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Canada

Effect of timing of inoculation and *Fusarium* spp. on FHB development and DON contamination in oat

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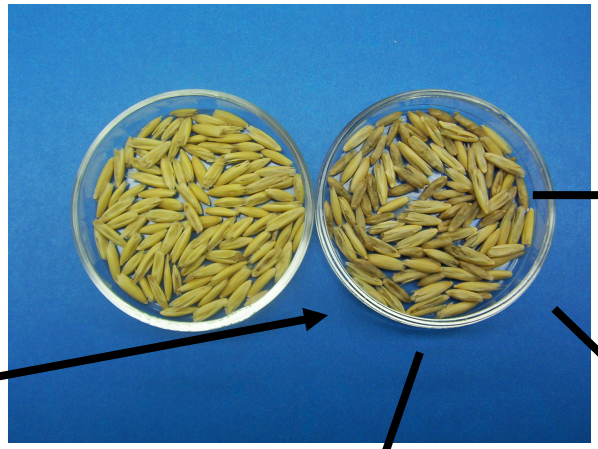
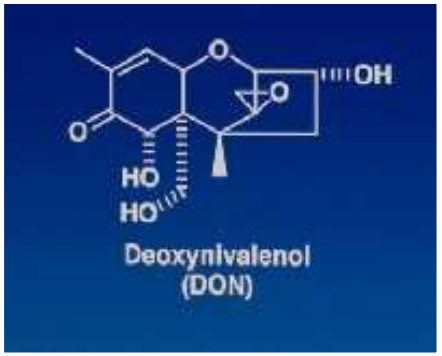
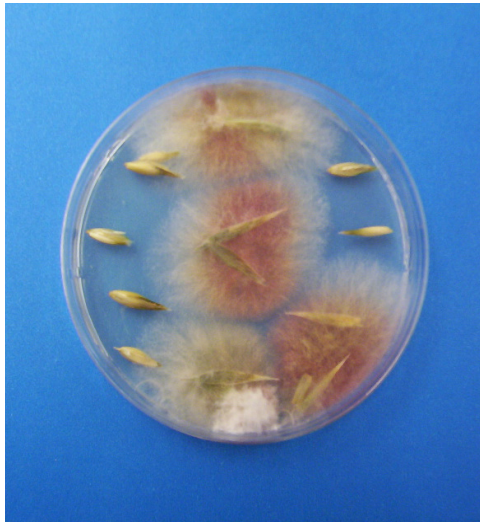
Fusarium head blight (FHB) of oat







Screening of oat genotypes for resistance to FHB

- Commonly been evaluated by field screening, which depends on
  - natural occurrence of *Fusarium* spp. or
  - artificial inoculation in a FHB nursery

- Problem: does not account for the effects of
  - the **timing of inoculation** on oat reactions to FHB
  - differences in **pathogenicity of *Fusarium* spp.**
  - any possible *Fusarium* species × oat genotype **interaction**

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Inconsistent disease reactions

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More tests, loss of time and resources

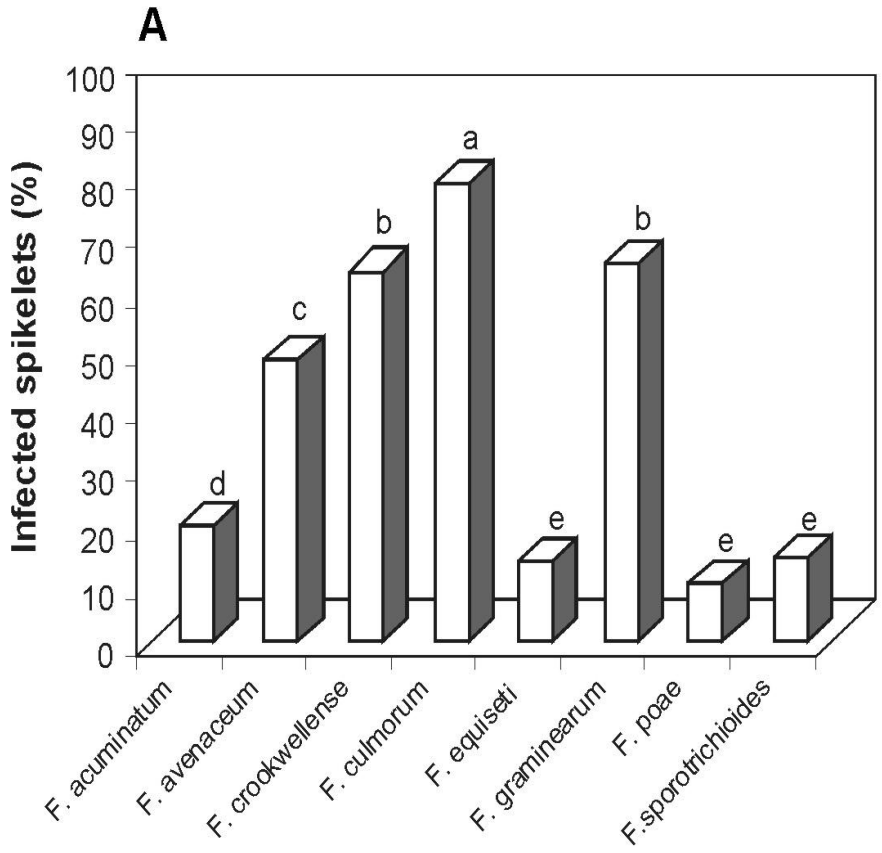
Which *Fusarium* spp. cause FHB on oats?

Results of oat disease survey in Ontario, 2008-2013:

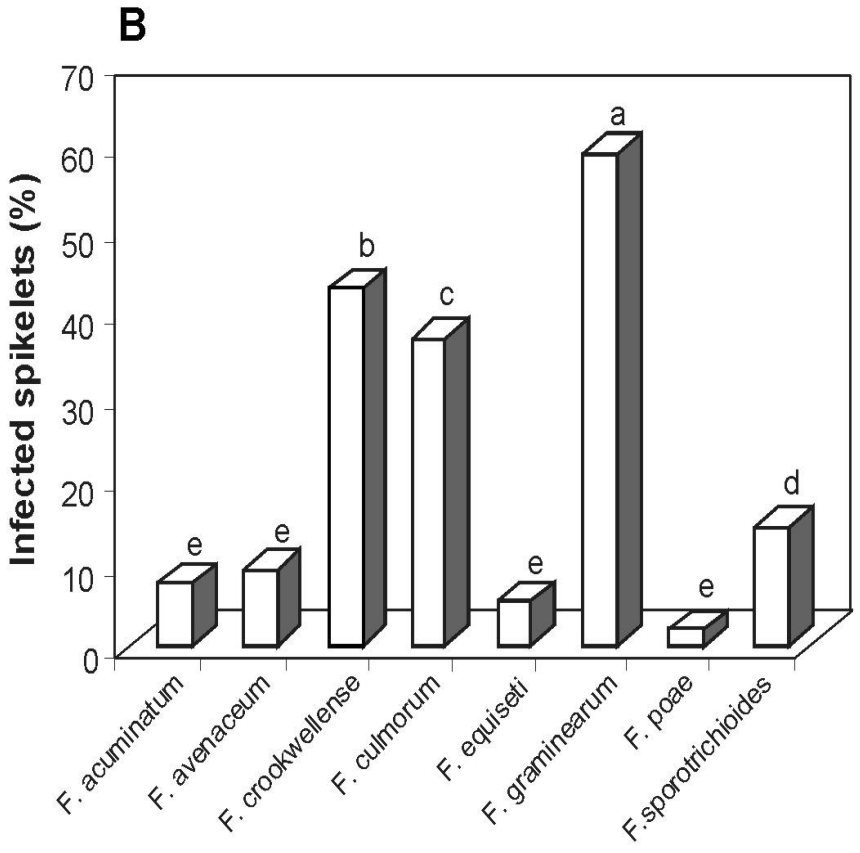
	% of kernels					
Fusarium spp.	2008	2009	2010	2011	2012	2013
F. avenaceum	0.5	5.6	0.8	0.7	1.0	4.2
F. equiseti	0.7	1.2	1.4	1.7	0.8	1.1
F. graminearum	3.0	4.8	5.4	3.3	0.3	10.0
F. poae	10.3	12.8	14.3	56.3	27.2	20.5
F. sporotrichioides	2.8	7.6	2.5	4.5	0.7	5.8
F. culmorum	0.0	1.7	0.0	0.0	0.0	0.0
Fields surveyed	11	10	15	12	15	19
Kernels tested	550	500	750	600	750	950
Infected kernels (%)	17.2	33.7	25.0	66.5	30.0	42.1

Xue et al. 2009. Can. Plant Dis. Surv. 89: 84-85.
Xue, A.G. and Chen, Y. 2010. Can. Plant Dis. Surv. 90: 86-87.
Xue, A.G. and Chen, Y. 2011. Can. Plant Dis. Surv. 91: 88-89.
Xue, A.G. and Chen, Y. 2012. Can. Plant Dis. Surv. 92: 94-95.
Xue, A.G. and Chen, Y. 2013. Can. Plant Dis. Surv. 93: 121-122.
Xue, A.G. and Chen, Y. 2014. Can. Plant Dis. Surv. 94: 135-136.

Pathogenicity of eight *Fusarium* spp. causing head blight in barley (A) and wheat (B)



Xue, et al. 2006. Phytoprotection 87: 55-61.



Xue, et al. 2004. Can. J. Plant Pathol. 26: 81-88.

Objectives

- To determine the effect of timing of inoculation on oat reactions to FHB
- To examine the comparative pathogenicity of four common *Fusarium* spp. in causing FHB
- To examine any possible *Fusarium* spp. × oat genotype interaction

Experiment on inoculation timing

- Six timings of inoculation
- Twelve oat genotypes
- mixture of three isolates of *F. graminearum*
  (DAOM 178148, DAOM 212678, DAOM 232369)

Six plant growth stages at inoculation

51 55 59 61 65 69

Zadoks' growth stage (ZGS)

ZGS 51	first spikelet visible
ZGS 55	half of ear emerged
ZGS 59	emergence of ear completed
ZGS 61	beginning of flowering
ZGS 65	flowering halfway (50% anthesis)
ZGS 69	flowering completed

Origins of 12 oat genotypes used in this study

Genotype	Origin
AC Morgan	LRC[1], AAFC[2], Lacombe, Alberta, Canada
CDC Dancer	CDC, U of S[3], Saskatoon, Saskatchewan, Canada
Spurs	IAES[4], U of I, Urbana, Illinois, USA
LAO-643-047	LRC, AAFC, Lacombe, Alberta, Canada
LAO-645-052	LRC, AAFC, Lacombe, Alberta, Canada
ND990118	NDStU[5], Fargo, North Dakota, USA
OA1019-4	ECORC[6], AAFC, Ottawa, Ontario, Canada
Prescott	ECORC, AAFC, Ottawa, Ontario, Canada
SO00013	CDC, U of S, Saskatoon, Saskatchewan, Canada
W00058	CRC[7], AAFC, Winnipeg, Manitoba, Canada
W00276	CRC, AAFC, Winnipeg, Manitoba, Canada
WI-X8177-1	U of W[8], Milwaukee, Wisconsin, USA

[1]LRC: Lacombe Research Centre; [2]AAFC: Agriculture and Agri-Food Canada; [3]CDC, U of S: Crop Development Centre, University of Saskatchewan; [4]IAES, U of I: Illinois Agricultural Experiment Station, University of Illinois; [5]North Dakota State University; [6]ECORC: Eastern Cereal and Oilseed Research Centre; [7]CRC: Cereal Research Centre; [8]U of W: University of Wisconsin.

Inoculation and disease development in growth room

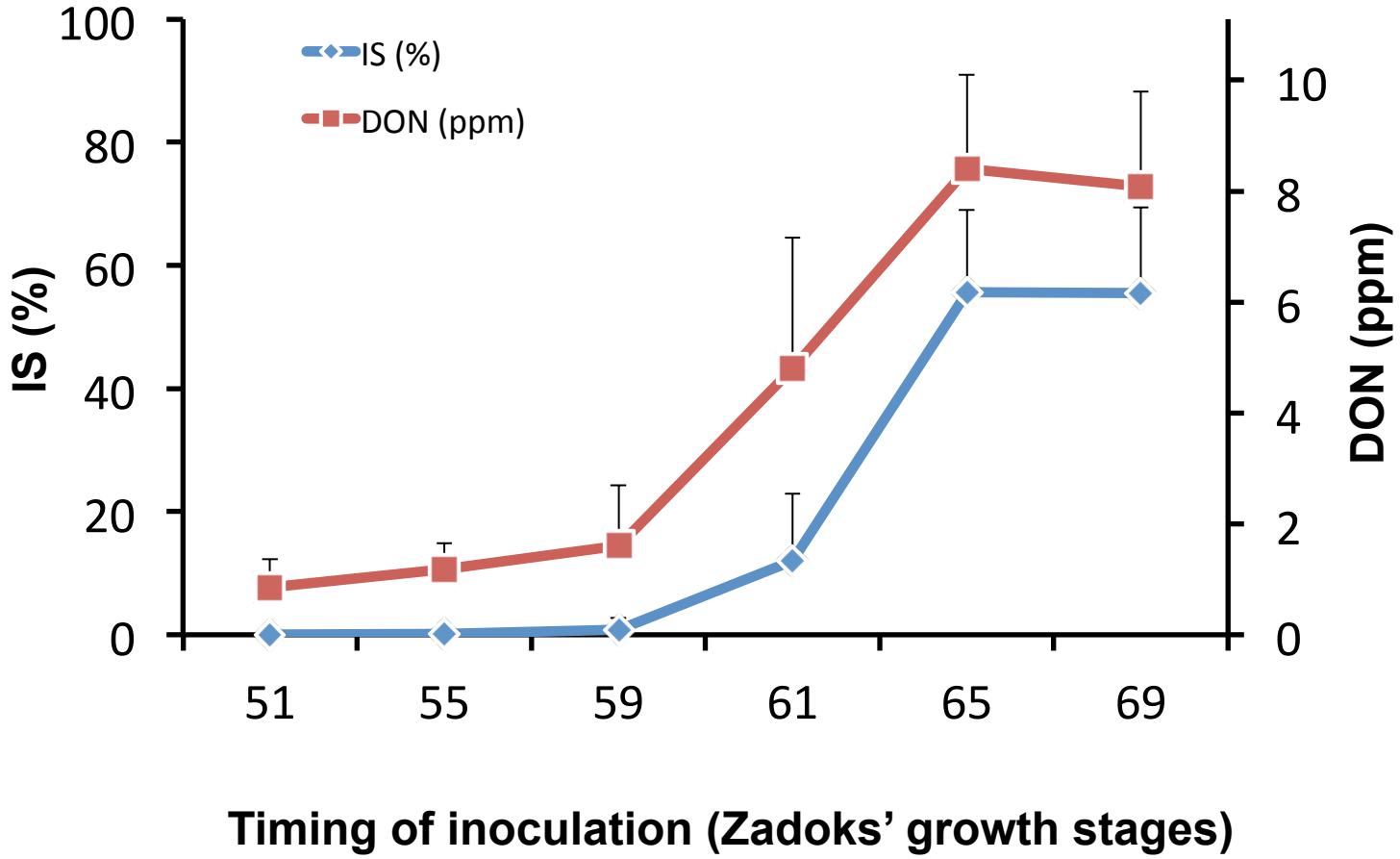
Disease assessments

- Symptoms of FHB
  - rated as % of infected spikelets (IS) for all inoculated spikes

    at the soft dough stage (ZGS 83-85), 20-23 days after the 50% anthesis stage

- DON concentration
  - Mycotoxin Research Lab, ECORC, by the competitive direct enzyme-linked immunosorbent assay (CD-ELISA) procedure

Effect of timing of inoculation with *F. graminearum* on infected spikelets (IS) and deoxynivalenol (DON) content of oats

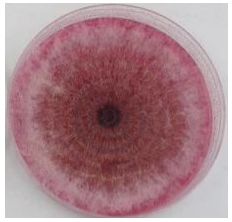


Values are mean across 12 oat genotypes and four replicates for IS and two oat genotypes and four replicates for DON content. Vertical bars represent standard deviation.

Experiment on pathogenicity of *Fusarium* spp.

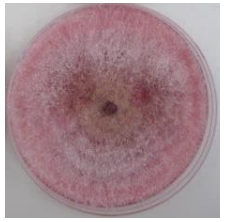
- Four *Fusarium* spp.

F. avenaceum



F. culmorum

F. graminearum



F. sporotrichioides

- Twelve oat genotypes:

  AC Morgan, CDC Dancer, Spurs, LAO-643-047, LAO-645-052, ND990118, OA1019-4, Prescott, SO00013, W00058, W00276, WI-X8177-1

- Inoculated at the 50% anthesis stage (ZGS 65)

Disease assessments

- Symptoms of FHB
  - IS percentage was assessed four times (6, 10, 13, and 21 days after inoculation), to compare the disease development caused by the four *Fusarium* spp. over time and summarized as area under the disease progress curve (AUDPC)

- DON concentration
  - Mycotoxin Research Lab, ECORC, by the competitive direct enzyme-linked immunosorbent assay (CD-ELISA) procedure

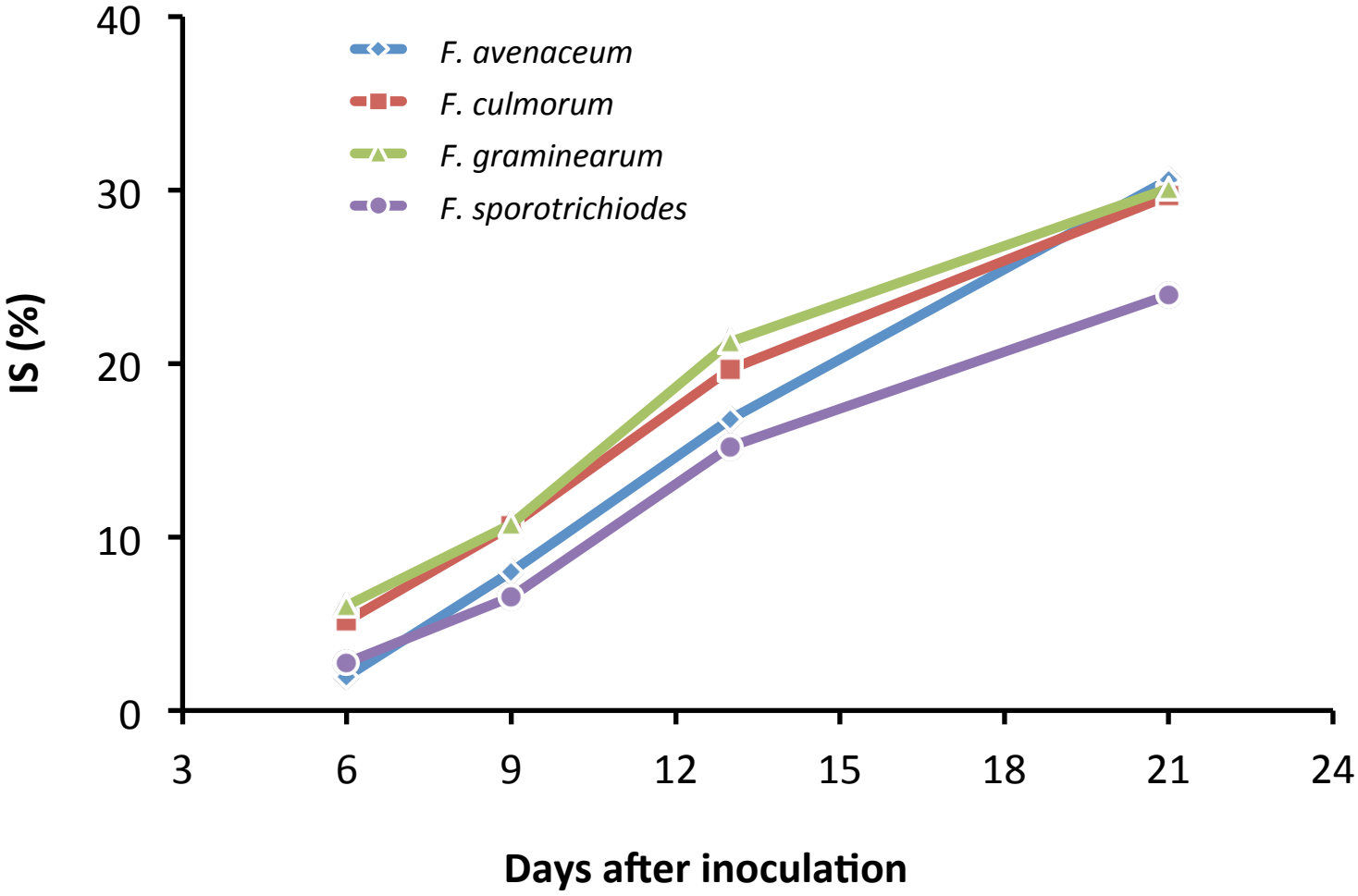
ANOVA for AUDPC and DON content of 12 oat genotypes inoculated with four *Fusarium* spp.

Source of variation	DF	Mean Square AUDPC		Mean Square DON	
Replicate	3	130.8		0.1	
Fusarium spp.	3	2714.9	*	1278.9	**
Error A	9	537.9		0.1	
Genotype	11	6822.1	**	1.4	**
Genotype × *Fusarium* spp.	33	1456.6		1.1	*
Error B	132	796.9		0.3	

* Significant at $P \leq 0.05$

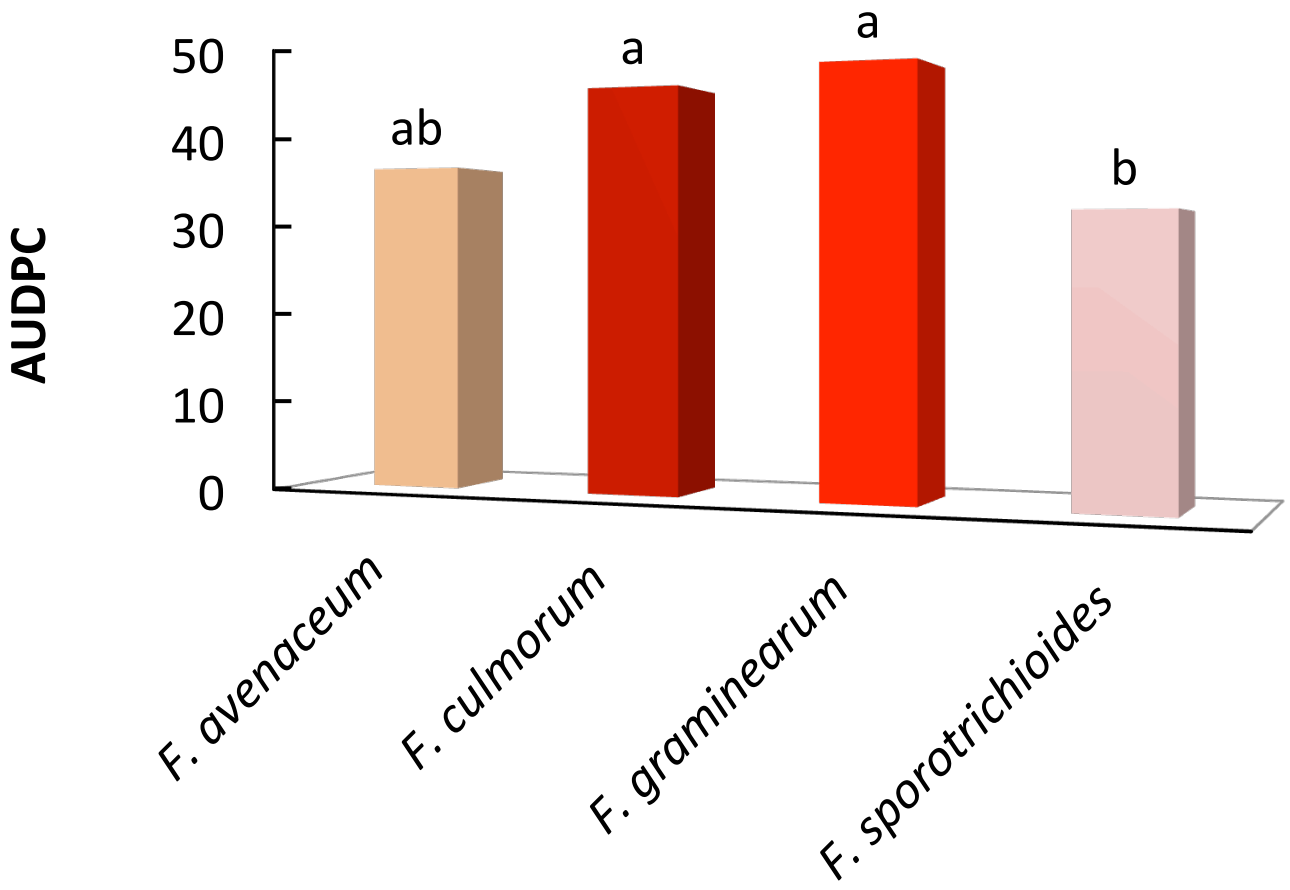
** Significant at $P \leq 0.01$

FHB progress curves from four *Fusarium* spp. on oats



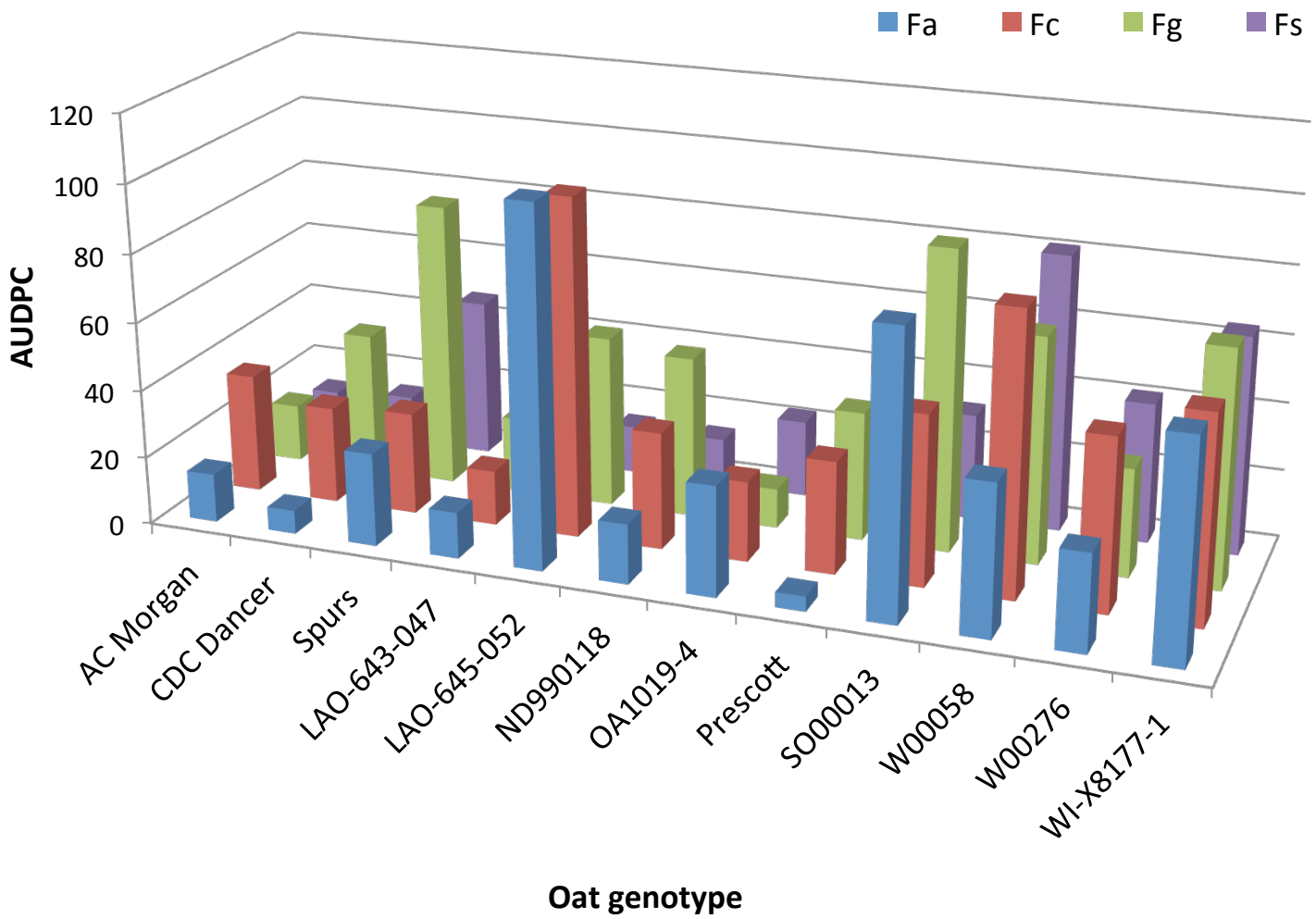
Values are mean across 12 oat genotypes and four replicates.

Pathogenicity of four *Fusarium* spp. in causing FHB in oats

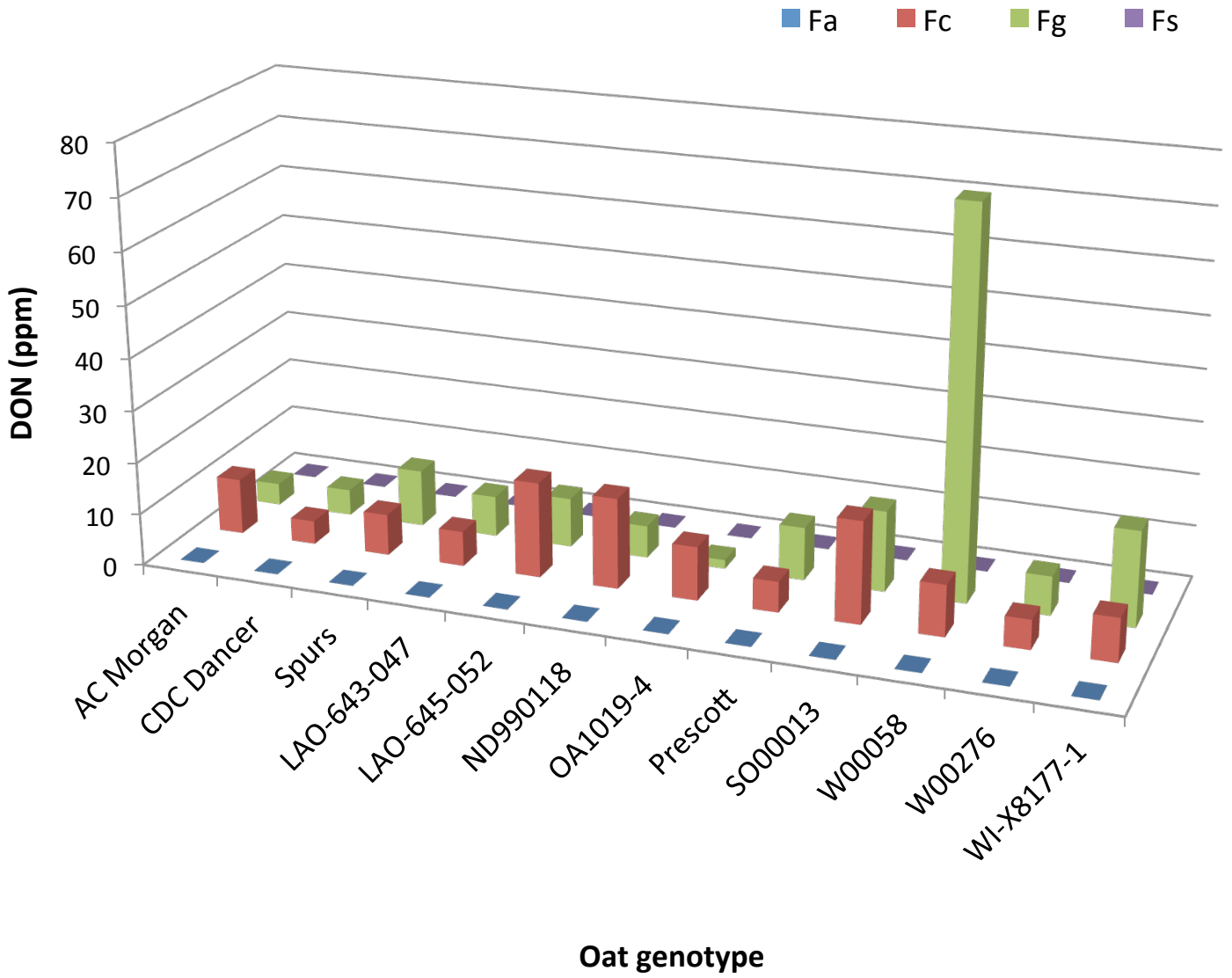


Values are mean of 12 oat genotypes and four replicates.

Reaction of 12 oat genotypes to four *Fusarium* spp.



Reaction of 12 oat genotypes to four *Fusarium* spp.



Summary

- Inoculation at or before the complete emergence of ears resulted in little or no visible FHB symptoms but DON contents ranging from 1 to 4 ppm were detected in the harvested grain
- Severe levels of FHB (40 to 75% IS) and DON (6-10 ppm) were observed when plants were inoculated at or after the 50% anthesis stage
- Inoculation at 50% anthesis was considered the most appropriate timing as it allowed sufficient time for disease development and assessment prior to physiological maturity of the plant

Summary cont.

- All four *Fusarium* spp. can cause typical FHB symptoms and *F. culmorum* and *F. graminearum* produced DON in the harvested grains
- *F. culmorum* and *F. graminearum* were equally highly pathogenic; *F. avenaceum* was intermediate; *F. sporotrichioides* was least pathogenic
- Oat genotype × *Fusarium* spp. interaction was not significant for AUDPC
  - oats may share common genes for resistance to these pathogenic species
  - breeding for resistance to *F. graminearum* may also give enhanced resistance to other *Fusarium* spp.

Acknowledgements

Art McElroy

Marc Savard

Thank you!

Questions?