Effects of cropping factors and health promoting compounds in different oat cultivars on *Fusarium* species infection and mycotoxin contamination

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Introduction

Small-grain cereal varieties differ substantially with respect to their content in health promoting compounds (HPCs). The various HPCs found in wheat, barley and oats include substances with antioxidant potential such as phenolics, tocopherols, arabinoxylans and carotenoids, as well as ß-glucan. Compounds with antioxidant potential are considered to prevent human diseases such as cancer, cardiovascular diseases and Parkinson (cited in Yu *et al.* 2002). The polysaccharide ß-glucan on the other hand is a soluble dietary fibre associated control of cholesterol and attenuation of insulin levels. Apart from containing HPCs, cereals must be safe and thus free of health threatening substances. Contamination of cereals with mycotoxins, especially through different *Fusarium* species, constitutes a substantial risk to human health. Interestingly, fungal growth and/or toxin production can be inhibited by different plant endogenous HPCs (Boutigny *et al.* 2010).

The project HEALTHY & SAFE

Funded by a National Research Programme (www.nrp69.ch) of the Swiss National Science Foundation, the project “Are healthy cereals safe cereals? - Ensuring the resistance of small grain cereals to *Fusarium* diseases” (HEALTHY & SAFE) was launched at the end of 2013. The overall objective of HEALTHY & SAFE is to reduce the risk of contamination of small-grain cereals by *Fusarium* toxins while developing value added varieties containing HPCs. Using a systematic approach, the occurrence and frequency of toxigenic *Fusarium* species on oat and barley are assessed in grains from all over Switzerland. In parallel, the resistance against Fusarium head blight (FHB) and mycotoxin accumulation in grains of novel genotypes with enhanced content in HPCs and potentially improved resistance traits are currently evaluated.

Species occurrence and effect of cropping factors - *Fusarium* monitoring on oat harvest samples

In 2013, oat harvest samples and information on cropping measures were collected from Swiss growers. In total, 93 commercially produced oat samples from 11 cantons were examined with a seed health test for incidence of various toxigenic FHB causing species and are currently analysed for content of different mycotoxins using LC-MS/MS. Three *Fusarium* species were dominant: *F. poae* (FP; 57% of all *Fusarium* species), followed by *F. graminearum* (FG; 17%) and *F. langsethiae* (FL; 16%)(Figure 1). The average infection rates for these species were 3.5, 1.1 and 1.0%, respectively. Based on this species spectrum, we expect hazardous mycotoxin contaminations including nivalenol, deoxynivalenol and its acetylated forms as well as T-2 and HT-2 toxins. First analyses on the effect of cropping factors revealed that winter oat samples displayed a significantly higher FP and FL mean incidence (4.8%, 2.0%, respectively) compared with spring oats (2.7%, 0.4%). In contrast, the opposite was observed for the FG incidence (0.2% in winter oats, 1.7% spring oats). The varieties had a highly significant effect since mean FP and FL incidences in the samples of the variety “Wieland” were twice as high as those in the variety “Triton”. Again, the opposite was detected for FG. It is not clear yet whether these effects are due to the different flowering times and the respective weather conditions or to an intrinsic variety effect. Concerning crop rotation, the current data set allowed merely tendencies to be observed. Still, oat samples from fields with the previous crop spelt wheat showed higher incidences of both FP (10.7%) and FL (3.7%) compared with other previous crops (mostly wheat, maize and barley, ranging between 2.6 and 4.0% for FP and between 0.3 and 1.3% for FL). Furthermore, higher FP and FL incidences were detected from samples with maize as the pre-previous crop compared with other pre-previous crops. The fact that some of the cropping factors showed the same influence pattern on FP and FL suggests that these FHB causing species might occupy the same ecological niche. The type of tillage only showed a significant effect for the FG incidence with higher incidences after direct sowing (5.2%) compared with samples from reduced tillage (0.7%) or ploughed fields (0.9%). Upon completion of the toxin measurements, correlation between species incidence and mycotoxin content will be evaluated. The *Fusarium* monitoring will be conducted again in 2014.

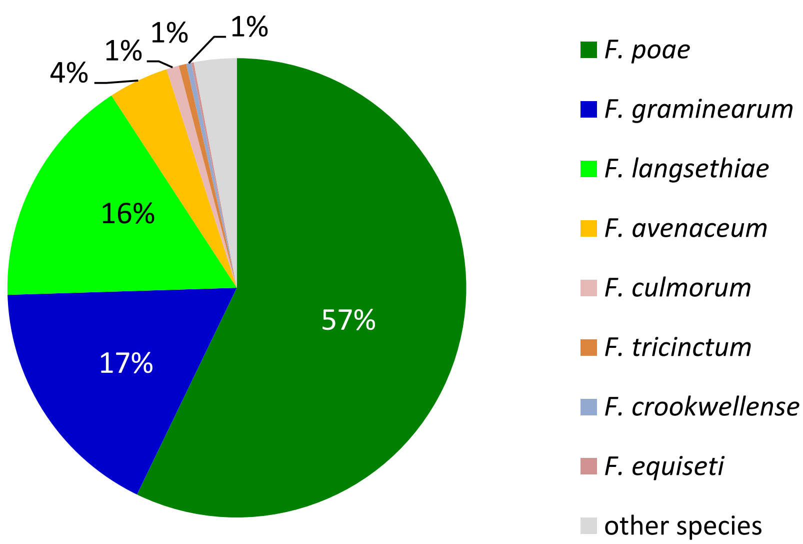

Figure 1. Fusarium head blight monitoring of Swiss oat harvest samples from the growing season 2013. Ratio of *Fusarium* species (%) detected with a seed health test in 93 oat samples from 11 cantons. Oat samples were accompanied by information on respective cropping measures and are presently analysed for the content of mycotoxins.

Resistance experiments with artificial infections

A large range of different wheat, barley and oat varieties were sown in autumn of 2013 and spring of 2014 at three Swiss experimental sites representing different climatic conditions. For oats, 20 varieties, deriving from breeding programmes in Germany, the Czech Republic, France and Canada, were chosen. The choice was based on both agronomic qualities and on their content of β-glucan, anthocyanins or carotenoids. During booting and flowering, these oat varieties were artificially inoculated with a mixture of three single conidia FP isolates originating from the above mentioned oat monitoring. Apart from rating of FHB symptoms in the field, collected grain samples will be analysed for species incidence, fungal DNA and mycotoxin content.

Epidemiology, forecasting and implementation

Results concerning the occurrence of FHB causing species, the effect of cropping factors and HPC enhanced varieties on toxin accumulation as well as ongoing epidemiology experiments in climate chambers and under field conditions will be merged and analysed to reveal potential correlations and to extend the existing computer-based forecasting system for wheat, www.FusaProg.ch, towards oats and barley. Information on the occurrence, risk factors and safety measures to minimise toxin accumulation will be disseminated to the cereal and nutrition sectors, including growers, food transformers and consumers. Finally, information on the resistance to FHB will also contribute to successful breeding of new varieties for improved safety of healthy cereals.

References

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