

*Fusarium* resistance in oats derived from  
***Avena sterilis* L.**



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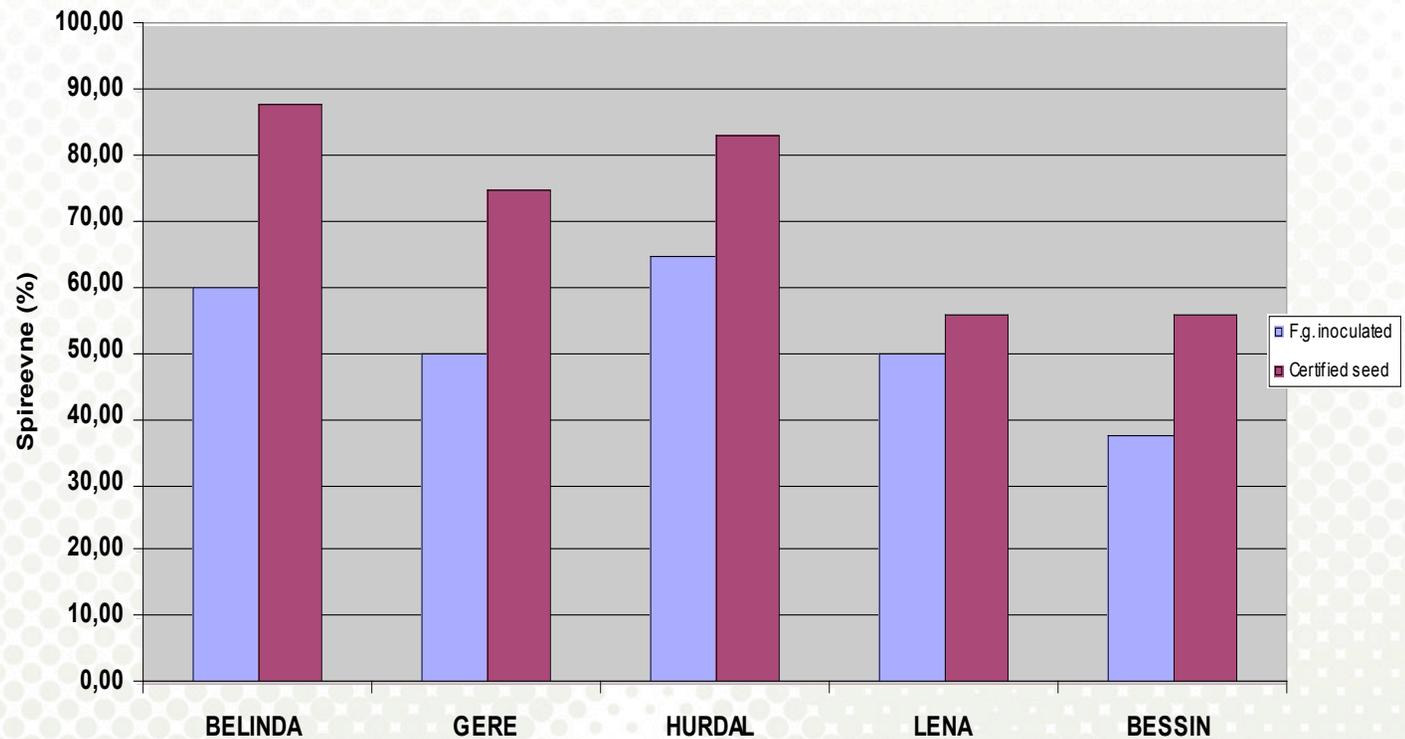
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## Fusarium in oats

- In Norway: oats more resistant than wheat and barley in inoculation trials (cf. In Canada, Poster V-4)
- But most problems in practice!
- Severe germination problems in in certain cultivars, shortage of certified seed
- - due to *F. graminearum*?
- The etiology is unclear
- Are there available resistance sources?

## Germination in seeds from inoculation plots and normal trials, 2007 - due to *F. graminearum*?



## Known active resistance mechanisms in oats

- Oats *do have* Type 2 resistance to pathogen spreading (infection across the pedicel has not been observed, Langevin et al. 2004)
- Oats *appear to have* tolerance to trichothecenes from *F. graminearum* (Langevin et al. 2004; our observations)
- Oats *may have* Type 1 resistance against initial infection or in kernels (*toxins can be removed by dehulling*)
- **Limited diversity in resistance**

## Cultivar differences in oats: a varied picture world wide – and in this meeting

- Late cultivars more affected (Finland, Russia)
- Hull-less better than hulled
- Tall cultivars – no clear trends
- Cultivar differences do exist, especially some very bad ones
- Russia: Gavrilova et al, abstract V-\*: screened 100 accessions from the VIR collection, a wide variation
- Canada (Yan's poster): Cultivar differences, 'Robust' vs. 'CDC Dancer'
- Canada (Mitchell-Fletch's poster): Accessions better than this
- Norway: Cv. 'Bessin' most susceptible, 'Belinda' much better

## Cultivar assessments in oats: How?

- Choice of *Fusarium* species (inoculation success)
- Late season infections important?
- Pathogen species differ according to cool/warm, dry/wet, tillage
- When are oats infected?
- The toxins may be removed by dehulling – why bother?

## Possible measures of *Fusarium* infection in oats.

- **Fusarium Head Blight** (Type 1 -2)
- **Fusarium infected kernels: Freezer blotter test** (Type 1-2)
  - 100 harvested seeds imbibed and frozen on filter paper. Medium heritability.
- **Damaged kernels, spikelet sterility, yield effects** (Type 5)
  - Has not been adequately investigated (but next talk)
  - Finland: "highest toxin contents in small grain"
- **Mycotoxin determinations:** Relationship between kernel infection and toxin level unclear

**Fusarium symptoms unreliable**, discoloration for many reasons, if present (Susceptible left (cv. 'Hurdal'), resistant right (Z615))



Cv. 'Hurdal' / *F. graminearum*: pink mycelium or empty spikelets with infected pedicel



Cv. 'Hurdal' / *F. graminearum* : Discoloration and decaying seeds



Freezer blotter test : 100 seeds on a wet filter paper are imbibed, frozen, thawed and incubated for 8-10 days. Count heavily, medium and uninfected seeds, as %.



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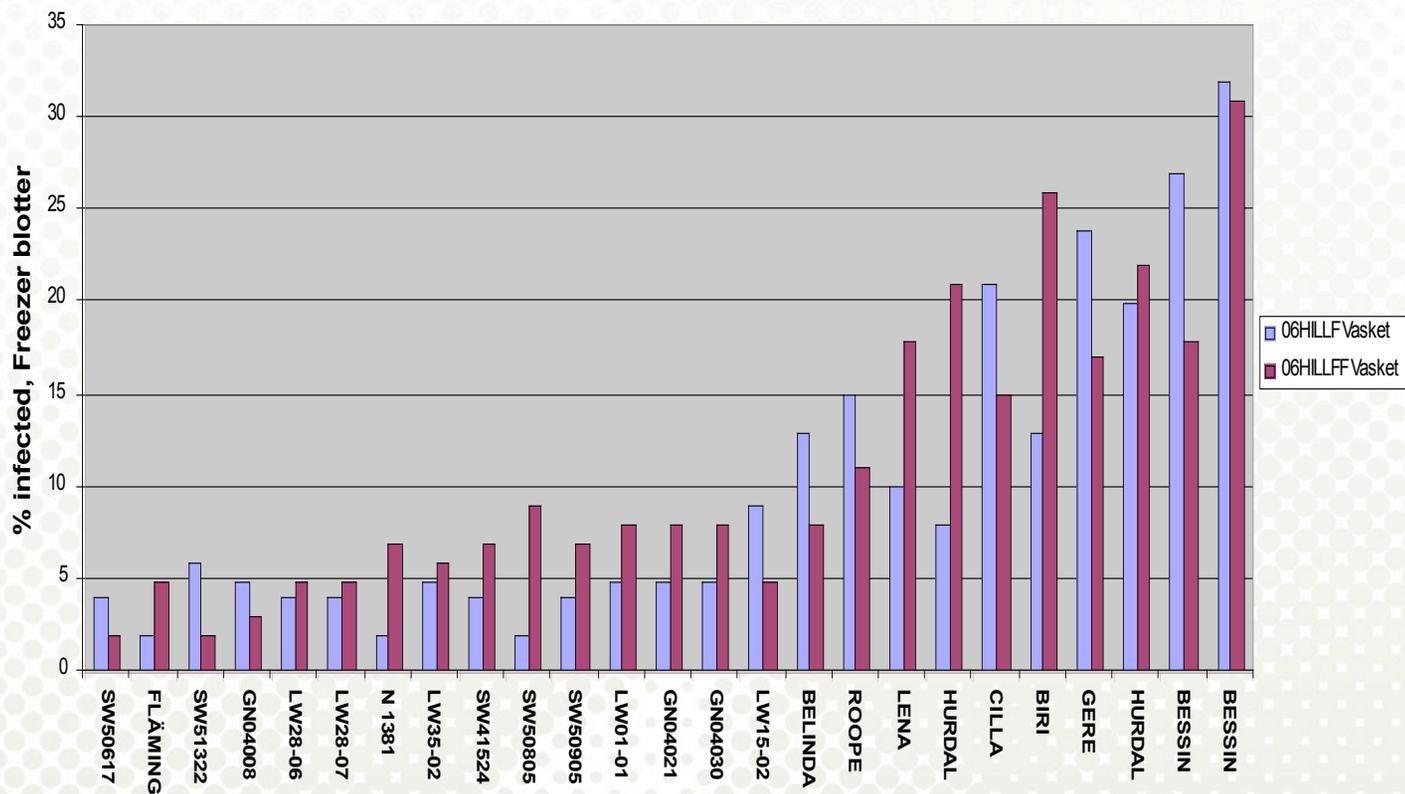


Correlations ( $r$ ) between the freezer blotter test and DON. (Liu et al. 1997) need to be verified

Results 1993-1994	Fusarium head blight Vs. DON	Freeze & blot highly infected Seeds vs DON
Spring wheat (df=6)	0,39	0,85**
Winter wheat (df=19)	0,41	0,55**
Barley (df=12)	0,00	0,74**
Oats (df=13)	?	0,63**

# Differences in seed infection exist in oats

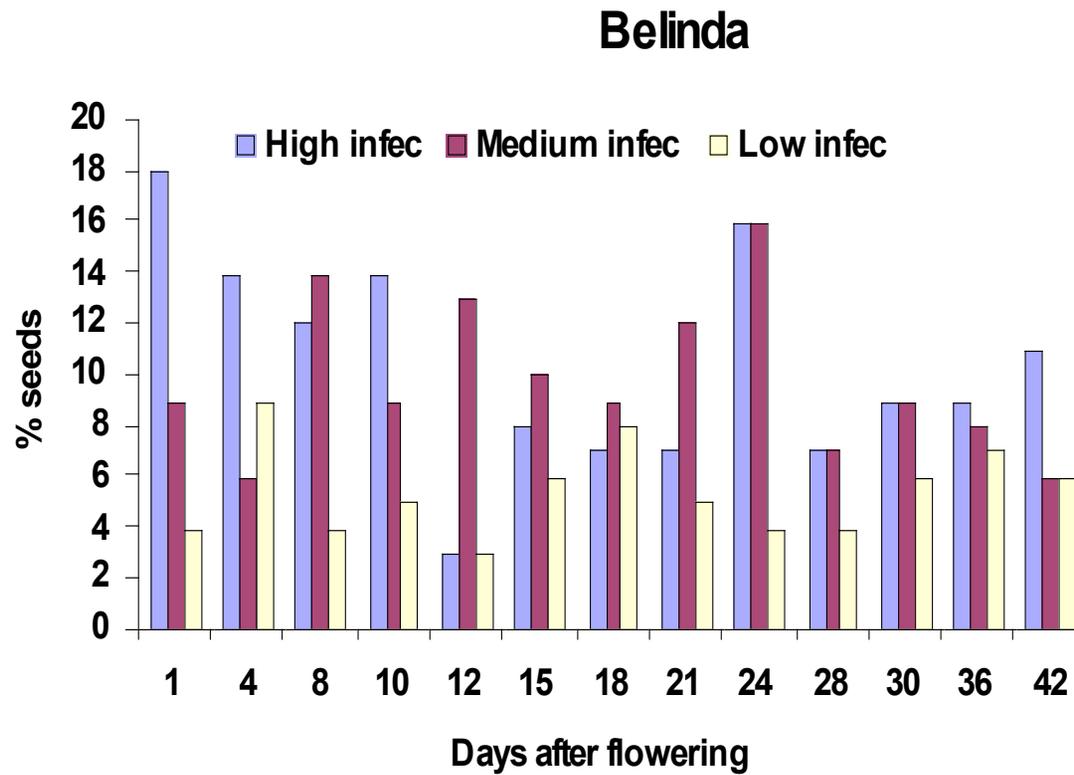
2006 oat breeding lines inoculated by *Fusarium graminearum* .



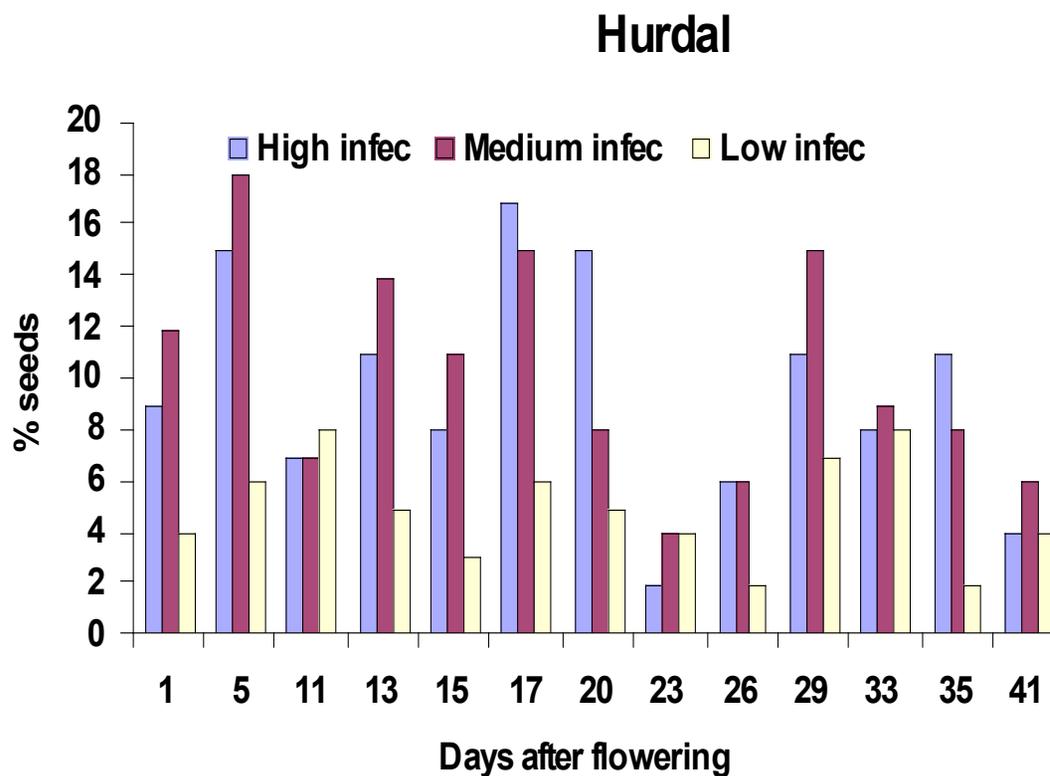
## The infection time and susceptibility in oats

- In 2007, cv. 'Hurdal' and 'Belinda' were inoculated at 5 day intervals with *F. culmorum* from anthesis to maturity
- Spray-inoculation with plastic bags, water as non-inoculated control
- Very wet season
- Seed infection, germination percentage and yield components measured at maturity
- (M.Sc. Thesis Selamawit Tekle Gobena 2008-09)

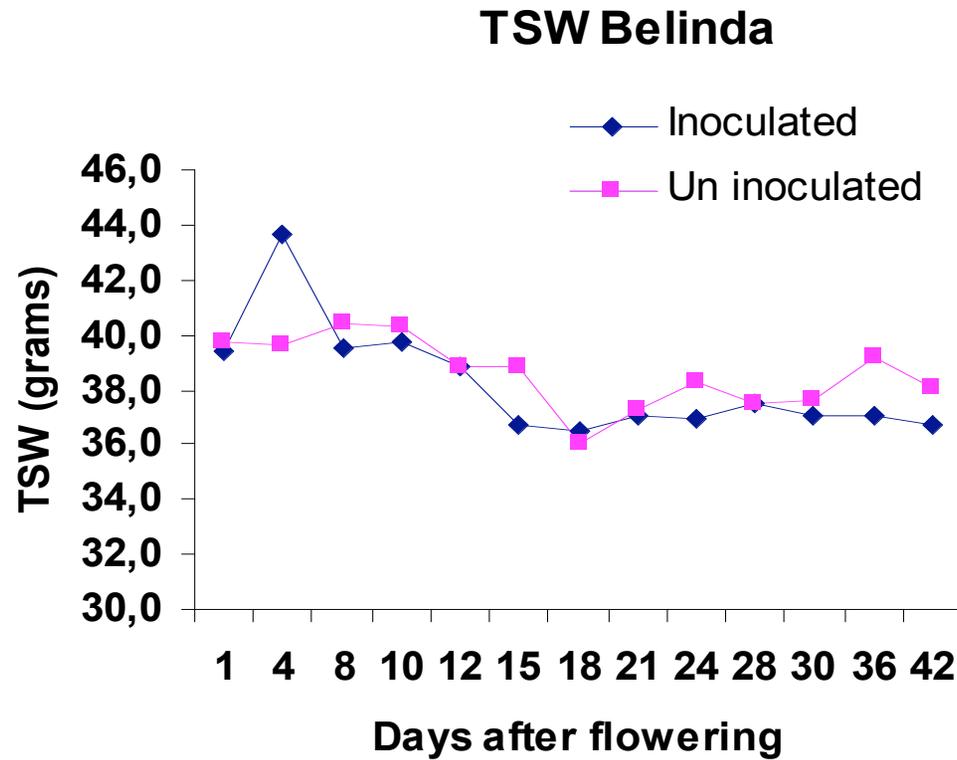
The window of susceptibility in oats seems wide open! Cv. 'Belinda' (late)



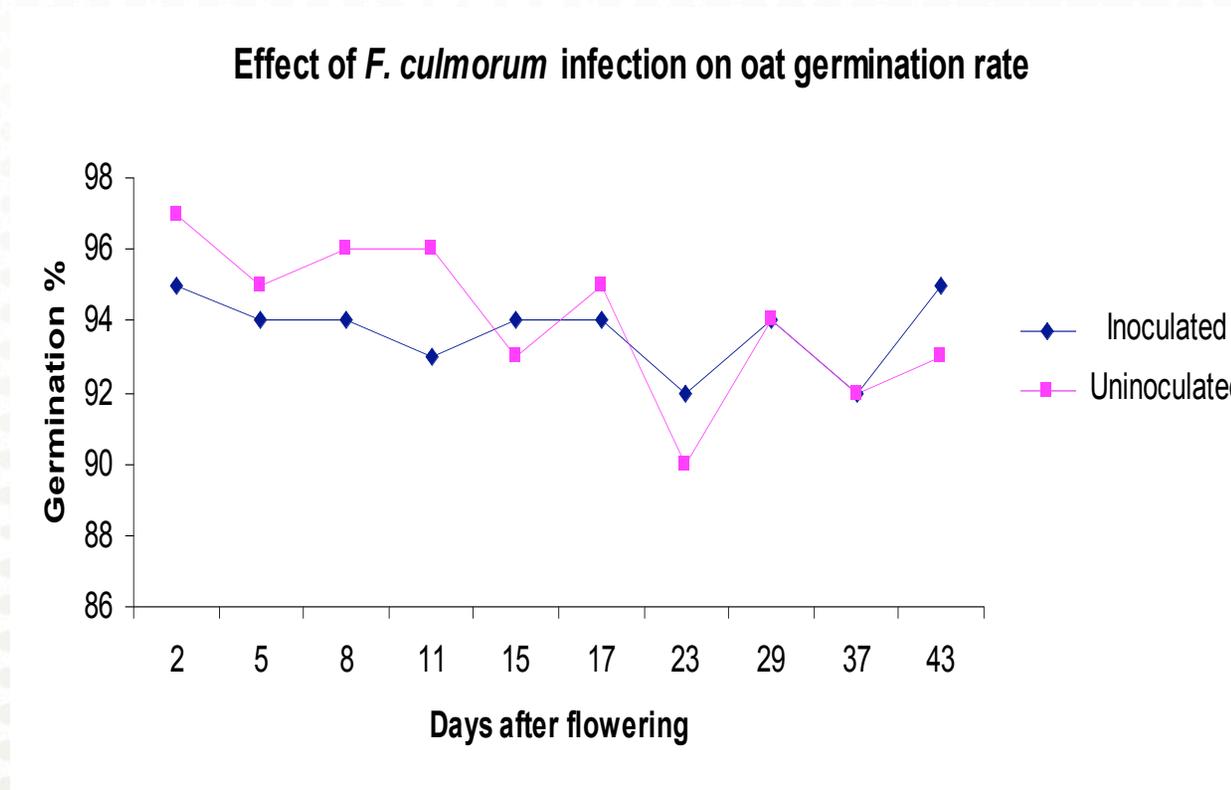
# Cv. Hurdal (early)



# The infection time and thousand seed weight



## The infection time and germination percentage, cv. 'Hurdal'



In 2007 a severe natural infection in a 'Belinda' field due to *F. avenaceum*, *F.poeae*/*F. langsethii*



## Decaying spikelet, peduncle infection in progress



## Caryopses apparently infected from the anthers



## Anthers densely overgrown by hyphae (1)



## Anthers densely overgrown by hyphae (2)



## Infection in anther on inner side of palea



## Resistance in oat lines derived from *A. sterilis*

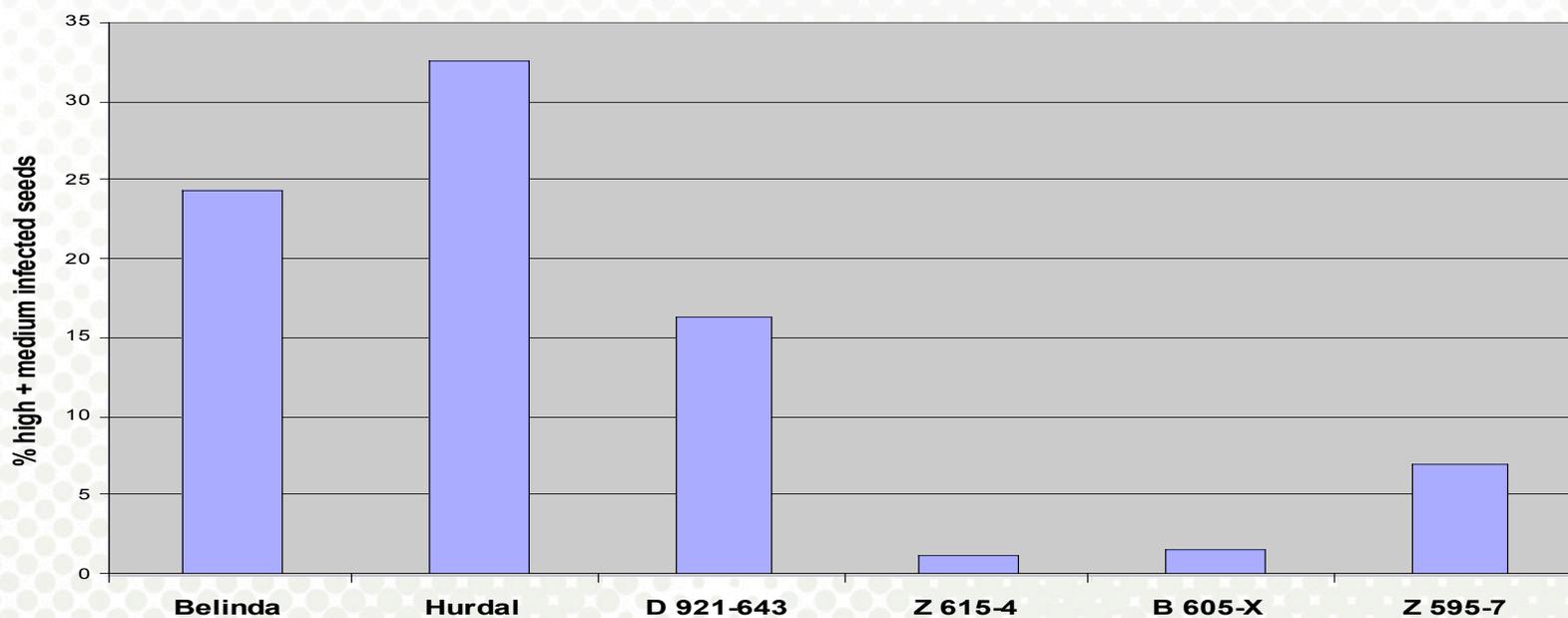
- D921-643: *A. sterilis*, PI317789 (Israel)\*3/Otter
- B605X: Selection from an irradiated composite cross population
- Z595-7: *A. sterilis*, PI411560 (Eritrea)/Tippecanoe
- Z615-4: *A. sterilis*, PI411560 (Eritrea)/Ogle

Seed infection in oats: left susceptible cultivar 'Belinda', right resistant '615-4'



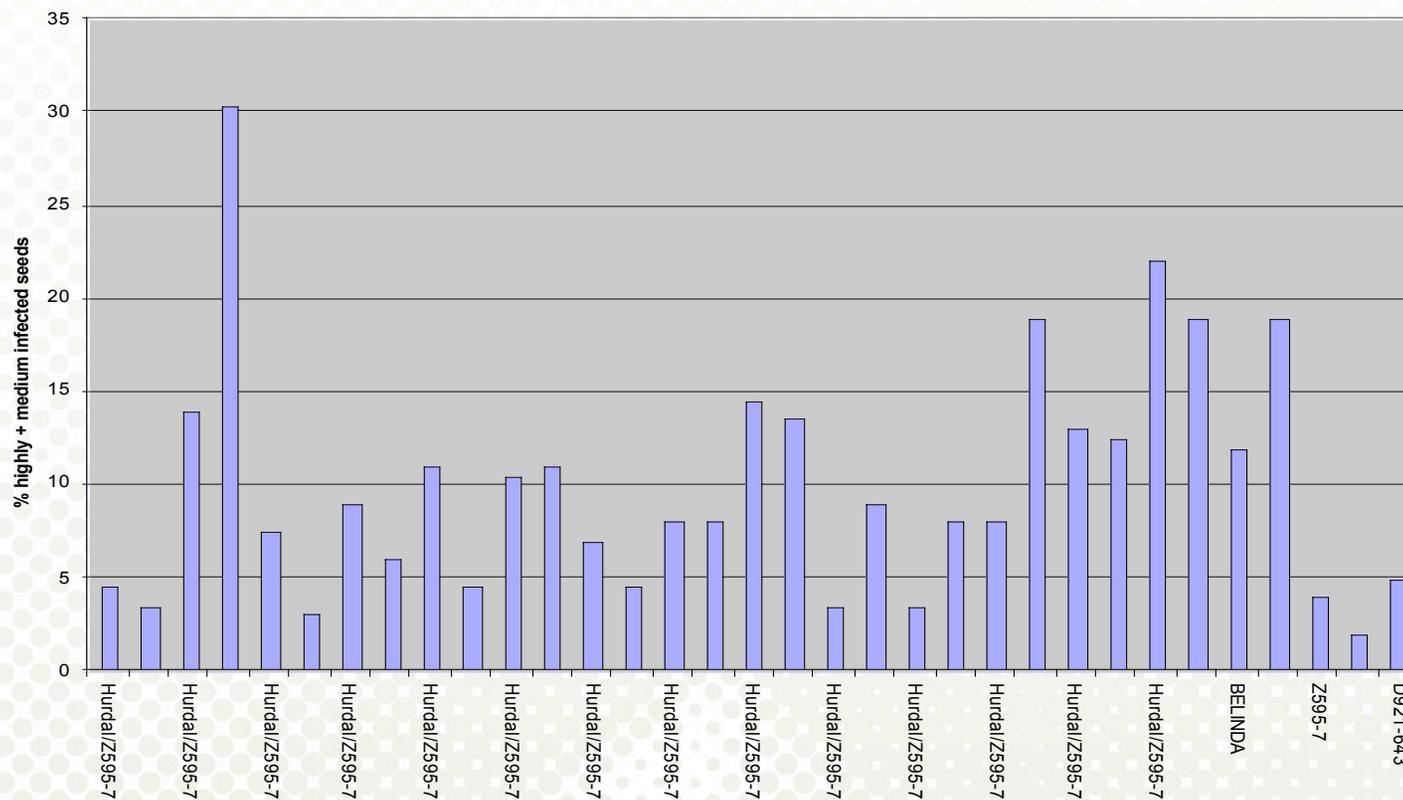
2005 greenhouse test (Line D921 more seed infection, but well developed seeds = tolerance?)

**Freezer blotter test for inoculation test in greenhouse with *Fusarium culmorum*. Results 10 days after freezing.**



## 2007 field test of 30 SSD lines, Hurdal x Z595-7: Full segregation apparent

Freezer blotter test after spray inoculation in field 2006 at Aas by *Fusarium cuminum* mixture.



## Next steps and open questions (1)

- We need to clarify the infection process in a susceptible interaction
- Collaboration with Dr. Ruth Dill-Macky UMN, M.Sc. Thesis Selamawit Tekle Gobena 2008-09, using a GFP-strain of *F. graminearum*
- Does the "dehulling of toxins" reflect late infections of semidead glumes?
- The relationship of resistance parameters - % Fusarium infected seeds vs DON levels?
- What heritability can we achieve given the imperfect measures?
- The relationship to anther extrusion and open flowering

## Next steps and open questions (2): Marker development

- Nordic proposal on EST/SNP-development in oats
- 800000 EST sequences from a panel of 8-10 genotypes
- SNP development
- Open for coordinated approaches!