

Climate Change impacts on deoxynivalenol contamination in wheat

- Modelling results for north western Europe in 2040 -

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Introduction

- European climate has warmed faster than rest of world
- Even small changes in climate can have significant effects on ecosystems:
 - will affect food production, security and safety
 - influences particularly primary plant production systems which may result in changes in mycotoxin contamination in plants

➔ Effects of climate change on food safety cannot be ignored

No quantitative estimates of impacts of climate change effects on mycotoxin contamination of cereal grains were available



Aims of study



Estimate the impact of climate change effects on mycotoxins in cereals, covering:

- Direct effects of changes in local weather on fungal infection and toxin production
- Indirect effects due shifts in grain phenology

Focus on deoxynivalenol (DON) in wheat in north western Europe

Produce maps of changes in wheat phenology and DON contamination of this area (on grid basis)



Study design

- Modelling approach: output one model is input for the next model
 - Climate change projections
 - Wheat phenology
 - DON contamination
- Models for phenology and DON contamination in north western Europe were developed



Climate change scenarios



Study scenarios for climate change:

- IPCC scenario A1B ("middle scenario")
 - Climate for 2031 – 2050 (2040, with 20 yearly variation)
 - Reference situation (baseline) 1975-1994
- Two combinations of global and local climate change models (NL, UK)
 - Data from climate change models downsized to obtain daily temperature, precipitation and solar radiation

Crop phenology model

- Phenology mainly depends on temperature, but also on day-length
- Empirical crop phenology model developed for estimating changes in flowering, maturation and harvest
- Using data from field experiments
 - 1990-2009 from north west Europe
 - 1000 records for winter, 300 for spring wheat
- Simple empirical models fit to data



Predictive DON model

- Empirical model based on observational field data from Sweden, Finland, Norway and the Netherlands
- Data (717 records):
 - wheat field location, wheat variety, resistance class against *Fusarium* spp.
 - wheat flowering date (FD), harvest date (HD), length FD to HD
 - rainfall, temperature, relative humidity, each in 6 weekly periods around FD and up to HD
 - DON level at harvest (response variable)
- Multiple regression analyses, select best set of explaining variables



Scenarios

Modelling scenarios:

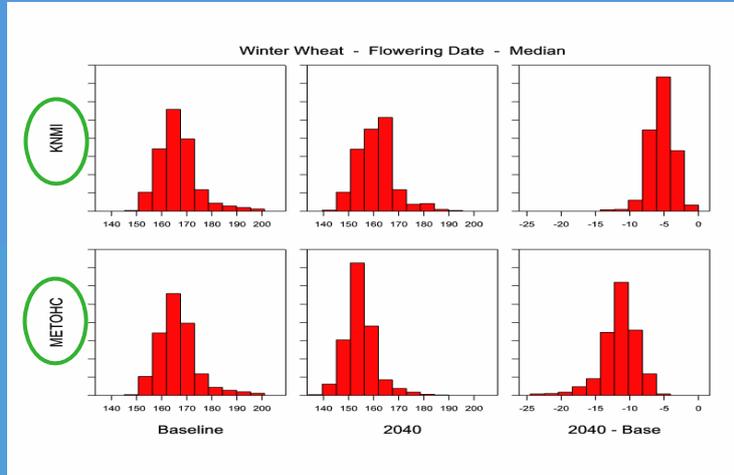
- Per grid in north western Europe (820 grids)
- 50 simulation runs per grid, for annual variability
- Impact models: wheat phenology & DON contamination
- 8 sets of output data (each 50 runs per grid)
 - NL and UK climate change data
 - spring / winter wheat
 - Baseline and future climate scenario

Processing results:

- 50th and 90th percentile values of the 50 records of estimated Flowering date and DON level (per grid)



Projected wheat flowering

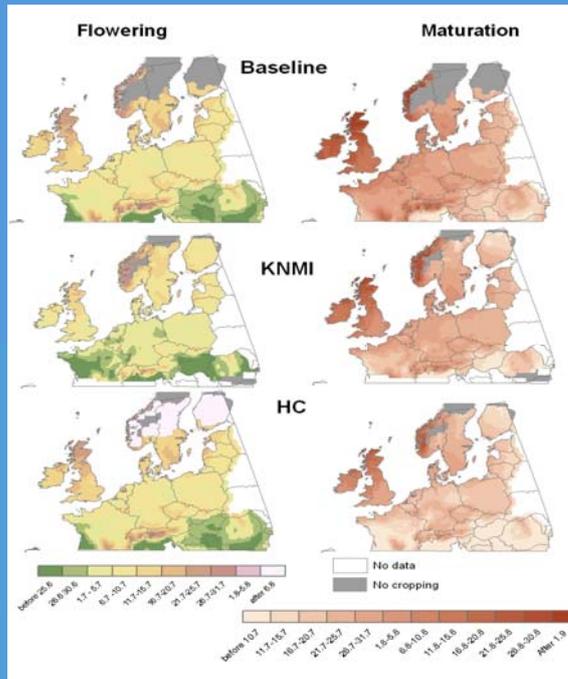


Median Flowering Date (median of 50 runs) for 920 grids.
Wheat flowering – critical period for Fusarium spp infection – earlier in season



Modelling flowering and maturity

Mean flowering and maturity dates for winter wheat. Baseline and climate change KNMI and METOHC Period 2031-50



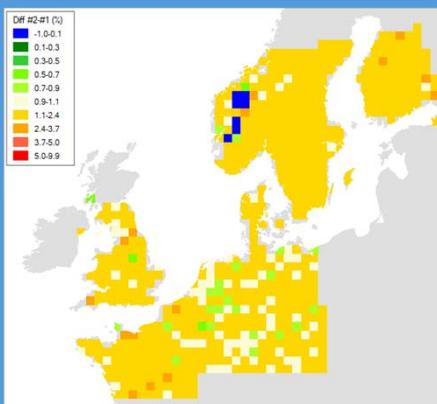
Main results: DON

- Median DON levels in winter wheat increased in 92% and 88% of grids (n=820) for NL and UK climate change data, resp.:
 - NL : increase up to 2 times in 78% of grids
 - UK : increase 1-2 times in 44% and 2-3 times in 27% of grids
- Increase DON more distinct:
 - in spring wheat vs winter wheat
 - with UK data, than with NL data
- 90th percentiles showed some grids have extreme high DON levels

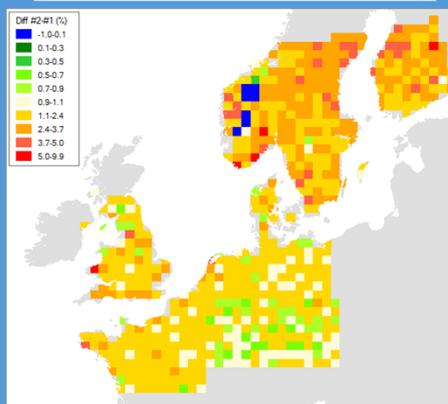


Increase of DON in winter wheat in 2040

NL KNMI climate model data

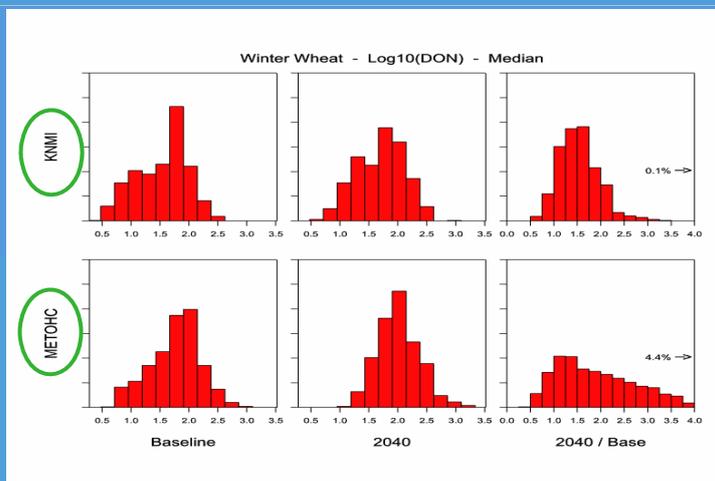


UK climate model data



*Estimated increase in DON contamination of winter wheat in North West Europe
2031-2050*

Projected DON contamination of wheat



Factor of in- or decrease of DON contamination in 920 grids.
DON contamination increases



Main conclusions

- Climate change effects were projected to, by 2040:
 - Enhance wheat flowering and full maturation by 1-2 weeks in most of north western Europe
 - Increase DON contamination, up to a factor of three
- Project results could be used by governmental and industrial risk managers to underpin planning and decision making processes in this area



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Thank you for your attention !



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