Organic World Congress 2020 | FRANCE

SEPTEMBER 21ST TO 27TH, 2020 IN RENNES
AT THE COUVENT DES JACOBINS • RENNES MÉTROPOLE CONFERENCE CENTRE
www.owc.ifoam.bio/2020

OWC 2020 Paper Submission - Science Forum

Topic 1 - Ecological approaches to systems' health

OWC2020-SCI-1151

LOW INCIDENCE OF FUSARIUM GRAMINEARUM IN ORGANIC FARMING ON BREAD WHEAT GRAINS OVER A 13-YEAR PERIOD

Bernard Rolland[1], Rémi Perronne[1], Jérôme Auzanneau[2], Denise Deffains[1], Patrick Delarue[1], Stéphane Gilles[2], Jean-Christophe Helleisen[1], Antonin Le Campion[1], Alain Monnier[1], Jean-Yves Morlais[1], Hélène Navier[1], Alexandre Pichard[2], Maxime Trottet[1], Patrice Walczak[3]

[1]BAP, INRAE, Le Rheu, [2]Agri-Obtentions, Orsonville, [3]BAP, INRAE, Lusignan, France

Preferred Presentation Method: Oral or poster presentation

Full Paper Publication: Yes

Abstract: Organic farming has been questioned about its ability to manage *Fusarium* infestation compared with conventional farming. In this study, we monitored, over a 13-year period in several sites in France, the fungal incidence of four genera of fungi on bread wheat grains from organic farming. We collected samples immediately after harvest in conditions of natural contamination on a list of winter wheat varieties from 2006 to 2018 in several sites in France. From each sample, 100 kernels were surface disinfected, plated on potato dextrose agar, and colonies were identified at the genus level, and at the species level for *Fusarium graminearum*. The fungal incidence observed on kernels over the period was on average 88 ± 16% (i.e. mean ± standard-deviation). Kernels were mainly infected by fungal species of the genus *Alternaria* (71 ± 25%), while the incidence of *Fusarium graminearum* is usually very low in our context (1 ± 2%), with the exception of year 2008 (49 ± 12% and 17 ± 9%, respectively in the two sites studied), which is confirmed by the highly significant effect of the year and the 'year × site' interaction. To conclude, in our study, *Fusarium graminearum* appeared not to be a major concern for wheat production in organic farming systems.

Introduction: The agricultural intensive production model is currently questioned because of agronomic, environmental, public health and sometimes socio-economic issues. In this context, reducing the reliance of agriculture on external inputs constitutes a priority to achieve more sustainable agricultural models. However, an alternative production model such as organic farming, that does not use fungicide, has been questioned about its ability to manage *Fusarium* infestation and mycotoxin contamination compared with the conventional high input model. Concerning the risk of mycotoxin contamination, a recent review highlighted that an organic farming system allows maintaining contamination at low levels, furthermore comparable or lower than in a conventional system (Brodal et al. 2016). However, the *Fusarium* pressure is not necessarily correlated with mycotoxin contamination, and many factors can affect the development of the pathogen, among which some depend on the cropping system, such as the fungicide use, the nitrogen level and the preceding crop,

while others not, such as climatic conditions. In this study, we monitored, each year over a 13-year period in several sites in France, the fungal incidence of four genera of fungi on bread wheat grains from organic farming systems.

Material and methods: Wheat samples were collected immediately after harvest from experimental field trials from 2006 to 2018 in two sites in France (Brittany and Ile-de-France), and in a third site in 2006 and 2007 (Poitou-Charentes). These samples were made in conditions of natural contamination on a substantial list of varieties representative of the winter wheat acreages in organic farming over the period, including both susceptible and resistant varieties to *Fusarium*. Sub-samples were chosen randomly and stored in paper bags at room temperature with 13-15% humidity until analysed, i.e. for about 6 months. One hundred kernels were randomly chosen from each sample, surface disinfected with NaClO solution for 2 min, rinsed 4 times with water, and dried for 12h under laminar flow hood. Ten kernels were plated in 10 separate 55 mm diameter Petri dishes filled with potato dextrose agar, and incubated for 5 days at room temperature under ambient light and day-night cycle. Each colony was first identified at the genus level based on phenotypic characteristics (pigmentation of aerial mycelium, growth rate of mycelium) among four genera, i.e. *Alternaria*, *Epicoccum*, *Fusarium* and *Microdochium* following descriptions of Pitt & Hocking (1997), and then at the species level to validate the presence of *Fusarium graminearum* using a microscope following descriptions of Seifert (1996). For subsequent statistical analyses, we focused on the *Fusarium graminearum* incidence on wheat grains for the two sites the most studied during 11 years, i.e. when both sites had tested the same varieties. In a full model, we tested the effects of three explanatory variables considered as factors, i.e. the year, the site, the variety, as well as the second-order interactions, on the *Fusarium graminearum* incidence. A $\log_{10}$-transformation has been applied on the response variable after adding a constant to the raw values (+ 1). We chose to apply a linear model with a $\log_{10}$-transformation rather than a binomial generalized linear mixed model due to a strong asymmetry in the data distribution, i.e. numerous cases for which *Fusarium* was not observed. We applied sum to zero contrasts on fixed factors. Prerequisites were met after $\log_{10}$-transformation, i.e. homogeneity of variances and normality of the residuals. The full model was compared with all models based on Akaike information criterion (AIC), and only the best model was presented.

Results: Sixteen varieties were evaluated from 1 to 13 years, with on average 6 varieties each year. The fungal incidence observed in our two sites studied over the 13-year period in organic farming system ranged from 38% to 100%, being on average 88 ± 16% over the period in both sites. Kernels were mainly infected by fungal species of the genus *Alternaria* (71 ± 25% over the period) and, to a lesser extent, by the genera *Epicoccum* and *Microdochium* (8 ± 9% and 3 ± 8%, respectively). In contrast, the incidence of *Fusarium graminearum* is usually very low, with the exception of year 2008 (1 ± 2% excluding year 2008, 49 ± 12% in Brittany and 17 ± 9% in Ile-de-France in year 2008, Figure 1). The results observed in Poitou-Charentes in 2006 and 2007 confirmed the dominance of *Alternaria* and the low incidence of *Fusarium graminearum* observed in the other sites. Based on the best model retained, the incidence of *Fusarium graminearum* on wheat grains for the two sites the most studied during 11 years was not influenced by the variety tested. The effect of the site was near to be significant ($F = 3.14$, $P = 0.07$), while both the effect of the year and the 'year × site' interaction were highly significant ($F = 40.08$, $P < 0.001$; $F = 5.61$, $P < 0.001$; respectively, see also Figure 1).

Discussion: In accordance with previous short-term studies in other countries, our results over a 13-year period highlight a usually low *Fusarium graminearum* incidence on organically produced bread wheat grains, while the fungal community is usually dominated by other genera of fungi (Lazzaro et al. 2015, Lenc 2015). Moreover, we emphasize that the year of

study has a significant influence in the incidence of *Fusarium graminearum*, potentially especially due to climatic differences between years, while the variety chosen does not. This result appears consistent with the factors known to promote *Fusarium* species, among which the application of fungicides not active against *Fusarium*, a high level of nitrogen fertilization or/and a preceding host crop, i.e. as much factors for which effects are controlled in an organic farming system. As an example, in year 2008, characterized by a high *Fusarium graminearum* incidence, both weather and the preceding crop were unfavourable. Indeed, in year 2008, the month of May was characterized by a high cumulative rainfall (136 mm, compared to a mean of 59 ± 26 mm over the period 2006-2018 excluding 2008), a high mean air temperature (15.2°C, compared to a mean of 13.7 ± 0.9 °C over the period 2006-2018 excluding 2008), and a maize as preceding crop, thus potentially explaining the high level of infestation observed. Moreover, we conducted mycotoxin analyses by LC-MS/MS on grains harvested in 2018 that confirmed the low concentrations of deoxynivalenol (DON) that was usually under the limit of quantitation (i.e. below 50 $\mu g.kg^{-1}$ of DON content on the bread wheat grains sample in 2018). To conclude, in our context, *Fusarium graminearum* appeared not to be a major concern for winter wheat production in organic farming systems.

Figure 1: Average incidence of *Fusarium graminearum* on bread wheat grains from organic farming system over a 13-year period in two sites in France (mean and standard deviation), with the exception of years 2006 and 2009 for which only the site in Brittany has been studied. The standard deviation is computed on the results obtained on the different varieties tested (n = 3-8 per year). The boxplots in black on the left and in gray on the right correspond to the sites in Brittany and Ile-de-France each year, respectively.

References:

Brodal G, Hofgaard I, Eriksen G, Bernhoft A & Sundheim (2016): Mycotoxins in organically versus conventionally produced cereal grains and some other crops in temperate regions. World Mycotoxin Journal 9, 755-770.

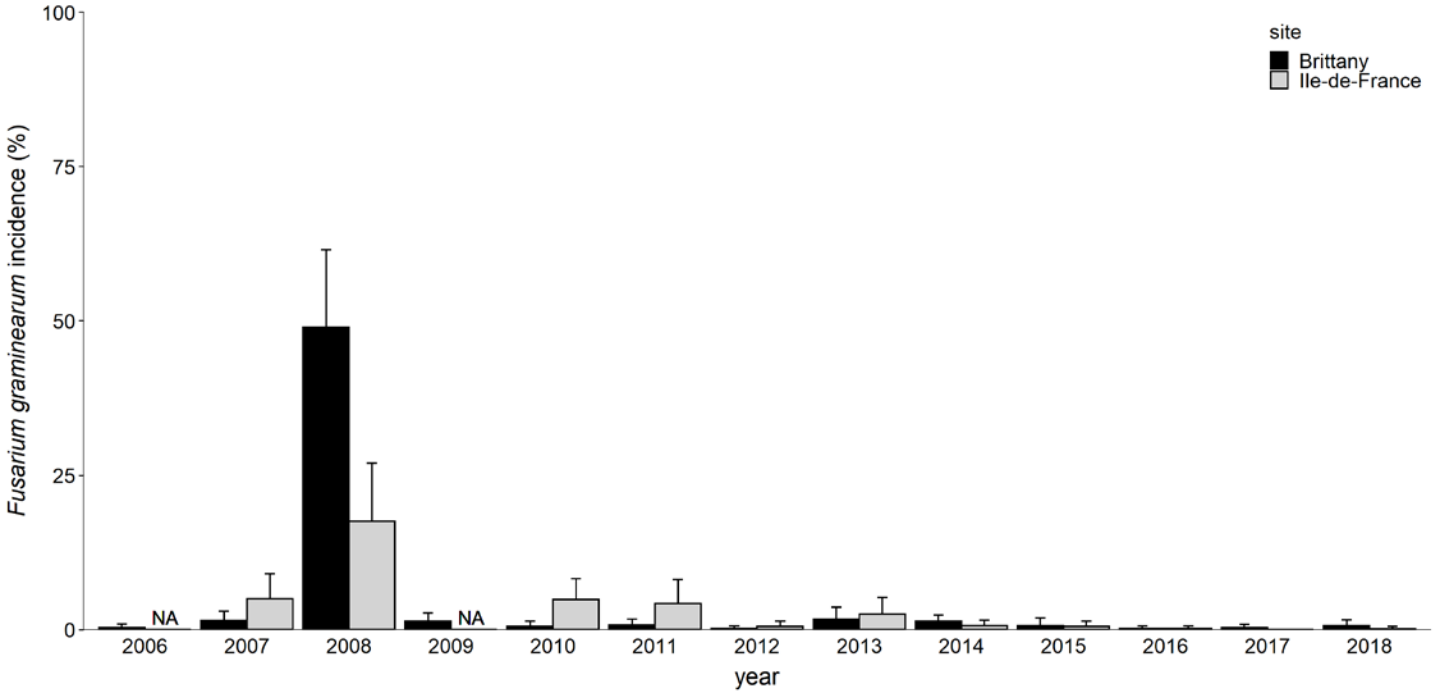
Lazzaro I, Moretti A, Giorni P, Brera C & Battilani P (2015): Organic vs conventional farming: Differences in infection by mycotoxin-producing fungi on maize and wheat in Northern and Central Italy. Crop Protection 72, 22-30.

Lenc L (2015): *Fusarium* head blight (FHB) and *Fusarium* populations in grain of winter wheat grown in different cultivation systems. Journal of Plant Protection Research 55, 94-109.

Pitt J & Hocking A (1997): Fungi and food spoilage. Eds. Pitt J & Hocking A. Blackie Academic and Professional, London.

Seifert K (1996): Fuskey: Fusarium interactive key (No. 632.4/S459). Agriculture and Agri-Food Canada.

Image:



Disclosure of Interest: None Declared

Keywords: bread wheat, France, fungal incidence, *Fusarium graminearum*, long term experiment, organic farming