From field to storage: which factors favour the presence of mycotoxins in ancient cereal varieties in organic systems?

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Fig. 1. Fusarium Head Blight on a soft wheat ear (INRAE)

Introduction

Several mycotoxins found in cereal products are synthesized by fungi either in the field (*Fusarium graminearum)* or during storage (*Aspergillus sp.* and *Penicillium sp*.). Deoxynivalenol (DON) is the most commonly found one. The usual visible symptom of *Fusarium* contamination on cereal ear is Fusarium Head Blight (FHB) (Fig. 1). In conventional agriculture, fungicides are the main treatment used to control fungi contaminations, whereas in organic productions, prophylactic methods are applied (tillage, weeding,…). This study provides knowledge about factors that favour the presence of mycotoxins in different ancient cereal varieties grown specifically under organic management.

Aims

- Determine what are the effects of weather conditions and cropping practices on mycotoxins' contamination of post-harvest grains
- Assess the impact of storage on mycotoxins' contamination of grains

Material & methods

Grains were collected from 2 sites: a 500m² experimental platform at INP Purpan (Toulouse, France) divided into 85 agricultural plots and 54 agricultural plots distributed on 35 farms, in south of France.

- In the experimental platform, 44 populations of rivet wheat and other ancient cereals were grown. In the farms, 16 populations of 3 species of cereals were grown. Throughout the growth cycles, agronomic data (flowering date, competitive ability, *Fusarium* diagnosis, …) were collected. After harvesting, grain samples from all the agricultural plots were collected. Farmers stored their own grains in their farms for around 9 months, and then post-storage grains' samples were collected, for the 54 agricultural plots only.
- Multi-mycotoxins analysis were done on grain samples, especially Aflatoxins, Deoxynivalenol, HT-2 and T-2 toxins, Nivalenol, Ochratoxin and Zearalenone, before storage and, when it was possible, after storage.

Results & discussion

1/Rainfall influence on post-harvest grain's DON's contamination on the experimental platform

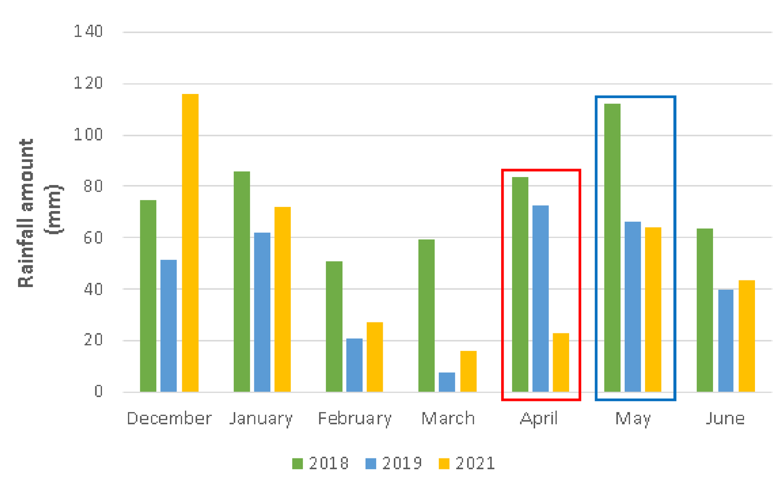

Fig. 2. Rainfall amount at Toulouse in 2018, 2019 and 2021

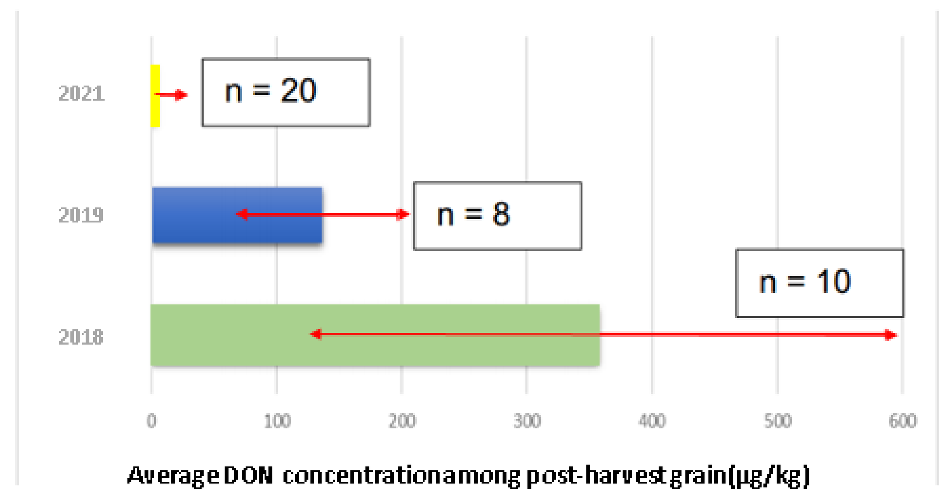

Fig.3. Average DON concentration (µg/kg) of grains from the experimental platform (n=number of analysed samples)

According to the literature [1], a minimum of 40 mm of precipitation around flowering stage (around May) is the main factor that explains the presence of *Fusarium graminearum*, and therefore DON's contamination. Average DON's concentration in 2019 and 2021 should thus be equal, according to the similar rainfall amounts in May (Fig.2). However average DON's concentration in 2021 is significantly lower than in 2019 (Fig.3). Rainfall in April is the most correlated factor with mycotoxin's contamination (Pearson correlation matrix). Rainfall amount in the pre-flowering stage seems to be an important factor explaining grains' DON's contamination.

2/Climate influence on DON contamination in wheat grains from 54 farmer plots

9 agricultural plots were located in the Mediterranean climate and 45 in the Oceanic climate (Fig.4). No agricultural plots in the Mediterranean climate were contaminated with DON (Table 1). It is well known that dry climate limits the presence of *Fusarium*.

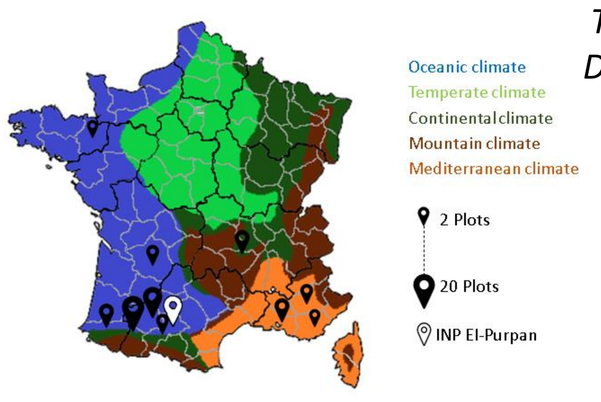

Fig.4. French climate map showing the location of the farming plots

Table 1. Impact of climate on the presence of DON (more than 50 µg/kg), in 2020 and 2021

Location	Number of samples with DON
Alpes-de-Haute-Provence	0/3
Bouches-du-Rhône	0/4
Var	0/2
Dordogne	1/3
Haute-Loire	0/4
Pyrénées Atlantiques	4/4
Ille-et-Vilaine	0/2
Haute-Garonne	3/3
Haute-Pyrénées	20/20
Gers	7/9

Mediterranean climate
Oceanic climate

3/Farming practices influence on post-harvest grain's DON's contamination on 54 agricultural plots

Table 2. Influence of different farming practices on the presence (more than 50 µg/kg) of DON.

Farming practice	Criterion	DON not detected	DON detected
Species	Rivet wheat	1	12
	Soft wheat	20	23
Weeding	No	13	29
	Yes	8	5
Seeding period	Early	4	10
	Normal	5	14
	Late	1	8
	Very late	11	3
Tillage	No	1	12
	Yes	20	23

Practice correlated to DON's presence
Practice not correlated to any of them
Practice not correlated to DON's presence

Weeding and tillage, as well as very late seeding, seem to be efficient ways to limit the presence of DON (Table 2). It is similar to what is found in the literature for cereals [2] [3].

4/Evolution of the DON contamination during farm storage

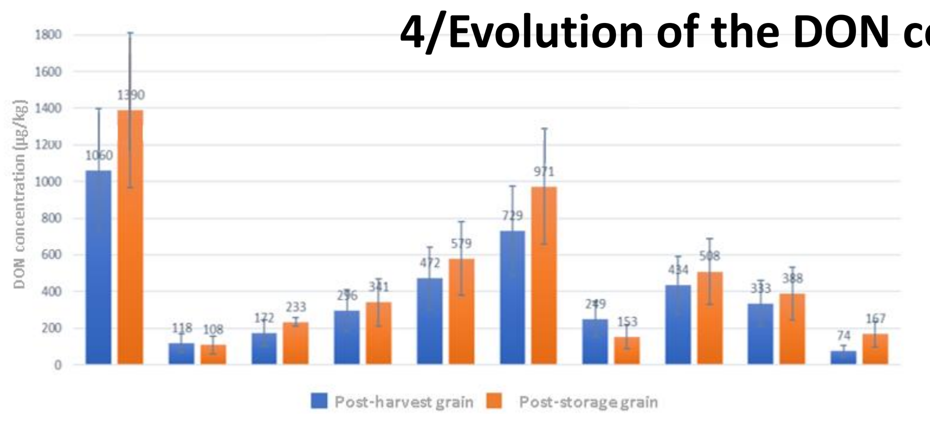

Fig.5. DON's concentration before and after an around 9 months' storage on farm

10 samples collected from 8 farms, were analysed before and after storage. DON's concentrations tend to increase after storage, but not significantly (Fig.5). Same results were observed for the other analysed mycotoxins (data not shown).

Conclusion & perspectives

- Rainfall around pre-flowering stage seems to be an important factor for DON's contamination
- Mediterranean climate limits DON's presence in grains
- Several agricultural practices (weeding, tillage, very late seeding) reduce DON's presence in the grains of ancient cereals varieties and in modern varieties
- DON's contamination tends to increase during storage, but it is not significant
- Those results should be confirmed by other experiments

Acknowledgements & references

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