

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



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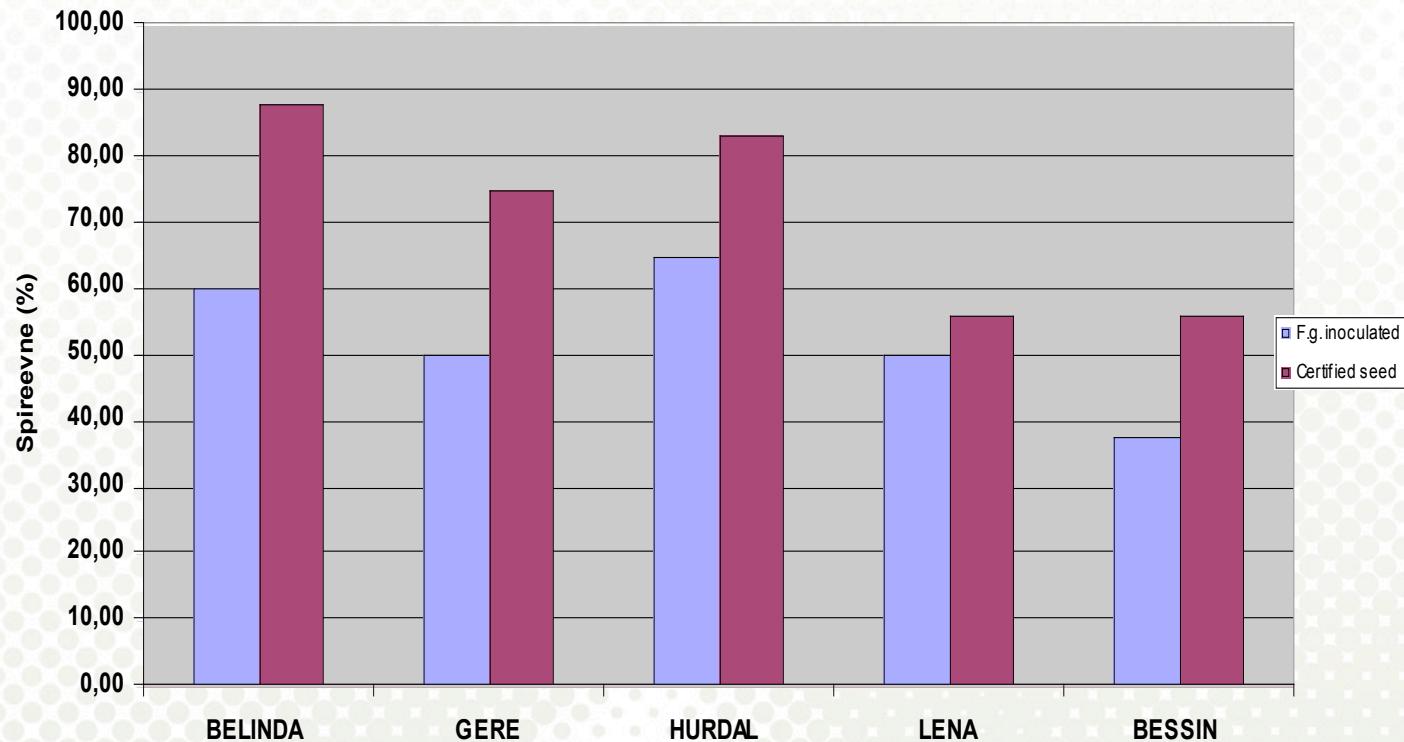
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Fusarium in oats

- 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 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-Fletcher'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



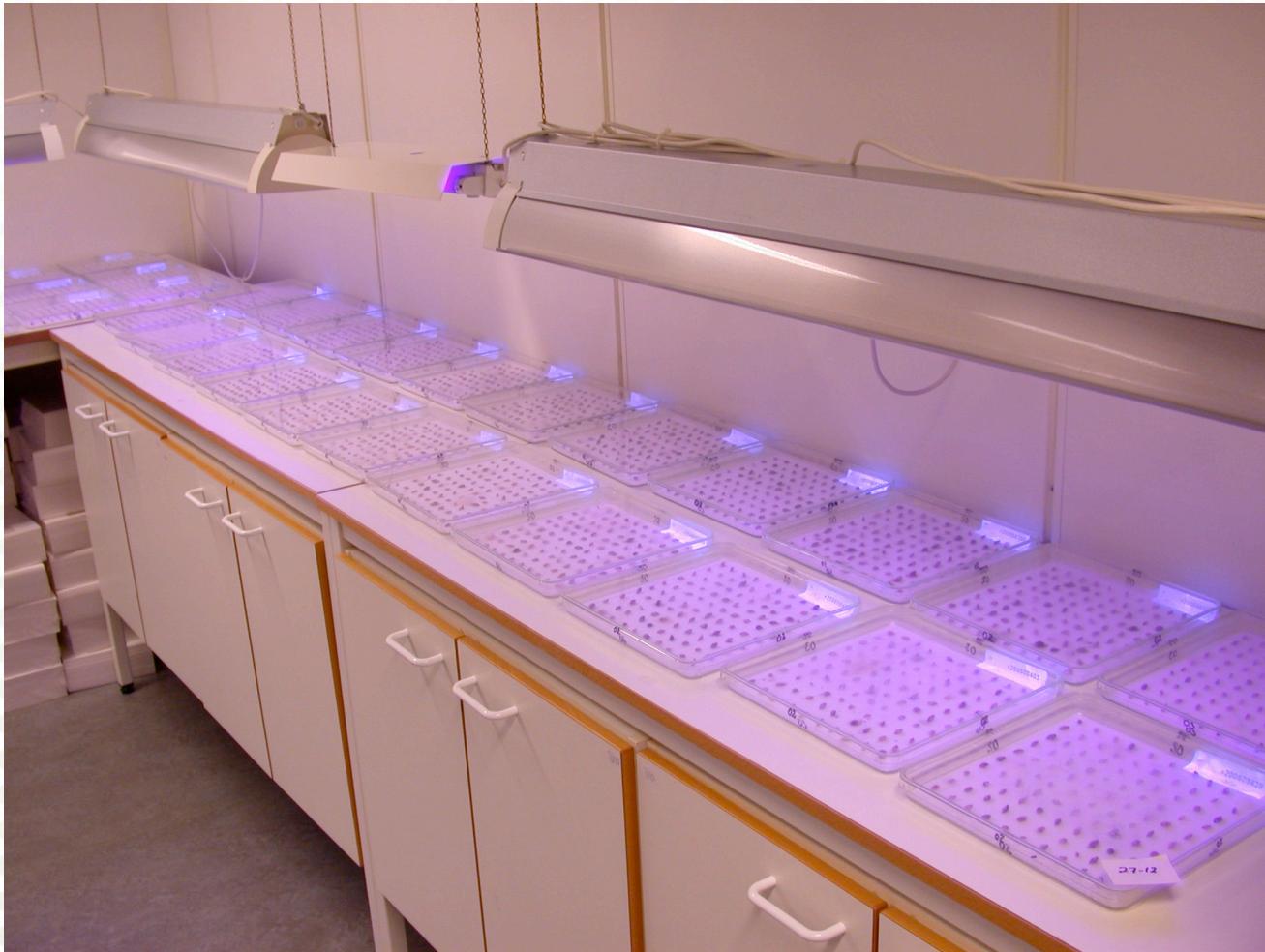
Cv. 'Hurdal' / *F. graminearum* : Discoloration
and decaying seeds



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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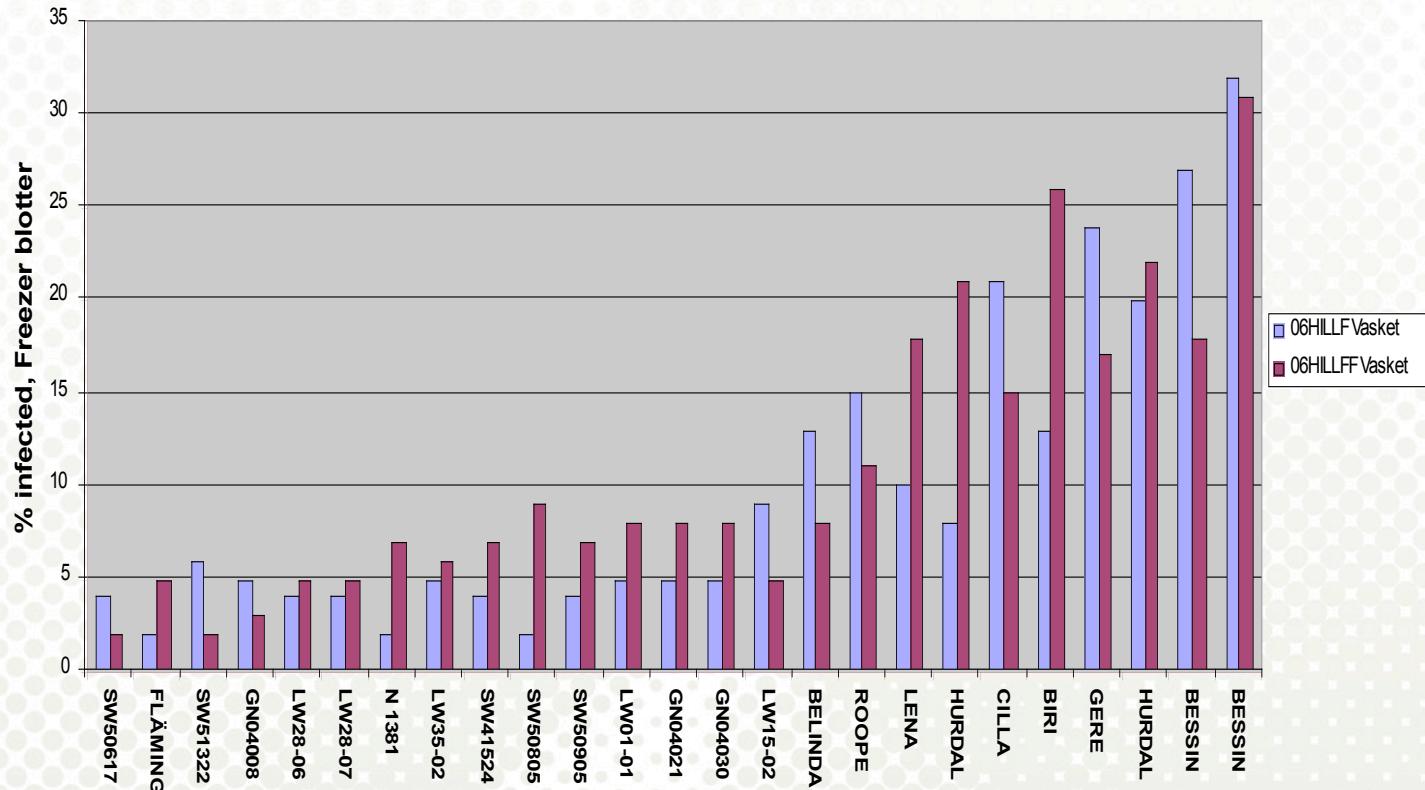


Correlations (r) between the freezer blotter test and DON. (Liu et al. 1997) need to be verified

| 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

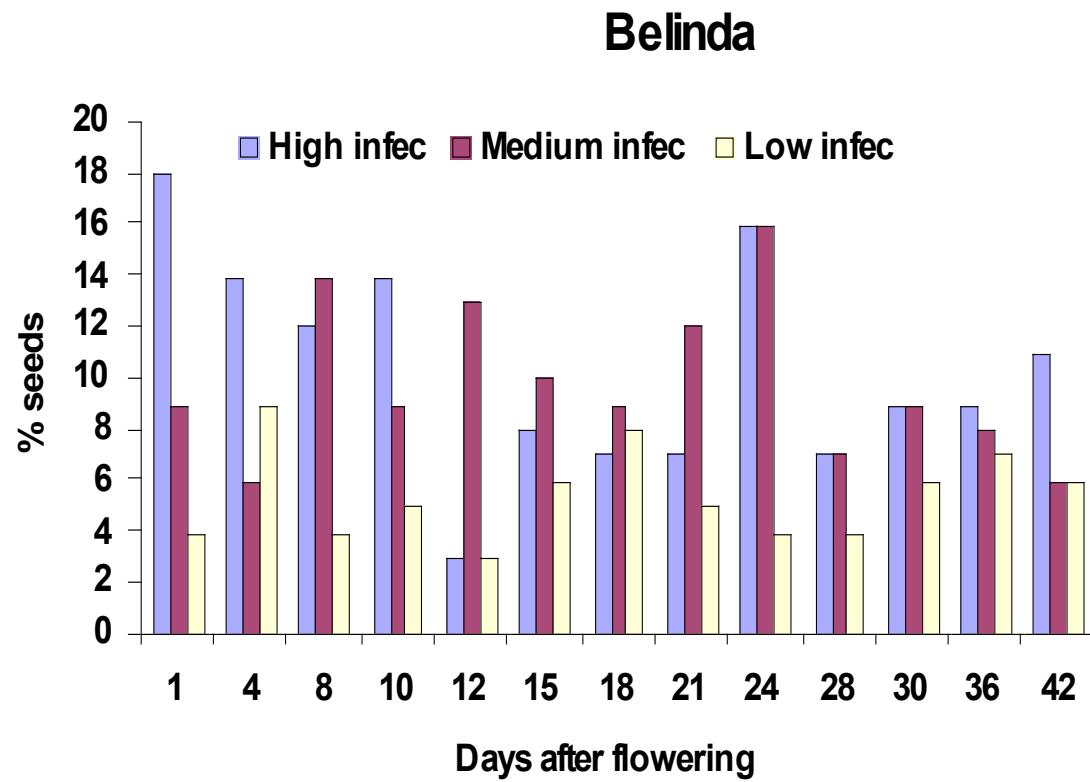
2006 oat breeding lines inoculated by *Fusarium graminearum*.



The infection time and susceptibility in oats

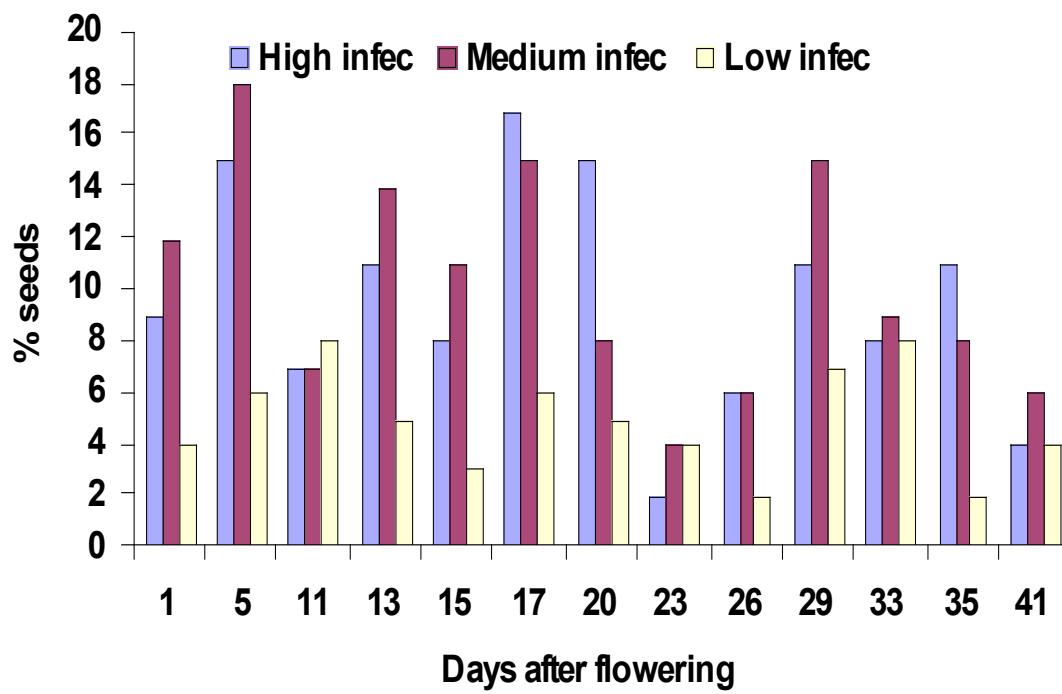
- In 2007, cv. 'Hurdal' and 'Belinda' were inoculated at 5 day intervals with *F. culmorum* from anthesis to maturity
- Spray-inoculation with plastic bags, water as non-inoculated control
- Very wet season
- Seed infection, germination percentage and yield components measured at maturity
- (M.Sc. Thesis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

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

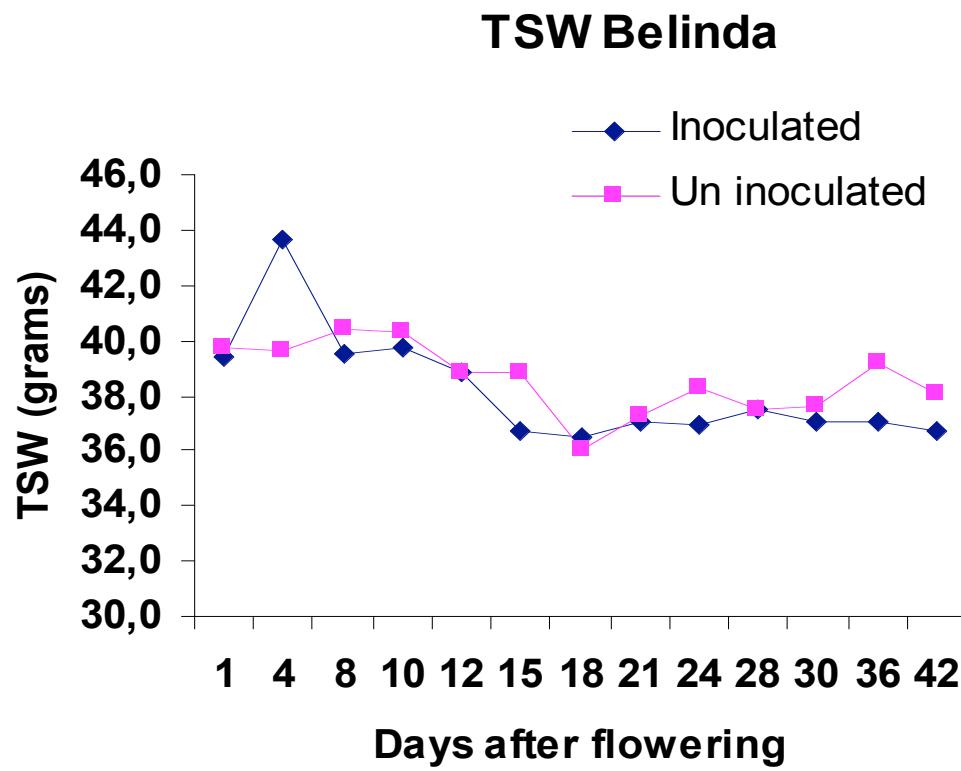


Cv. Hurdal (early)

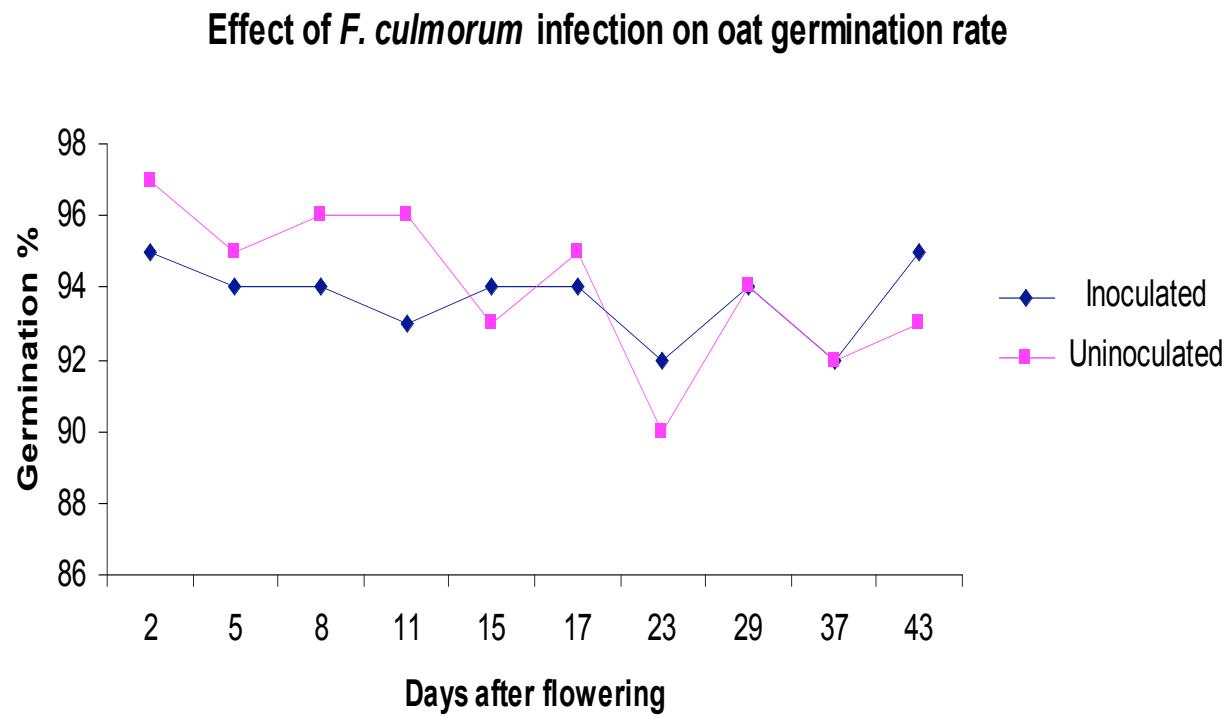
Hurdal



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*

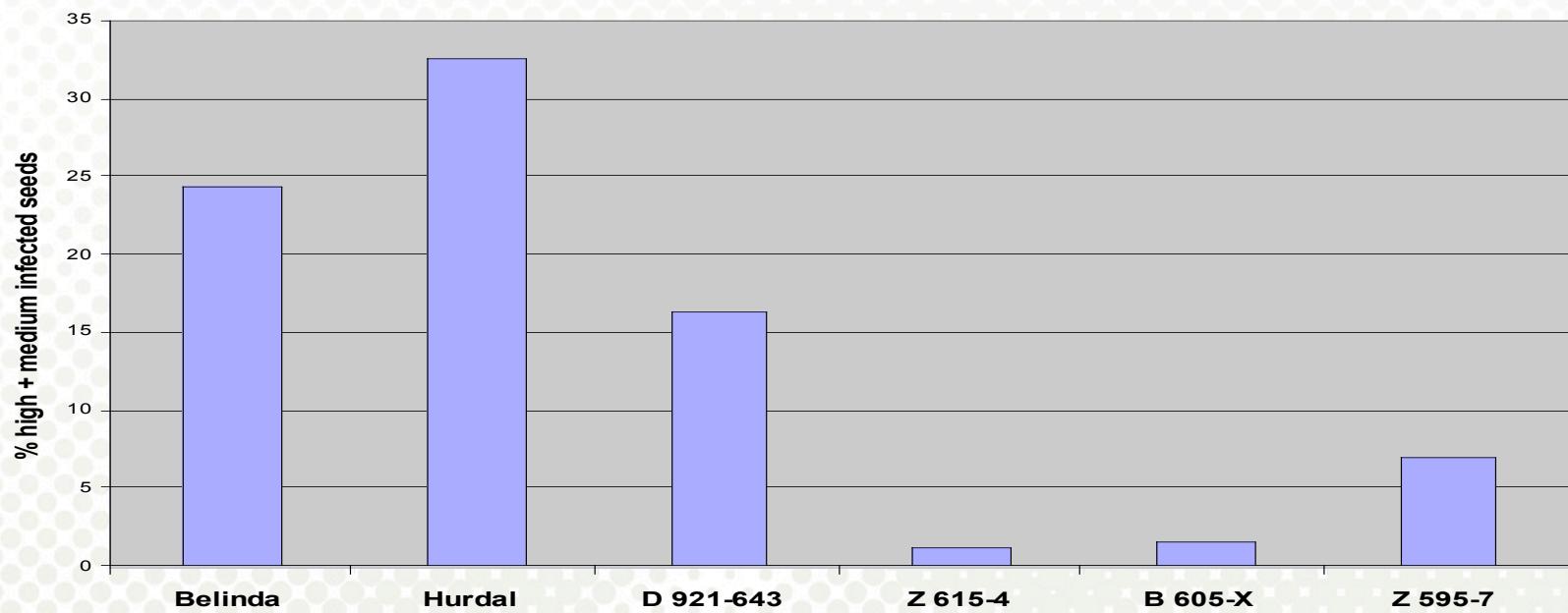
- D921-643: *A. sterilis*, PI317789 (Israel)*3/Otter
- B605X: Selection from an irradiated composite cross population
- Z595-7: *A. sterilis*, PI411560 (Eritrea)/Tippecanoe
- Z615-4: *A. sterilis*, PI411560 (Eritrea)/Ogle

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



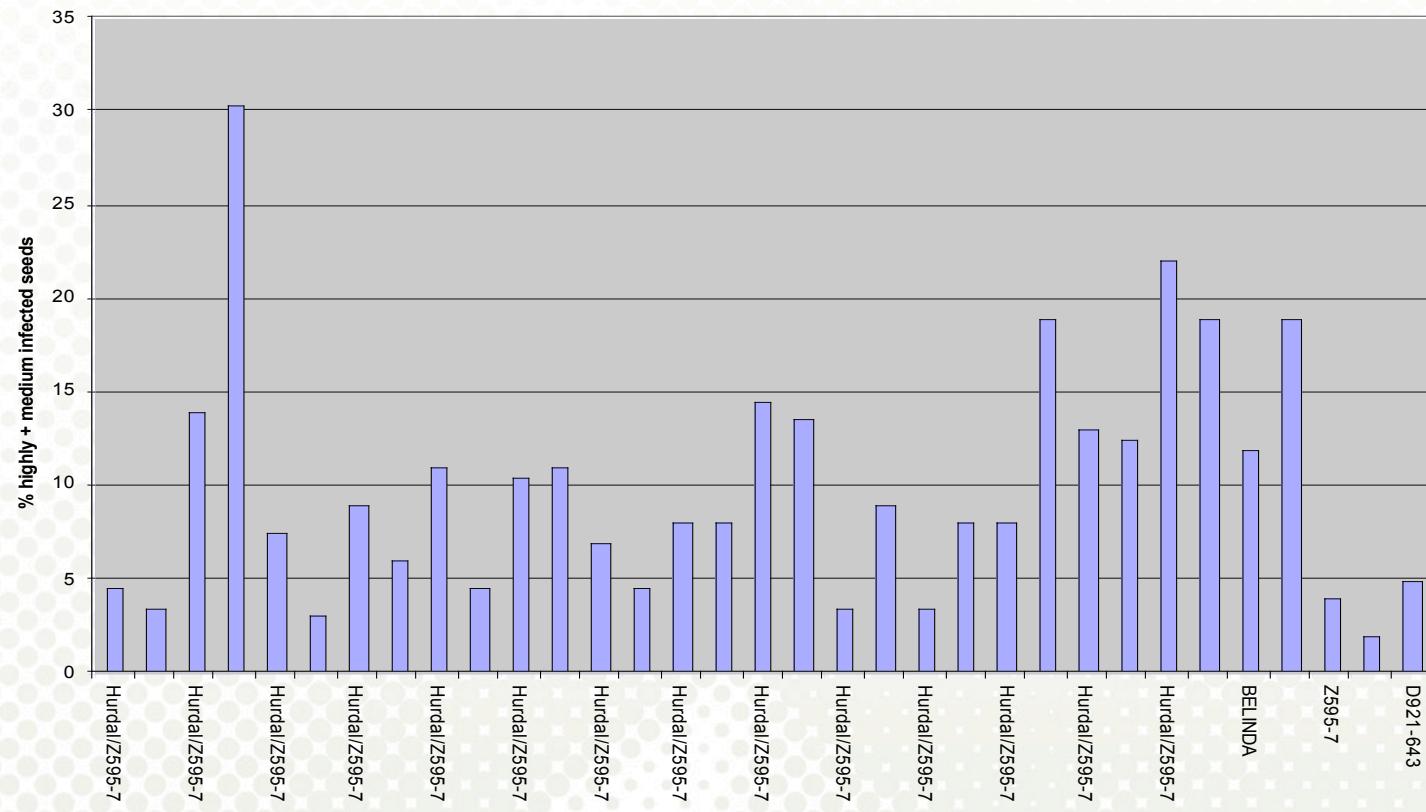
2005 greenhouse test (Line D921 more seed infection, but well developed seeds = tolerance?)

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 culmorum* 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!