Ecological role of mycotoxins in wheat crop residues and consequences on the multitrophic interactions in the soil and further development of Fusarium graminearum

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<u>Muhammad Abid</u>, J.Leplat, L. Fayolle, E. Gautheron, C. Heraud, N. Gautheron, V. Edel-Hermann, and C. Steinberg*
INRA-National Institute of Agronomical Research/University of Burgundy
17 rue Sully, F-21000 Dijon, Dijon, France.
E-mail : muhammad.abid@dijon.inra.fr
* christian.steinberg@dijon.inra.fr

Back ground

Fusarium graminearum

- Ascomycete
- Facultative parasite and pathogen
- Asexual stage produces Macroconidia and the sexual stage (*Gibberella zeae)* produces Ascospores

Causes Fusarium head blight and seedling blight which is a destructive disease of wheat and barley

Diseased wheat spike

Produces mycotoxins (as Deoxynivalenol=DON) Contaminate the grains and make them harmful to animal and human

***F. graminearum* overwinters in the soil , on crop residues and on weeds. It serves as primary inoculum for the next season**

The world is moving from the reduced tillage practices to zero tillage, leading towards leaving the crop residues on the soil which may serve as habitat for pathogens.

Decomposers | **Antagonists**

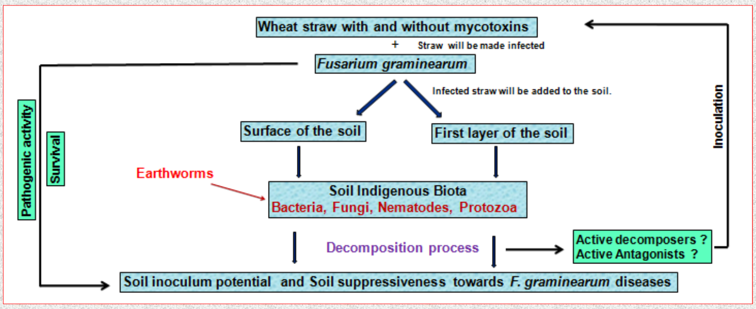
To survive *F. graminearum* have to compete with other soil biota i.e. fungi, bacteria, nematodes, earthworms and protozoa etc.

Do mycotoxins (as deoxynivalenol) provide a competitive role for their survival in these habitat during decomposition?

Objectives of study

- **To study the role of mycotoxins towards the survival and pathogenic activity of *F. graminearum* on wheat crop residues during decomposition process.**
- **To examine the interaction among *F. graminearum*, soil biota (i.e. fungi, bacteria, protozoa, nematodes and earthworms) and mycotoxin i.e. Deoxynivalenol.**
- **To depict the active decomposers as well as putative antagonists which inhibit the development of the pathogenic fungus either by decomposing the ecological habitat or through direct antagonism.**
- **To co-inoculate these beneficial microorganisms with *F. graminearum*.**

Research plan



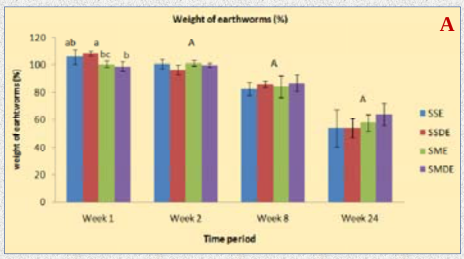
Preparation of microcosms

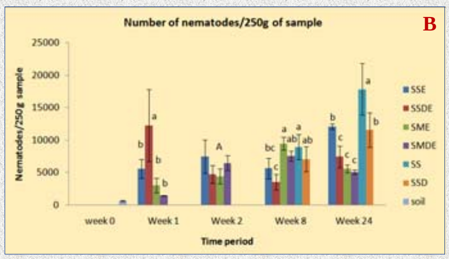
NO.	Modalities	*F. graminearum*	Straw placed on surface	Straw incorporated	DON	Soil	Earthworms
		(10^3 spores/g straw)	(10g DW)	(10g DW)	(100mg/Kg)	(1kg DW/pot)	(4/pot) 13.67g ± 0.76
1	SS	+	+			+	
2	SSD	+	+		+	+	
3	SSE	+	+			+	+
4	SSDE	+	+		+	+	+
5	SME	+		+		+	+
6	SMDE	+		+	+	+	+

The experiment was conducted in the microcosms. These were incubated at 17°C.

Results

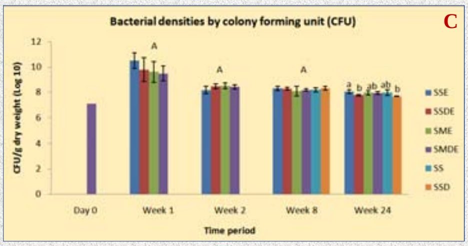
The straw is well incorporated in the microcosms inoculated by earthworms. It is also observed that the presence of DON increased the incorporation process by earthworms.

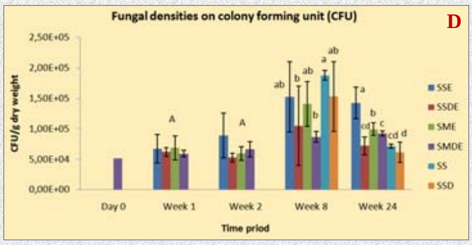


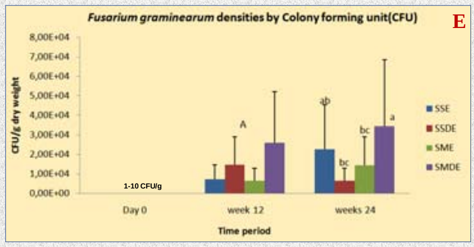


➢ A- The earthworms decreased their weights which may be due to the decrease in available nutrient, Although we did not measure the N content in the microcosms, we suspect that nitrogen could be the limiting factor . This decrease in the weight was not correlated to DON whether the straw was mixed or placed on the surface.

➢ B- The nematode population was lower in the presence of DON and in the presence of earthworms. DON might be toxic towards nematodes but the later case may be explained by unintentional predation and by out competition by the earthworms







➢ C- The burst in the bacterial density was observed during the 1st week which was probably due to the rapid use of easily available nutrients in the straw. The population dynamics of the bacteria were similar in all the modalities. No DON effect was depicted.

➢ D- Globally, the strategy of development of the fungi was different from the bacterial one. No burst was observed in the first two weeks but the fungi grew later. Their enzymatic machinery probably allowed them to decompose and use materials which were unavailable for the bacteria, which in turn, were faster in using easily available nutrients. The impact of earthworm on the development of fungi community was not significant as well as the one of DON, although a general trend suggests putative negative effect of the mycotoxin.

➢ E- *F. graminearum* developed from about 1 to 10 CFU/g of soil and straw mixture to more than 10^3 CFU/g of mixture after 24 weeks in all the modalities. A beneficial effect of DON was observed all along the experiment when straw was incorporated in the soil while this effect was only observed up to the 12th week of incorporation when the straw was left at the surface of the soil.

Conclusion

General trend more than significant conclusion can be drawn from the analysis of the results. DON seems to provide the advantage to *F. graminearum* while the mycotoxin negatively affect the fungal community as well as the nematode community but not the bacterial community. The role of earthworm in the incorporation of straw is clear and seems to be not affected by DON.
All the samples are stored at -20 °C. The use of molecular tools as well as the forthcoming quantification of DON in the residues during 24 weeks of observation will provide the clarification and may confirm or not the trends we observed.