Fusarium infection and mycotoxins on cereals in reduced tillage

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Fusarium infection and mycotoxins
- background

- *Fusarium* species have a wide range of hosts and they survive in crop debris
  - infections to growing plants: from seed or crop debris
  - *Fusarium* head blight: reduced grain quality and risk for mycotoxin contamination
- EU Commission regulation 1881/2006, limits for DON and ZEN contents in cereals and cereal products for food, for T-2/HT-2 maximum contents have not been set yet
- Risk for mycotoxins increasing also in nordic countries:
  - climate is changing- has already changed
  - farming practices are changing- tillage practices, cereal production systems, crop rotation
  - mycotoxin producers are changing: species relations, new races
Fusarium species and mycotoxins in Finnish cereal grain

- Surveys every year of harvested grain: beginning from 1999
  - samples from all growing regions, mainly oats and barley
- DON, 3-AcDON, DAS, NIV, F-X, T-2, HT-2, ZEN analysed
- Background data: factors affecting mycotoxin contents- crop rotation, soil type, plant protection, lodging, tillage
  - differences between cereal species and growing regions: weather conditions
- *Fusarium* infection of grain: analysed from 2007
- The main species: *F. avenaceum*, *F. culmorum*, *F. poae*, *F. graminearum*, *F. tricinctum*, *F. sporotrichioides*, *F. langsethiae*, *F. equiseti*
- The main mycotoxins: DON (*F. culmorum*, *F. graminearum*), T-2/HT-2 (*F. langsethiae*, *F. sporotrichioides*), NIV (*F. poae*)
  moniliformin and enniatins (*F. avenaceum*, *F. tricinctum*)- not surveyed
Fusarium infection and reduced tillage

- Reduced tillage and direct drilling are increasing
  - environmental effects, economical aspects, need of labour
- Fusarium infection and tillage:
  - less tillage- increasing risk for Fusarium head blight and high mycotoxin contents
- Question to answer: is reduced tillage or direct drilling a risk for cereal grain quality?
  - differences between oats and barley in Fusarium infection and mycotoxin contents?
Studies on reduced tillage

- *Fusarium* infection during the grain development – the effect of cultivation practices:
  - studied in a field trial 2004-2006, pre-crop barley, four oat and barley cultivars
  - autumn ploughing/ direct drilling
  - fungicide treatment at flag leaf stage (prochloraz Sportak 45 EC)

- Tillage practices on barley: trials in Ylistaro, Jokioinen and Mietoinen
  - direct drilling, reduced tillage, ploughing
  - fungicide treatment, glyphosate
  - pre-crops
Development of *Fusarium* infection

- Differences between oats and barley and ploughing/direct drill
- Species relations changed during the trial period:
  - weather influences: wet and cool season- dry and warm season- different infection patterns
- The first species detected at ear emergence: *F. langsethiae, F. poae*
  - both species in dry and warm conditions, *F. langsethiae* also in humid and cool conditions
- *F. culmorum, F. graminearum* early in humid and warm conditions
- *F. avenaceum* in cool and humid, *F. sporotrichioides* in warm and humid conditions
  - *F. culmorum, F. avenaceum* and *F. tricinctum* infections increase until harvest
- Direct drilling favor *F. avenaceum* infections and also *F. langsethiae*
- More *F. culmorum* and *F. poae* on ploughed areas compared to direct drill
  - *F. avenaceum* competes with *F. culmorum* and *F. poae* in direct drill
- *F. graminearum*: not enough data to see differences
Development of *Fusarium* infection

**F. langsethiae on oats 2006**- infection % in kernels at sampling dates (5) from panicle emergence to harvest

![Graph showing infection % over different sampling dates and tillage methods.]

**F. langsethiae on barley 2006**- infection % in kernels at sampling dates (5) from ear emergence to harvest

![Graph showing infection % over different sampling dates and tillage methods.]

Sampling from 3.7. 2006
1 = week27
2 = week29
3 = week31
4 = week33
5 = grain
Development of *Fusarium* infection

**F. culmorum infection on oats 2005**

<table>
<thead>
<tr>
<th>Week</th>
<th>Infection %</th>
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<tbody>
<tr>
<td>1</td>
<td>5</td>
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<tr>
<td>2</td>
<td>20</td>
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<tr>
<td>3</td>
<td>30</td>
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<td>4</td>
<td>40</td>
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<td>5</td>
<td>50</td>
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- **Tillage**: red diamond
- **Direct Drill**: blue square

**F. culmorum infection on barley 2005**

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- **Tillage**: red diamond
- **Direct Drill**: blue square

Sampling from 4.7. 2005
1= week27
2= week29
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5= grain
Fusarium infection in harvested grain

**Fusarium langsethiae in harvested oat grain**

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<thead>
<tr>
<th></th>
<th>2005</th>
<th>2006</th>
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<tbody>
<tr>
<td>Roope</td>
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<td>0</td>
</tr>
<tr>
<td>Freja</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Veli</td>
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<td>0</td>
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<tr>
<td>Belinda</td>
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**Fusarium langsethiae in harvested barley grain**

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<tr>
<td>Annabell</td>
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<td>0</td>
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Fusarium infection in harvested grain

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Tillage: direct drill
Mycotoxins and tillage

- The highest mycotoxin contents in high temperatures and humidity:
  - DON producers are favoured by humid conditions
  - in dry conditions more DON on oats than barley
- In dry conditions T-2/HT-2 contents high in grain:
  - *F. langsethiae* -infections high
- T-2/HT-2 in direct drilling
- DON-contents in harvested grain were not near to the EU limits
  - in direct drilling often lower DON contents: trial in Jokioinen and Ylistaro- opposite results from other trials
  - differences between cultivars, late cultivars often have higher toxin contents than early ones
- Variation between years: humid/dry year
Mycotoxins in grain

DON contents (ug/kg) in oat grain

DON contents (ug/kg) in barley grain
Mycotoxins in grain

T2+HT2 contents (ug/kg) in oat grain


T2+HT2 contents (ug/kg) in barley grain

Mycotoxins and tillage practices

- Mycotoxin producing *Fusarium* species > mycotoxins: weather conditions affect
- Sometimes more *Fusarium* = more mycotoxins, but infection time also affects, cereal species, cultivar
- Relations between *Fusarium* species change, but what is the situation after 10 years?
Fungicide treatment

• The effect of fungicide treatments in trials:
  - no significant effect on *Fusarium* infection
  - no effect on mycotoxin producers, no effect on mycotoxins
  - fungicide applications before ear emergence not effective
  - late infection: not possible to control
**Weed control in reduced tillage**

- Weed control necessary for high quality grain
- Glyphosate use has increased: increase in direct drilling and reduced tillage
  - does it increase *Fusarium* infection and possibly mycotoxins?
  - not enough data to make conclusions

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**Mycotoxin producers on barley under different tillage practices, Jokioinen 2004**

- Direct drill
- Direct drill + glyphosate
- Reduced tillage
- Ploughed

**Mycotoxins on barley 2004, Jokioinen**

- DON
- T2 + HT2

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[Graphs showing mycotoxin levels under different tillage practices.]
Pre-crop

- The effect of pre-crop:
  - observed in the survey material- crop rotation= less mycotoxins
  - not much differences between cereal species as pre-crops
  - break crops in cereal cultivation useful: oilseed rape, leguminous crops, grasses

![Mycotoxin contents of barley cv Annabell after different pre-crops, Mietoinen 2005](image)

![Mycotoxin producers on barley cv Annabell after different pre-crops, Mietoinen 2005](image)
Conclusions

- Direct drilling and reduced tillage:
  - may increase T-2/HT-2- producers, especially on oats
  - may decrease DON-producers, especially *F. culmorum* > is it long lasting effect?
  - an increase *F. avenaceum* infection in humid growing seasons - effect on *F. culmorum*
  - less *F. poae* -infection especially on oats
  - effect on *F. graminearum*: - not detected, the species is quite common but perithecia are not often detected
  - *F. graminearum* is most likely increasing- changes the situation

- Control of mycotoxin producers in reduced tillage:
  - fungicide treatments not effective to control *Fusarium* and mycotoxins
  - crop rotation important
  - resistant cultivars
Thank you!