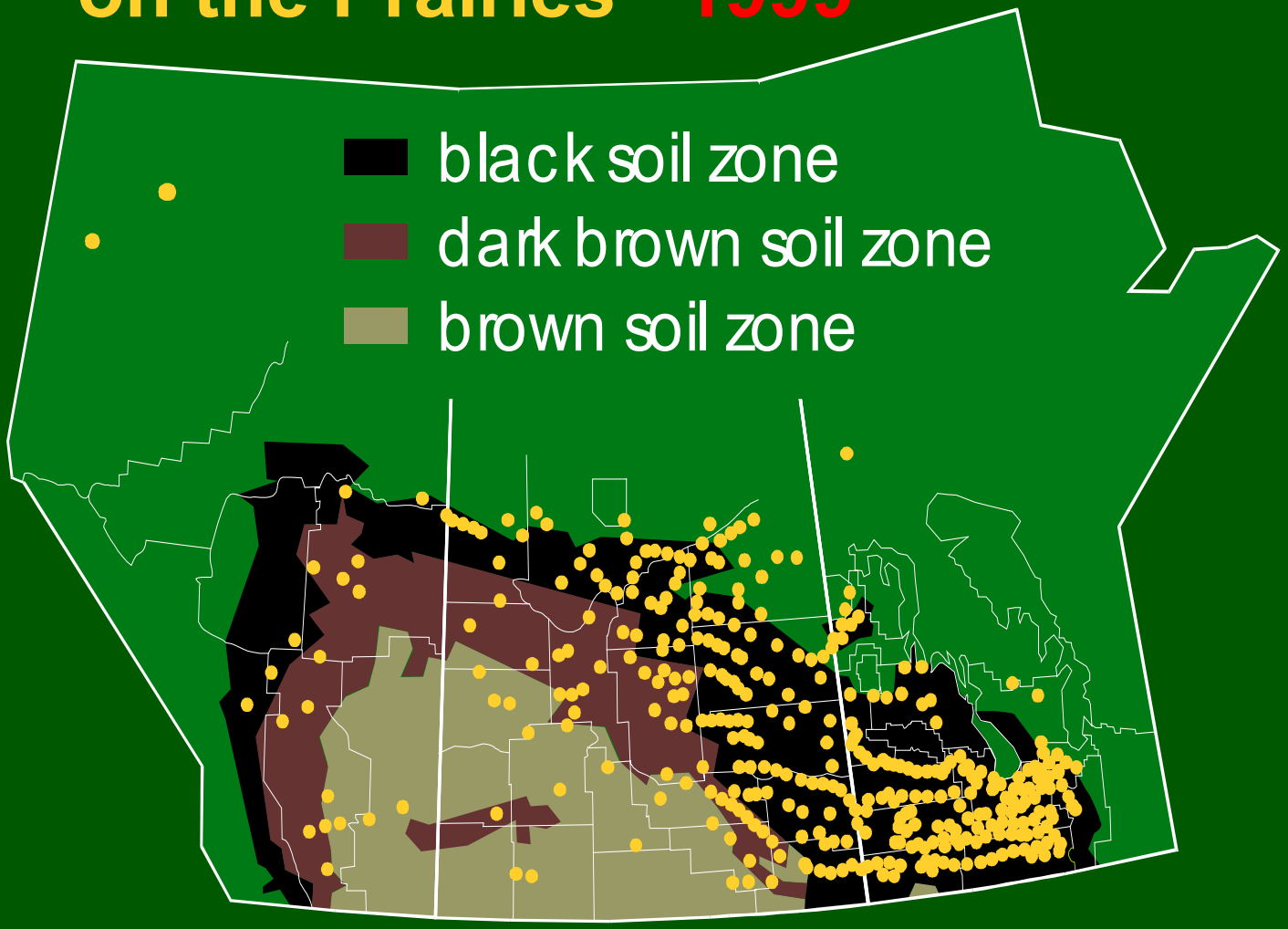
Location of *F. graminearum* on the Prairies 1985



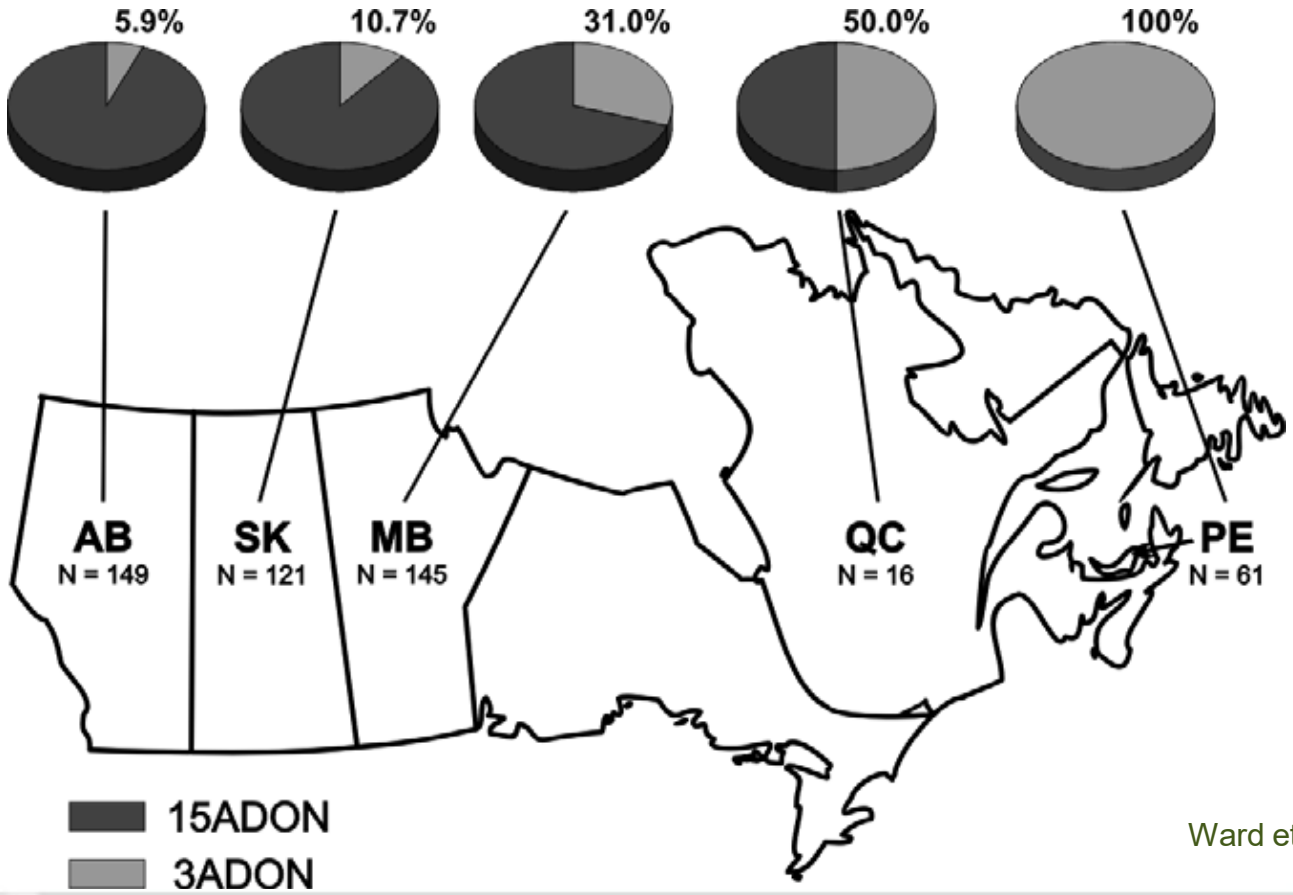
Location of *F. graminearum* on the Prairies 1993



Location of *F. graminearum* on the Prairies 1999



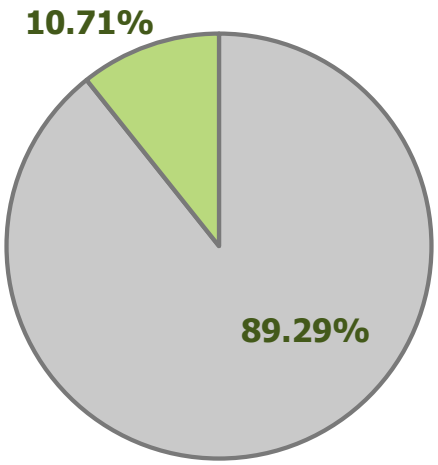
Fusarium graminearum chemotype frequencies in Canada,1984 to 2004



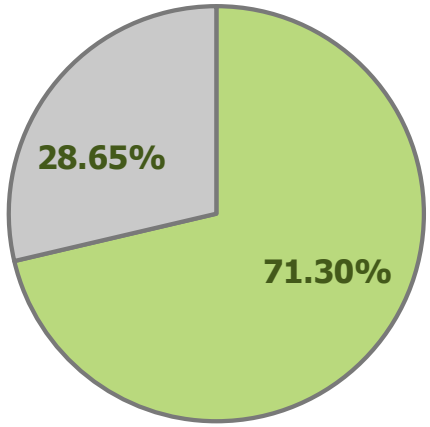
Ward et al. 2008

Chemotype frequencies of *F. graminearum* isolates collected from durum in Saskatchewan (2014 – 2016)

1984 - 2004; n = 121



2014 - 2016; n = 178



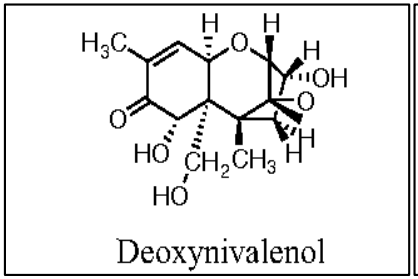
15 ADON 3 ADON

FHB, yield and quality losses

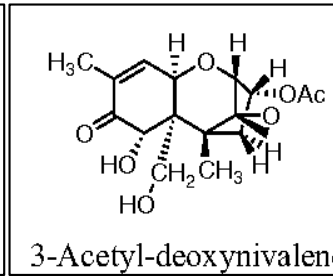
- Yield loss
  - 40-50% when severe
- Grade loss
- Mycotoxin contamination
  - Implications for animal & human health and end use market acceptability
- These losses are additive!

Saleability factors

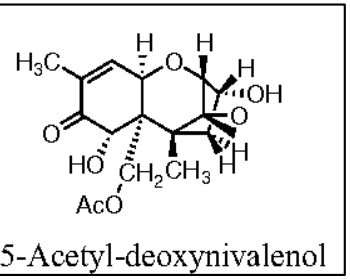
- Fusarium damaged kernels (FDK)
- Mycotoxins



Deoxynivalenol



3-Acetyl-deoxynivalenol



15-Acetyl-deoxynivalenol

Courtesy of G. Singh

FHB, yield and quality losses

- DON (deoxynivalenol) aka 'vomitoxin'
- In poultry, ingestion may stunt growth, poor feather development,
- In cattle poor weight gain,
- DON contaminated feed may result in feed refusal and vomiting in livestock, with pigs more sensitive than poultry or cattle
- DON levels >30 parts per million (ppm) occur

Use	FDA Advisory Level
Human Consumption	1 part per million (PPM) for finished grain products for human consumption. No standard for raw grain going into milling process.
Cattle over 4 months old	10 ppm (providing grain at that level doesn't exceed 50 percent of diet).
Poultry	10 ppm (providing grain at that level doesn't exceed 50 percent of diet).
Swine	5 ppm (not to exceed 20 percent of ration).
All other animals	5 ppm (providing grains don't exceed 40 percent of diet).

FHB and swine production

Fusarium head blight (FHB) strategies

- Cultural control – diverse rotations
  - managing infected residue
- Fungicide management of the disease and appropriate use of fungicides
  - increased seeding rates
- Genetically resistant varieties
  - clean seed and seed treatment
  - early seeding may avoid the disease
- **Integrated Pest Management imperative**

FHB, genetic resistance

- ‘Resistant’ cultivars, wheat
  - CWRS marketing class, many varieties are I (intermediate) or MR (moderately resistant), reduced spike symptoms, FDK, DON content
  - CWAD (durum) cultivars are S to MS
  - Better resistance means fewer FDK & less DON
  - Winter wheat may escape infection

ernment
of
atchewan

https://publications.saskatchewan.ca/#/products/83696

Varieties of Grain Crops 2019

f Contents

Symbols and Abbreviations Used:

§ Variety may not be described in 2020
--- Insufficient test data to describe
n/a = Not applicable
✪ Applied for PBR protection at time of printing (UPOV'91)
Plant Breeders' Rights (UPOV'78) at time of printing
Plant Breeders' Rights (UPOV'91) at time of printing

Relative maturity: VE = Very Early, E = Early, M = Medium, L = Late, VL = Very Late

Agronomic Rating: VG = Very Good, G = Good, F = Fair, P = Poor, VP = Very Poor

Disease Resistance: R = Resistant, MR = Moderately Resistant, I = Intermediate Resistance, MS = Moderately Susceptible, S = Susceptible

Accessing Public Release Varieties

Breeder seed of public release varieties is available to anyone (including farmers and seed growers) for multiplication, increase and marketing. There are no royalties or seed marketing agency fees attached to use or sale of seed produced from Breeder seed of public release varieties. While subsequent seed production may be Pedigreed, this is the buyer's choice and the buyer may increase the seed of public release varieties in any way he/she wishes (only pedigreed seed can be sold by variety name, for most major crop kinds). To purchase Breeder seed of public release varieties, contact the breeding institution listed in the Breeding Institution and Seed Distributors listings on pages 38-40.

Legal Disclaimer

CEREAL CROPS

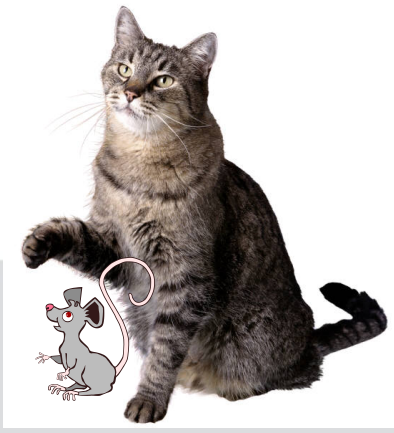
Wheat

Main Characteristics of Varieties

Category and Variety	Years Tested	Yield (%) Area 1 & 2	Yield (%) Area 3 & 4	Yield (%) Irrigation	Protein	Resistance To[2] Lodging	Sprouting	Stem Rust	Leaf Rust	Stripe Rust	Loose Smut	Bunt	Leaf Spot	FHB	Head Awnedness	Rel. Maturity (days)	Seed Weight (mg)
CWRS[1]		--- Relative to Carberry ---														---- Relative to	
Carberry	6	100	100	100	14.6	VG	F	MR	R	MR	MR	R	MS	MR	Y	99	35.7
CDC Adamant VB ✪	3	108	114	---	0.0	P	F	R	I	MS	S	S	MS	I	Y	-2	-1.7
AAC Alida VB ✪	2	105	108	---	+0.1	VG	VG	R	R	MR	R	I	MS	MR	Y	-1	+1.9
CDC Bradwell	5	101	108	---	0.0	VG	F	MR	R	MS	MR	R	MS	I	Y	0	-2.0
AAC Brandon	5	106	106	---	-0.4	G	P	R	R	MR	MR	S	I	MR	Y	0	+0.1
AAC Cameron VB	5	108	118	---	-0.6	F	F	MR	MR	S	S	R	I	I	Y	-2	+3.0
Cardale	5	99	101	---	-0.1	F	G	R	R	S	I	MR	MS	MR	Y	0	-1.3
SY Chert VB	2	100	106	---	-0.3	F	F	R	R	R	R	R	MS	I	Y	-1	-0.4
Coleman §	5	96	96	---	-0.2	VP	P	MR	R	MR	S	S	MS	MR	Y	-3	-2.8
AAC Connery	5	101	100	---	+0.3	G	G	R	MR	R	MR	I	I	MR	N	-2	0.0
AAC Elie	5	105	105	---	-0.2	G	F	R	R	MR	I	I	I	I	Y	0	-0.1
Glenn	6	99	102	102	-0.4	F	F	R	R	MR	I	I	I	I	Y	-1	-0.9
CDC Go §	5	95	102	---	0.0	G	P	R	I	MR	MS	I	S	MS	Y	-3	-1.9
Go Early §	5	96	102	---	+0.4	P	VP	MR	MR	I	MS	MR	S	I	Y	-4	0.0
Goodeve VB	6	101	107	100	0.0	G	G	MR	MR	I	MR	S	MS	S	N	-4	+0.1
CDC Hughes VB ✪	4	100	110	---	-0.1	F	G	R	MR	I	MR	MS	I	I	Y	-1	+2.1
AC Intrepid §	6	96	105	---	-0.2	G	P	MR	MR	MR	I	MR	MS	MS	N	-5	+3.2
AAC Jatharia VB	5	108	114	---	-0.2	F	G	I	R	I	S	MS	I	I	Y	-1	+0.8
CDC Landmark VB	4	109	112	---	-0.2	G	G	R	MS	MR	MR	MS	I	I	Y	-1	+1.2
CDC VR Morris	5	108	106	---	-0.2	F	P	MR	R	---	I	I	I	MR	N	-1	-0.5
SY Obsidian	2	99	105	---	-0.3	VG	F	MR	R	MR	R	MS	I	MS	Y	-2	+1.2
Parata ✪	2	98	106	---	+0.3	F	F	R	MR	MR	MR	S	I	I	Y	-2	-2.0
CDC Plentiful	5	105	104	---	-0.2	G	P	R	R	MR	R	I	I	MR	N	-2	-1.9
AAC Prevail VB	5	110	108	---	-0.5	F	G	MR	R	R	S	S	MS	I	N	-1	-0.5
AAC Redberry	4	105	108	---	-0.2	F	G	R	R	R	R	I	MS	I	Y	-3	-0.9
Shaw VB	6	112	114	103	-0.7	F	G	R	MR	I	S	MR	MS	MS	N	-1	+0.5
SY Slate	4	102	107	---	+0.4	P	P	MR	R	MR	MS	S	MS	I	Y	-2	-0.1
SY Sovite	3	98	104	---	0.0	F	F	MR	R	R	R	MS	MR	MR	Y	0	+2.1
CDC Stanley	6	102	105	100	-0.1	G	VG	R	MR	I	MR	S	I	MS	N	-1	-2.5
AAC Starbuck VB ✪	1	113	117	---	-0.3	G	F	I	MR	MR	MR	S	S	MR	Y	-1	+0.7
Stettler	6	105	107	100	+0.2	F	G	MR	MS	MR	R	MR	MS	MS	Y	-1	-0.6
Thorsby §	5	102	102	---	0.0	F	F	MR	R	R	I	S	MS	I	N	-3	+0.5
AAC Tisdale	3	100	109	---	+0.7	F	F	R	R	S	MR	MR	MS	MR	Y	-2	+0.8
CDC Titanium VB	5	106	110	---	+0.6	P	P	I	R	R	MS	I	MS	MR	Y	-2	+1.1
CDC Utmost VB	6	108	112	107	-0.4	F	G	MR	R	I	MS	S	I	MS	N	-3	-0.8
AAC Viewfield	4	109	108	---	-0.5	VG	G	R	MR	R	S	MR	I	I	Y	-1	-1.7
AAC W1876 §	5	98	101	---	+0.2	F	F	MR	R	I	I	I	MS	I	Y	-1	-0.5
AAC Warman VB	1	100	106	---	0.0	F	---	R	R	MS	MR	S	I	MR	Y	-2	-1.4
Waskada	6	108	107	101	-0.2	P	VG	R	I	MS	MR	R	MS	MR	Y	-1	+0.6
AAC Wheatland VB ✪	1	110	114	---	0.0	VG	G	R	R	I	R	MR	S	I	Y	-1	+1.2
WR859CL §	6	101	101	102	-0.1	F	G	MR	R	I	R	R	MS	MR	Y	-1	-2.0
SY479 VB	5	91	100	---	+0.6	G	VG	I	R	S	MS	R	MS	I	Y	-2	-1.4
CWRS moving to CNHR August 1, 2021[1]																	
Muchmore	6	102	98	102	-0.4	VG	G	R	R	MR	MR	R	MS	MS	Y	0	-0.2
AAC Redwater	5	102	101	---	+0.1	F	VG	R	R	MR	MS	I	MS	I	Y	-3	-3.5
Vesper VB	6	108	113	109	-0.7	P	F	MR	R	S	I	S	I	I	Y	-2	+1.0
5605HR CL	5	103	106	---	+0.1	F	F	MS	R	MR	R	MR	MS	MR	Y	-1	-1.0

FHB, management strategies

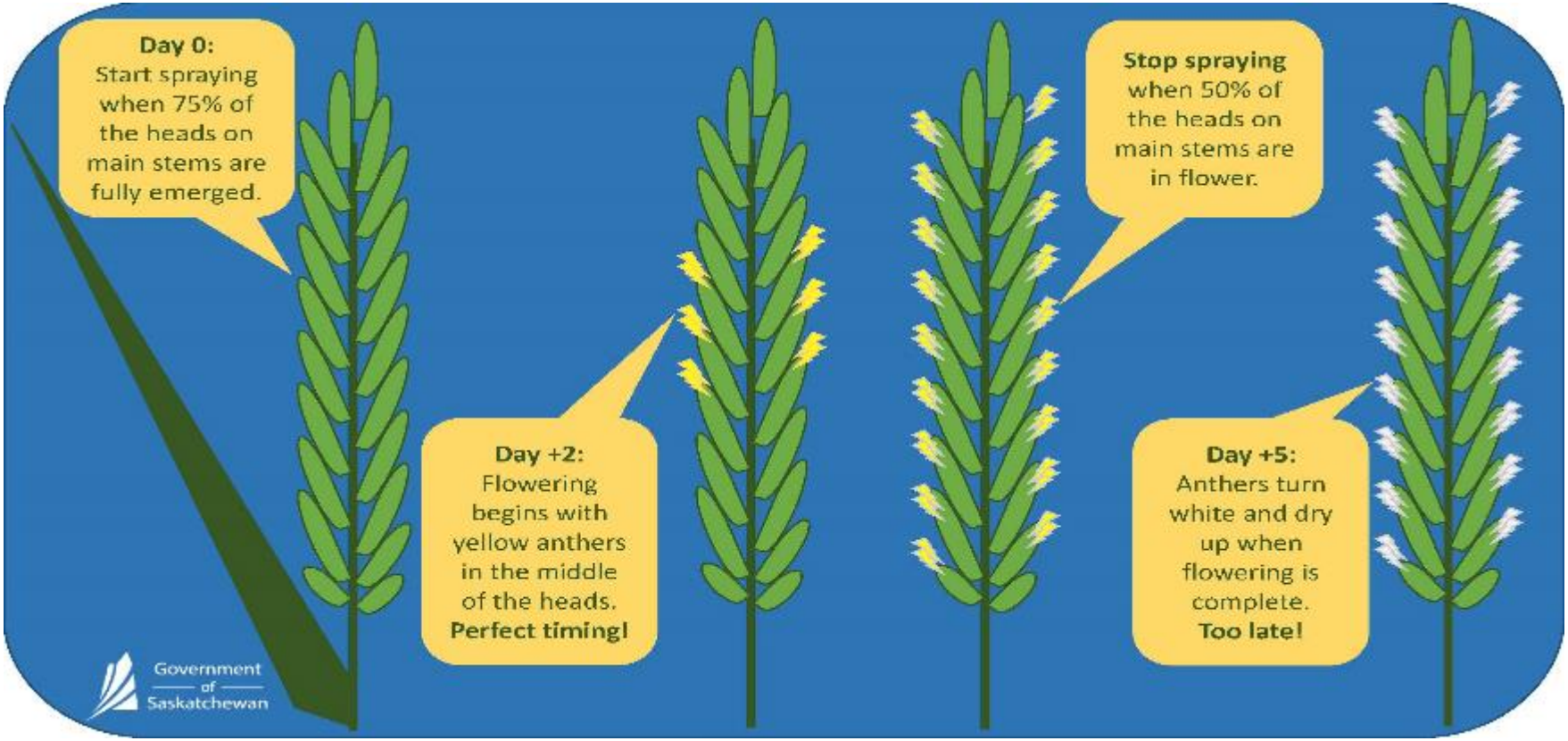
- Escape
  - early maturity, staggered planting dates
  - subtle differences among varieties in length of flowering period,



Infection in wheat

- infection occurs at anthesis (flowering) in cereals
- flowering starts 2 to 3 days after spike emergence and lasts ~4 - 7 days
- Infection occurs under warm (15-30^{o}C), moist (rain, dew or high relative humidity) conditions

Fungicide application timing: anthesis



BBCH 59 **BBCH 61** **BBCH 65** **BBCH 69**

BBCH growth stage scale; Lancashire et al. 1991, Ann. Appl. Biol. 119: 561-601.

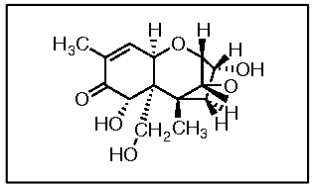
http://www.saskwheatcommission.com/producer-info/fusarium-risk-assessment-map/

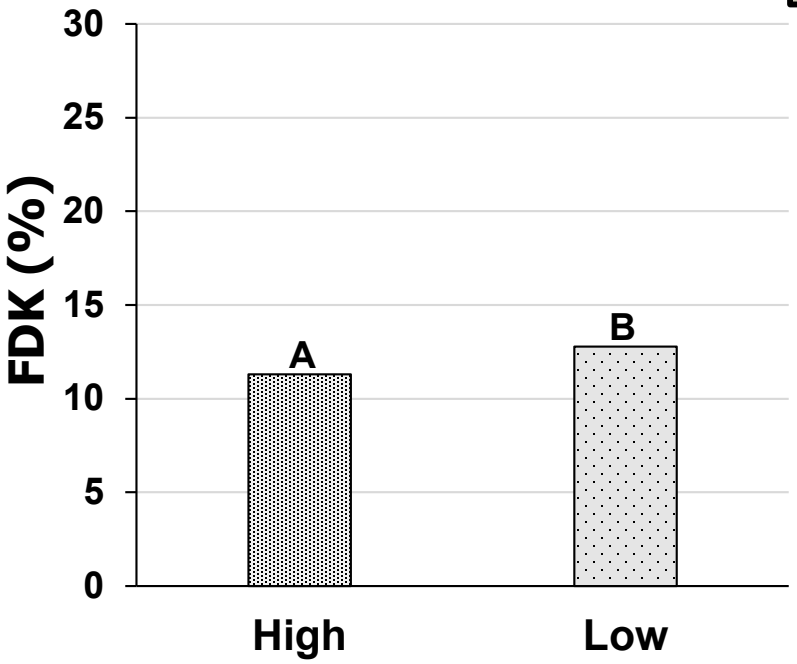
FHB, chemical control

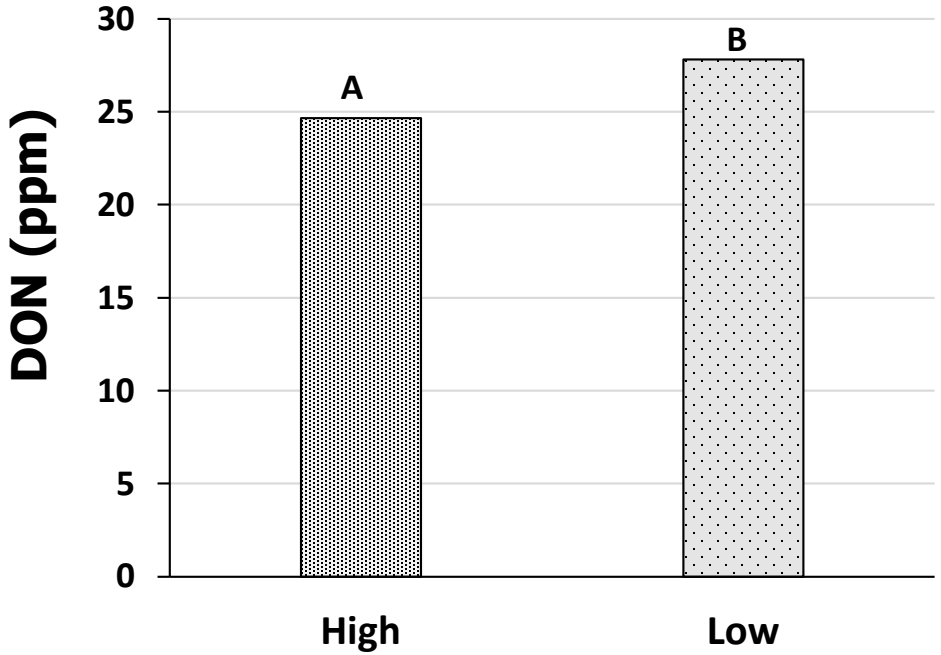
Fungicide efficacy has been inconsistent, and only suppresses the symptoms, NOT control

- perhaps due to the number of *Fusarium* species
- application equipment (sprayer technology)
- difficulty in timing applications

Seed rate effect on FDK and DON



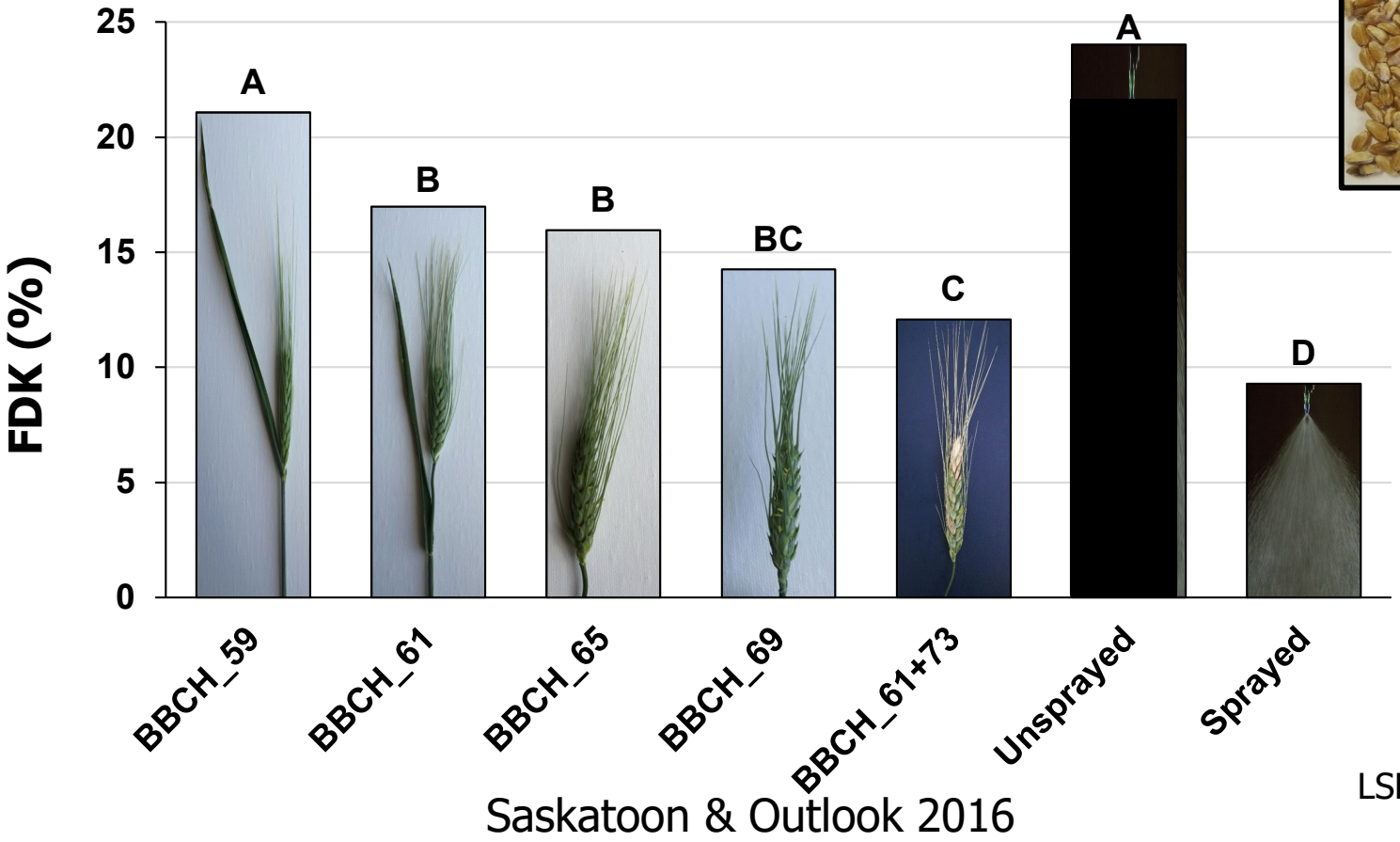




Saskatoon & Outlook 2016

$LSD_{(0.05)}$

Fungicide timing effect on FDK



$LSD_{(0.05)}$

Saskatoon & Outlook 2016

Photo credits: G. Singh and Sprayers 101

Fungicide timing effect on DON

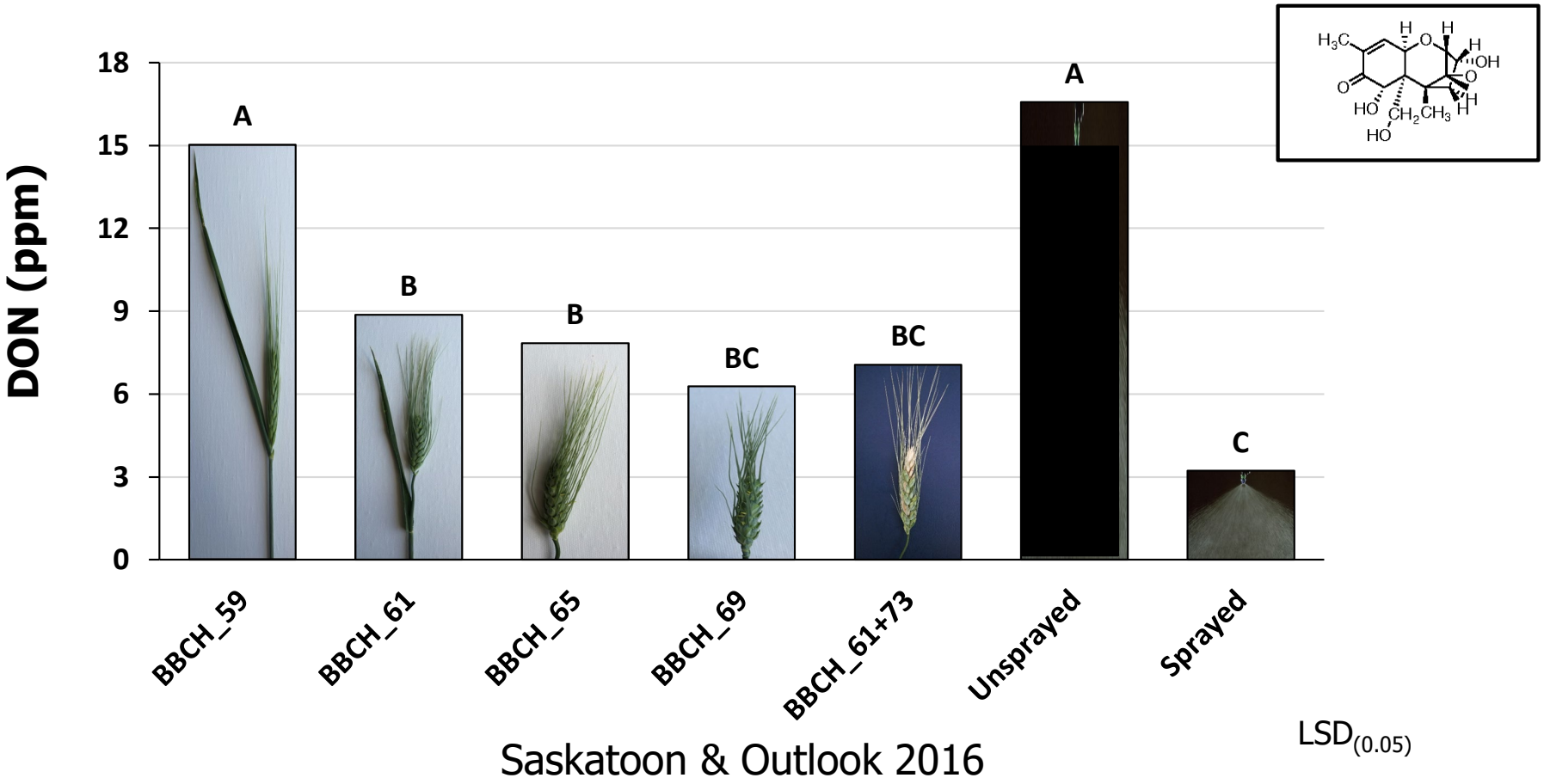
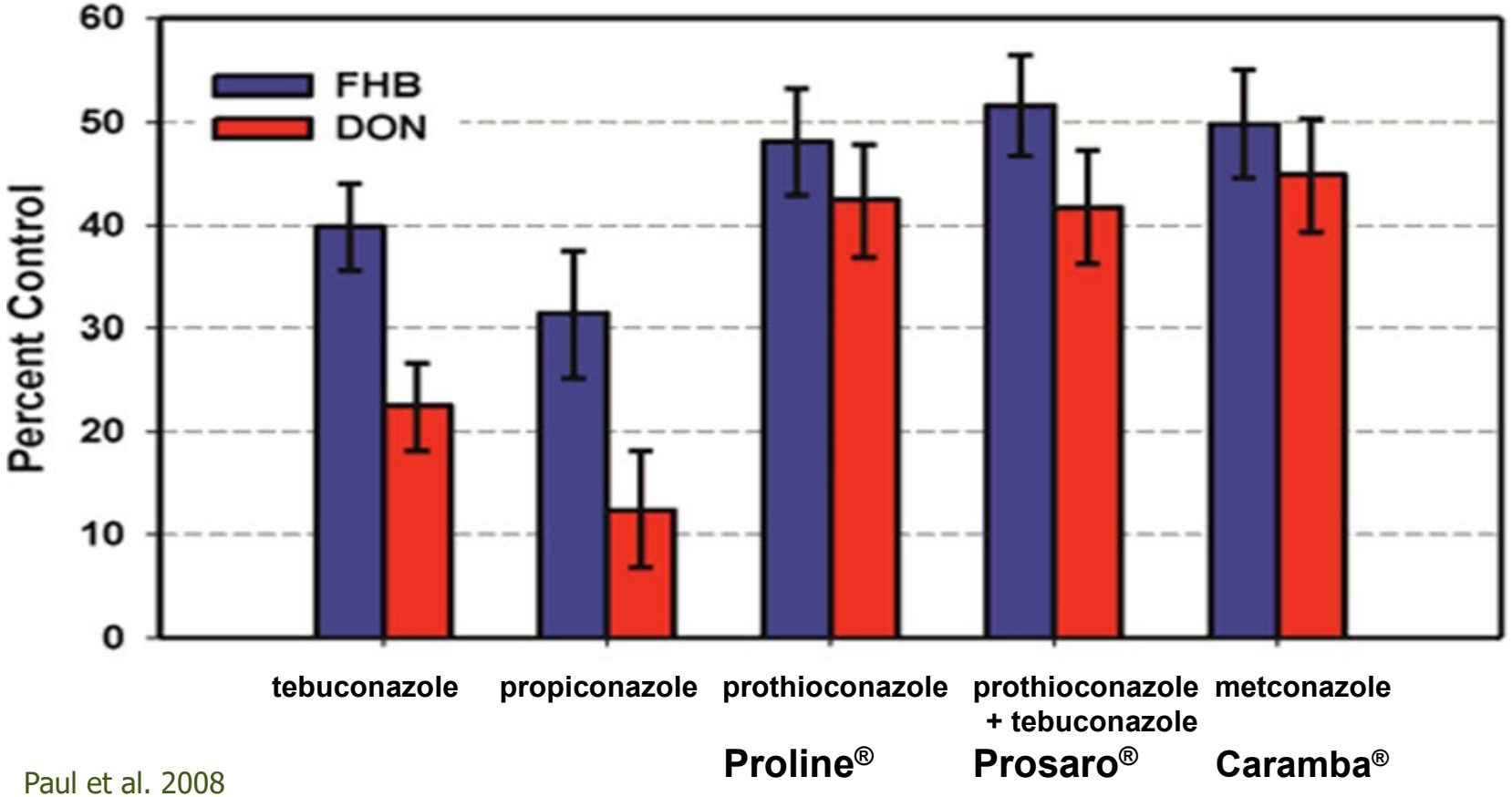


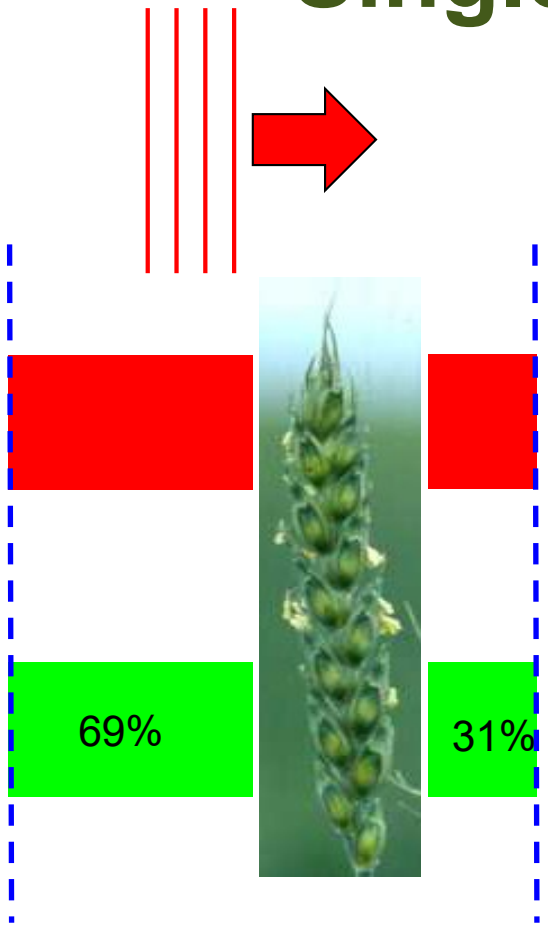
Photo credits: G. Singh and Sprayers 101

Fungicide products: efficacy of triazole fungicides

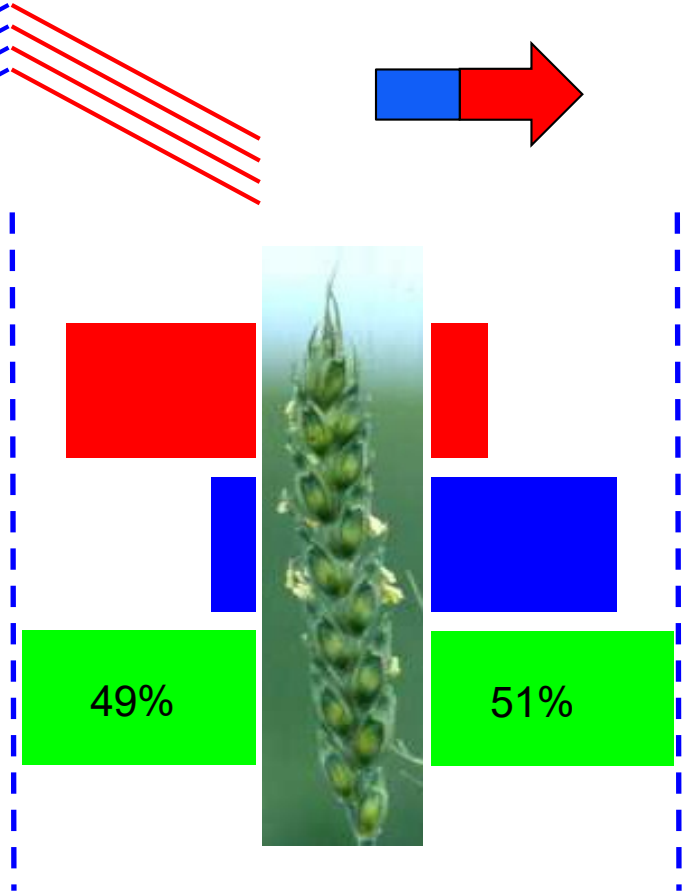


Paul et al. 2008

Single vs double nozzles



Expt 1 Tr. 1
5 mph, Single, Conventional



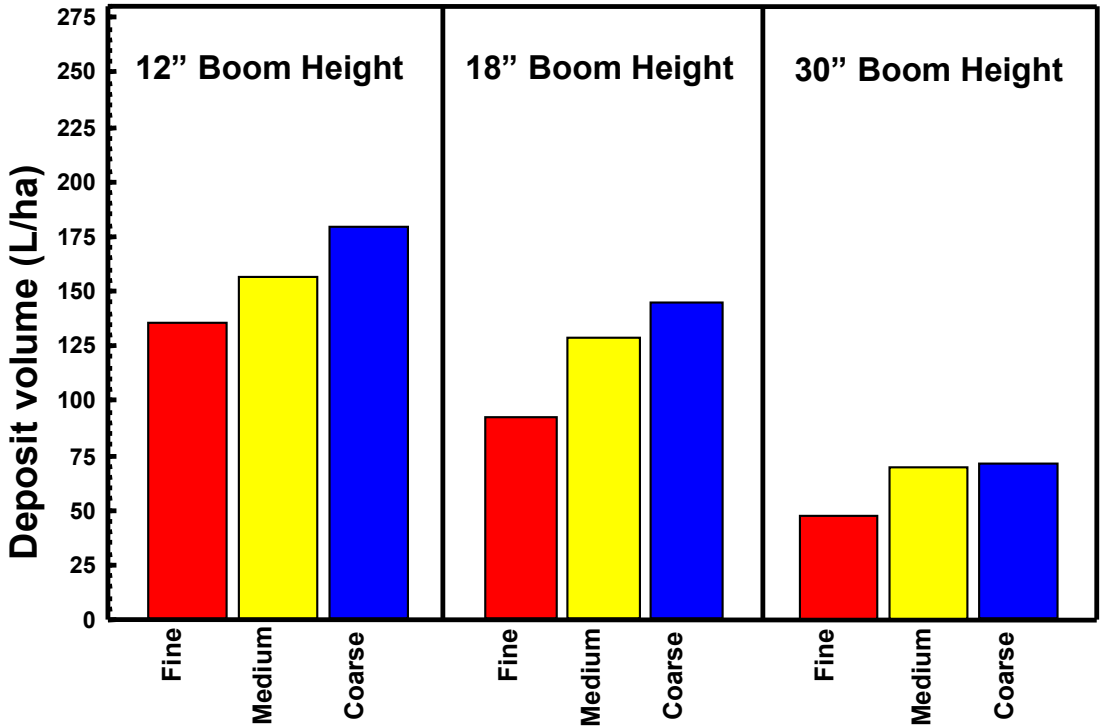
Expt 1 Tr. 3
5 mph, Double, Conventional

Courtesy T. Wolf – Sprayers101

Spray pattern (quality) & boom height

Single forward angled nozzle

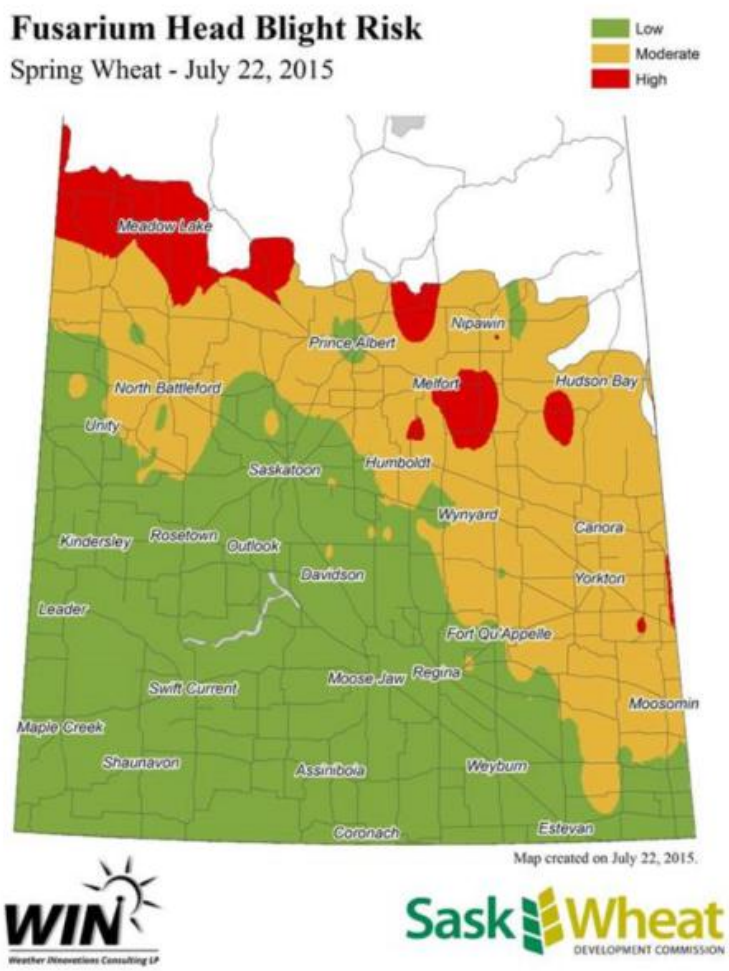
Deposit on simulated wheat heads

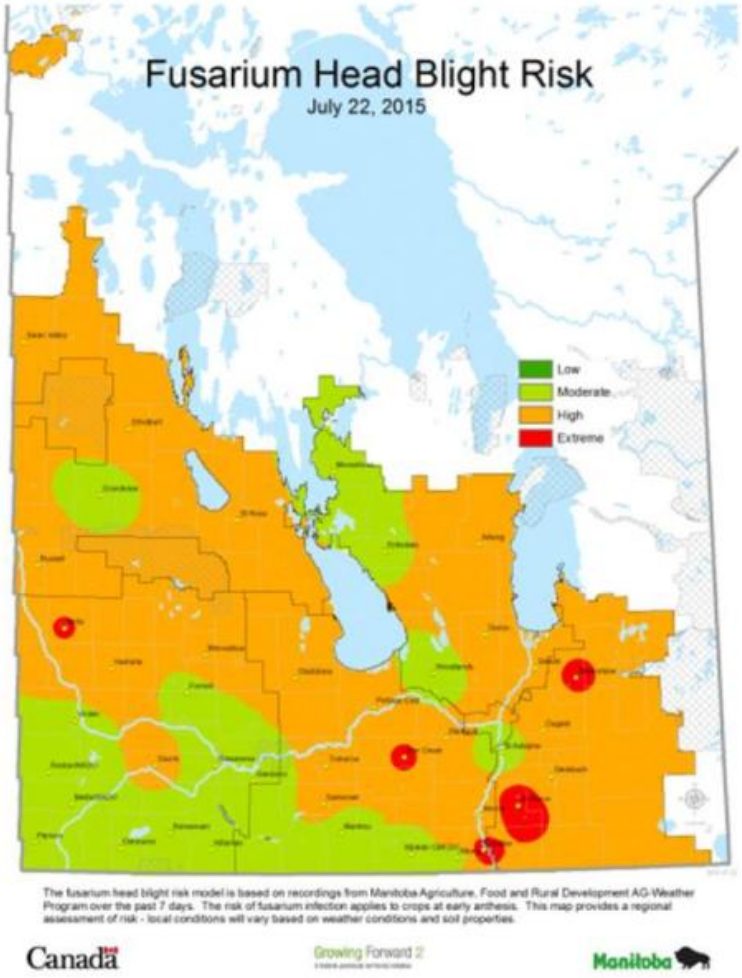


Courtesy T. Wolf – Sprayers 101 www.usask.ca

Other tools - Fusarium Risk Assessment Maps

https://static1.squarespace.com/static/5c40f31a620b85cf0d073e7b/t/5cdc7d3f7817f743060d2fb1/1557953860589/Fusarium-Management-Guide.pdf





Fungicide control of FHB depends on:

- cultivar,
- pathogen (*Fusarium* species, chemotype),
- application timing,
- the fungicide product and the rate of application
- spray patterns, nozzles, nozzle angles, boom height

Triazole fungicides applied at flowering can provide ***suppression NOT control***

FHB, control

- Optimize combine settings
  - Inspect crop 18-21 days after flowering
    - Bleaching symptoms will be at peak and give an idea of what to expect at harvest
  - FDK are lighter weight than healthy seeds in wheat
  - High air speeds blow out some FDK

FHB, seed treatment

- Effective against seedling blight, but little effect on epidemic development
- seed cleaning and fungicide treatment usually does not improve quality enough for use as seed (germination and emergence)
- Fusarium survives poorly on seed so germination may improve overwinter

Summary of FHB

- The integrated approach is required and is economically beneficial and stable across environments,
- Follow a diverse crop rotation (minimum of 3 crops) and use resistant cultivars (when available),
- Timely fungicide application using appropriate application conditions (boom height, nozzle orientation, spray volumes), provides reasonable suppression,

- **Combining a diverse rotation with resistant cultivars and fungicide (when warranted) is more efficacious than any single approach.**

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Thank you for the invitation to speak
to you this afternoon