Reducing the risk of deoxynivalenol contamination in oats via plant breeding

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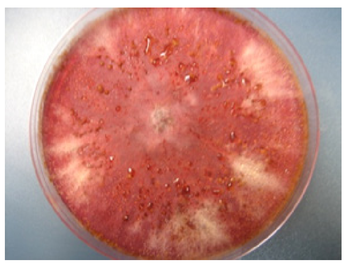
Boreal Tekes

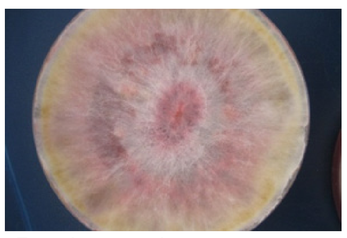
Fusarium head blight in Finnish oat production

Thirty percentage of the Finnish cereal acreage is covered with oats (*Avena sativa L.*) and this makes us the 2nd biggest exporter of oats. Fusarium head blight (FHB) disease lowers seed germination rate and generates mycotoxins such as deoxynivalenol (DON) in the infected grains. **In cereal trade, this has led to discarding of up to 30 % of seed lots due to exceeding of EU-set limit for DON-contents.**

The control of mycotoxin levels with good manufacturing and agricultural practices is limited. Breeding of **resistant cultivars would be an ecological and efficient way to control FHB in oats.** However it has many bottle necks. Current methods for analyzing the infection or mycotoxins in the grain are either expensive, imprecise or inconsistent and the known resistance sources are scarce.



Fusarium culmorum



Fusarium graminearum

The Aim

The aim of this project is to **develop efficient field and greenhouse phenotyping methods** for Fusarium infection and DON-contamination. Furthermore these methods are applied to **introduce novel resistance** to the oat breeding programs and to **study resistance** genetics

In field experiments a spawn inoculum that is based on *Fusarium graminearum* ascospores is applied and even some visual symptoms can be spotted.

Material and Methods

Wide collection of oats germplasm including Nordic cultivars, new breeding material and potential resistance sources from gene banks. **FIGS** (Bari et al. 2012) is applied to find novel resistant germplasm.

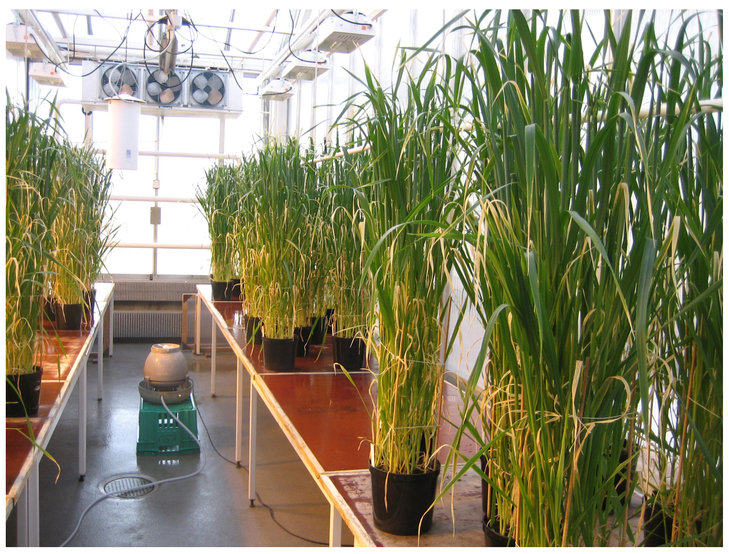
Finnish ***Fusarium graminearum*** and ***F. culmorum*** isolates are used for disease inoculation. Spawn, spray and point inoculation methods are studied.

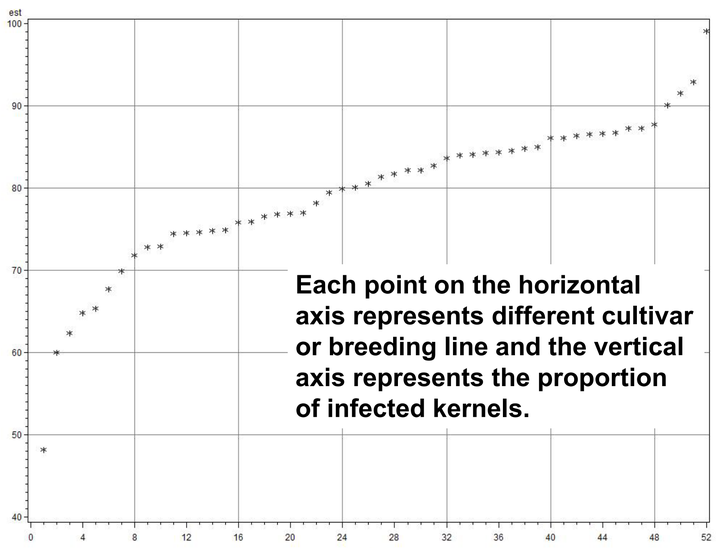
Possibly correlating agronomic and morphological traits are evaluated including oat flowering traits such as anther extrusion.

National Plant Phenotyping Platform (automated plant phenotyping infrastructure at University of Helsinki) will be tested.

Mapping populations will be established for disease screening and genotyped in order to **discover QTLs.**

Type of resistance	Evaluation methods
Type I: Resistance to initial infection (Schroeder & Christensen 1963)	FHB incidence and symptom severity (spray and spawn inoculations), fungal DNA (qPCR)
Type II: Resistance to fungal spread (Schroeder & Christensen 1963)	FHB severity (point inoculation), fungal DNA (qPCR)
Type III: Resistance to kernel infection (Mesterhazy, 1995)	Fusarium Damaged Kernels, Germination Capacity
Type IV: Tolerance (Mesterhazy, 1995)	Yield
Type V: Resistance to toxin accumulation (Miller at al. 1985, Snijders & Perkowski 1989)	Toxin (DON, T2/HT-2) contents measured by gas cromatography and mass spectrometry or by immunoassay methods (ELISA)





The greenhouse method can already be used for separating the most resistant and the most susceptible oat genotypes from each other.

Related publications

Bari, A., Street, K., Mackay, M., Endresen, D.T.F., Pauw, E. & Amri, A. 2012. Focused identification of germplasm strategy (FIGS) detects stem rust resistance linked to environmental variables. Genet Resour Crop Evol 59:1465-1481.

Gagkaeva, T., Gavrilova, O., Yli-Mattila, T. & Loskutov, I. 2013. Sources of resistance to Fusarium head blight in VIR oat collection. Euphytica 191(3): 355-364.

He, X., Skinnes, H., Oliver, R., Jackson, E. & Bjornstadt, Å. 2013. Linkage mapping and identification of QTL affecting deoxynivalenol (DON) content (Fusarium resistance) in oats (*Avena sativa* L.) Theoretical and Applied Genetics 126: 2655–2670.

Parikka, P., Hakala, K. & Tiilikkala, K. 2012. Expected shifts in Fusarium species' composition on cereal grain in Northern Europe due to climatic change. Food Additives and Contaminants 2012: 1–13.

Tekle, S., Dill-Macky, R., Skinnes, H., Tronsmo, A. & Bjornstadt, Å. 2012. Infection precess of *Fusarium graminearum* in oats (Avena sativa L.). European journal of Plant Pathology 132: 431-442.