Evaluating Nordic oats for *Fusarium* resistance in greenhouse

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Outline

- **Introduction: Oats and Fusarium**
- **Greenhouse methods for screening resistance**
- **Results from screenings**

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Introduction

Finland is producing 1 milj kg of oats yearly

- Finnish oats has good quality
  - pure oat fields
  - white colour
  - high beta-glucan..
- 30 % of Finnish acreage covered with oats
- Used for feed and food in several forms
- Export 300 000 tonnes/year

“pulled oats” © 2015 Gold&Green Foods Ltd.

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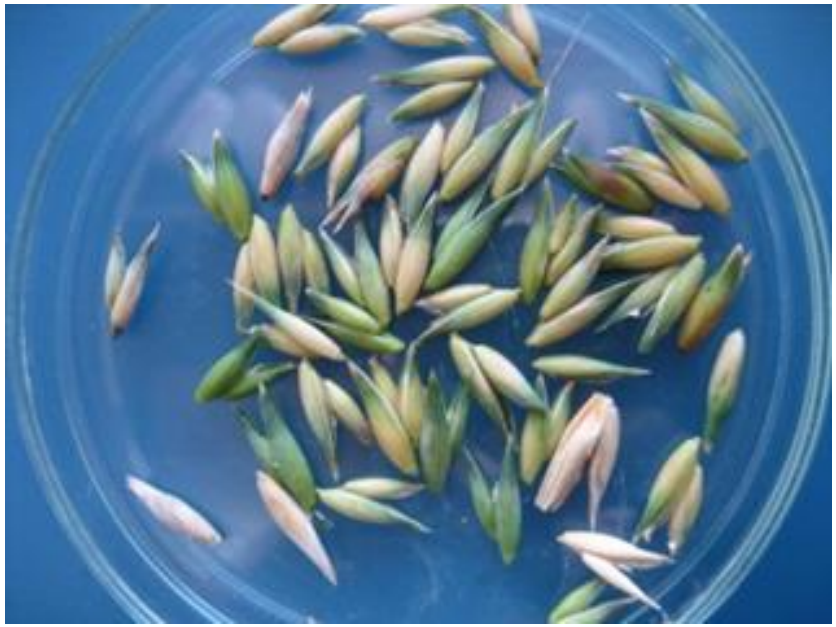
Fusarium head blight

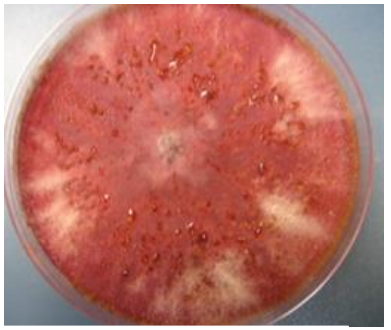
- Reduces germination, yield and accumulates mycotoxins into the grain
- EU-set limit for DON is 1700 µmol/mg
- Causal agents can be several fungi belonging to genus Fusarium



Fusarium head blight

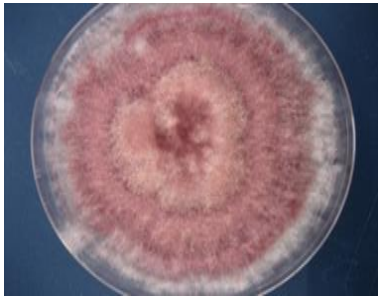
- Same species are prevalent in Finland as in Central Europe, however different chemotypes occur
- Changing climate and culture practices have already influenced on the disease prevalence and on species composition and further changes are likely

F.graminearum



F.culmorum

F.sporotrichioides



F.avenaceum

F.langsethiae

Pasquali et al. 2016. Frontiers in Microbiology 7: 406. doi:10.3389/fmicb.2016.00406.

Parikka et al 2012. Food Additives & Contaminants 29 (10)

Resistance breeding

- Resistance would be very desirable trait:
  - Ecological and economical way to control disease
  - Good agricultural and manufacturing practices give only limited control for toxin problem

- Bottlenecks for Fusarium breeding in oats:
  - Lack of known resistance sources
  - The nature of resistance is not well known (several types of resistance has been identified)
  - Lack of efficient methods for phenotyping and toxin analysis
  - Lack of genomic tools

Greenhouse inoculation method for resistance evaluation

- Developed by Luke (ex. MTT Agrifood) and Boreal Plant Breeding Ltd.

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Genotypes screened

- Nordic cultivars and breeding lines and interesting gene bank accessions

- The set of tested cultivars varied from trial to trial.
  - In total number of lines screened between 2013 and 2016 was around 250

- Check cultivars were included in each trial
  - Cultivar Belinda (Svalöf Weibull, Sweden, 1999) in this analysis

Experimental set up

Altogether 52 different oat lines or cultivars across 5 separate experiments were ranked

- Linear mixed model with arcsine square root transformed Fusarium incidence data

  ➡ Comparable estimates across experiments

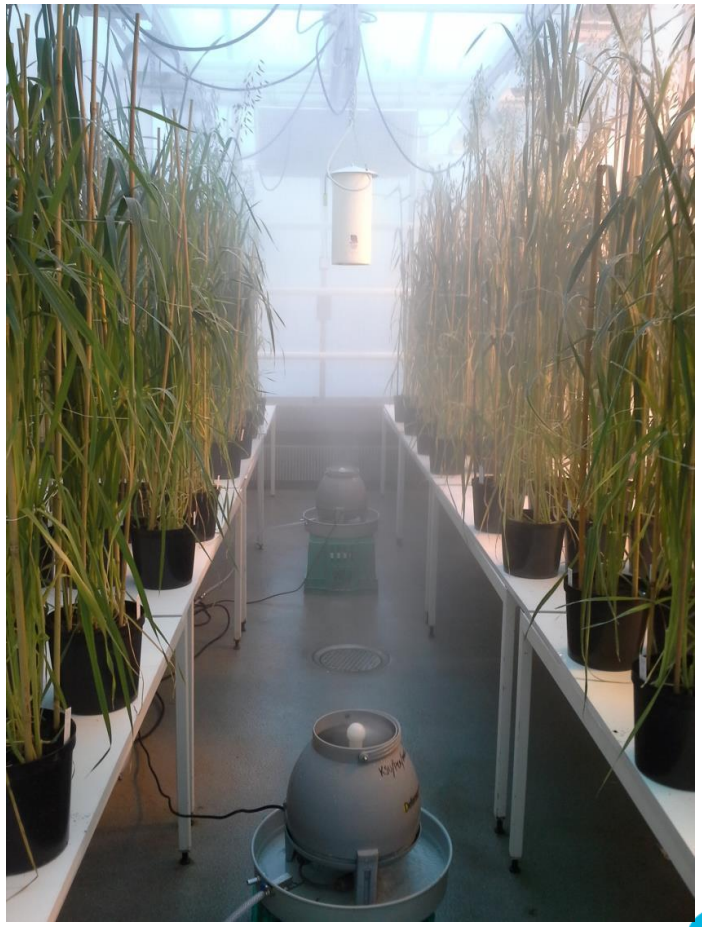
Details

- 3 pots per cultivar with 4 randomized replicates in each experiment
- 5 seeds per pot, seed treatment with fungicide Celest (*fludioxinil*)
- fertilized peat and sand mixture as growing medium

Greenhouse conditions

- Controlled temperature (+18˚ C day and +15˚ C night)
- 16/8 photoperiod with HSP lights together with natural light.

During inoculation mist irrigation was applied 2 h before and 6 hours after inoculation and since then temperature was held at +20 ˚ C



Fusarium culmorum was inoculated to the main stem at full flowering (BBCH 65)

- Isolate 05015 originating from Finnish barley grains in 2005
  - DON production confirmed*
  - Grown as single mycellum culture on PDA (potato dextrose agar)
- Spray inoculated with a concentration of 500 000 conidia/ml (Recently lowered to 80 000 conidia/ml)

*Kokkonen et al. 2010 International Journal of Food Microbiology 143 (2010) 17–25

Samples analyzed

- Samples of 5 panicles per pot harvested at BBCH 92.
- 10 grains from each panicle were placed on selective PCBN plates.
- Incubated in +23° C for one week
- Fusarium infected kernels were calculated
  =Fusarium Incidence data
- DON contents were analyzed with ELISA kit
- From the first experiments single mycelium cultures on PDA plates were made and checked with microscope

Results

Results

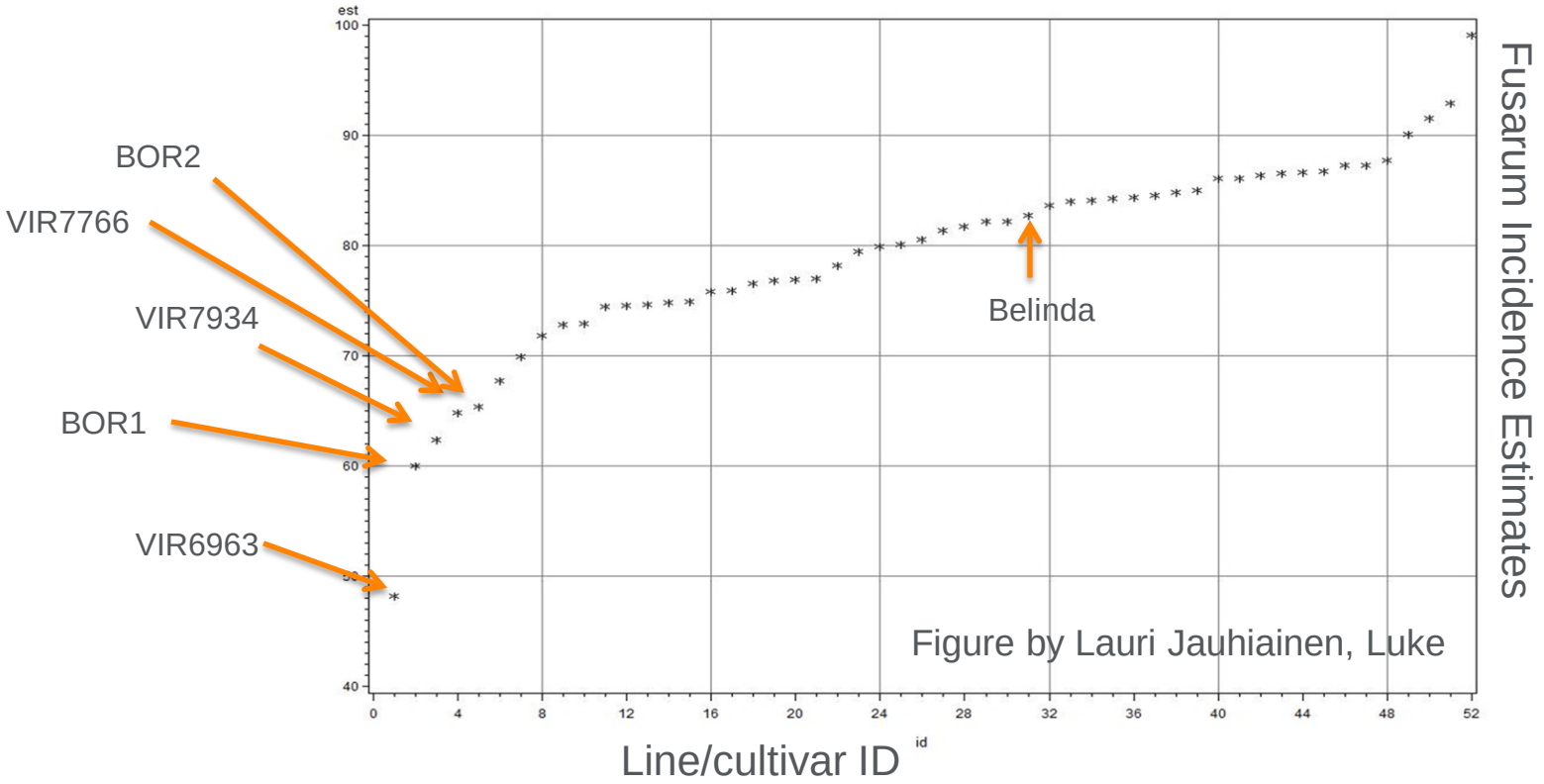
- The accessions with the highest or the lowest infection levels were shown to be statistically different from a cultivar with average estimate value.

- Due to high variation resistant cultivars may end up average in some experiments. However the worst cultivars cannot be mixed with the best

- Factors causing variation
    - Seasonal differences
    - Seed infections
    - High infection levels

Five lines were significantly better than Belinda

- 3 genebank accessions from Russia and Far East (VIR)*
- 2 Boreal breeding lines.



*Gagkaeva et al. 2013. Euphytica 191(3): 355-364.

Conclusions

- Nordic oat material has some differences in their resistance against infection, but more resistance is needed to control the problem
- Fine-tuning the suspension concentration helped to obtain better ranking
- With this method:
  - Best sources of resistance can be identified
  - The most susceptible breeding lines can be discarded
  - Resistance can be screened around the year

- Methods can be applied to other FHB causing species

However

- Many check cultivars need to be maintained in the set to control variation
- Correlation to field resistance needs to be confirmed

Thank you!

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