

Preventing the risk of T-2 and HT-2 toxins on spring barley

A first available tool

Spring barley, usually less susceptible to DON contamination than wheat, is however more exposed to T-2 and HT-2 toxins. Although much is still unknown about these toxins, the latest work has resulted in the first tool to prevent the risk.



Europe will fix statutory limits for T-2 and HT-2 toxins in cereals from 2011.

The European Commission foresees the introduction of maximum permissible limits for the toxins T-2 and HT-2, with possible implementation for the 2011 harvest. Oats, and to a lesser extent spring barley, are the cereals most affected by this problem.

The *Fusariums* which can produce T-2 and HT-2 toxins are not the same as those producing DON (table 1). One can well imagine the competition

Small-grain cereals are not all the same when faced with T-2 and HT-2 toxins.

between the different species of *Fusarium*, *Microdochium* or other fungi capable of developing on the plant from emergence till harvest. In this competition, the species which produce DON usually get the upper hand on the ears of wheat and durum wheat.

The species which produce T-2 and HT-2 toxins are the ones which do best on the ears of spring barley and oats (figure 1). Among the *Fusariums* likely to produce T-2 and HT-2 toxins, the most frequently encountered in northern Europe is

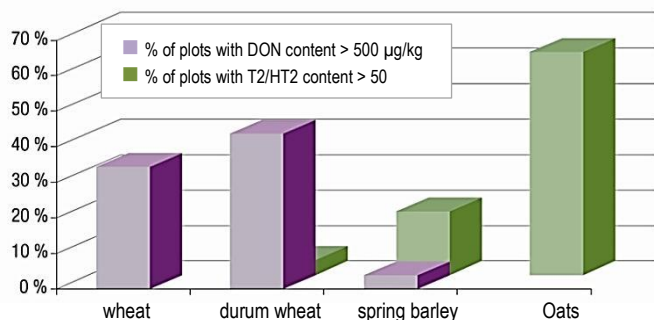
F. langsethiae. This recently-identified species has been the subject of much research. However it is not the only one, as *F. sporotrichoides* is also part of the landscape on our barley and oat crops.

Table 1 : *Fusariums* liable to develop on small-grain cereals, and the associated mycotoxins.

Main <i>Fusarium</i> species on small-grain cereals	Mycotoxins	
	Trichothecin mycotoxin A (toxins T-2, HT-2 etc.)	Trichothecin B (DON etc.)
<i>F. culmorum</i>	NO	YES
<i>F. graminearum</i>	NO	YES
<i>F. poae</i>	YES	YES
<i>F. tricinctum</i>	NO	NO
<i>F. sporotrichoides</i>	YES	NO
<i>F. langsethiae</i>	YES	NO

The species which produce DON and T-2 and HT-2 are not the same.

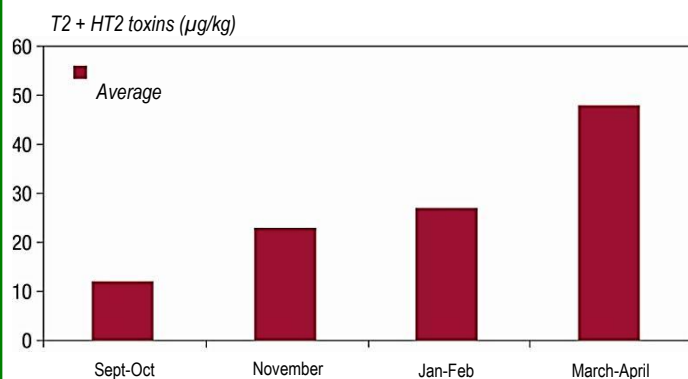
(DON contents T-2 and HT-2 toxins in different crops (Figure 1))



Source: ARVALIS – Institut du végétal
Wheat 2007 to 2009 (N = 335) ; durum wheat 2007 to 2009 (N = 355) ; springs barley 2006 à 2009 (N = 544) ; oats 2008 to 2009 (N = 51)

Wheat crops are the most susceptible to DON, whereas the T-2 and HT-2 toxins are frequently found on spring barley and especially oats.

Influence of the sowing date on the levels of contamination with T-2 and HT-2 toxins in spring barley (Figure 2)



Source : ARVALIS – Institut du végétal, survey on spring barley 2006-2009 (N = 54)

Late sowings have the highest contaminations. But note that the autumn sowing reports are anecdotal.

Since the 2006 harvest, 544 spring barley fields have been surveyed by ARVALIS – Institut du végétal in collaboration with partners from the barley industry (mainly the storage organisations). Each field is identified by its agronomic history and by the analytical results for the T-2, HT-2 and DON toxins, produced by liquid chromatography.

The first agronomic factor identified is the sowing date. Apart from its effect on yield, the risk of finding fields highly contaminated by T-2 and HT-2 toxins increases for late sowings (figure 2). The susceptible period for barley is not known, but these results suggest that late sowing means that the susceptible stage of the plant coincides with the liberation of the spores of *Fusarium*, which produces T-2 and HT-2.

Another important factor is the nature of the preceding crop. The highest levels of contamination are found in the fields where the previous crop was a small-grain cereal. Other preceding crops such as maize do not constitute a risk factor. The management of the residues of the previous crop before sowing barley is a second-degree factor. Although ploughing has no influence, the highest levels of contamination are found when the residues are exported. We observe quite the opposite of the problem on wheat, where residues on the soil favour DON.

Late sowing after small-grain cereals exacerbates the risk of contamination of barley crops.

This finding makes sense if one considers the competition between the different *Fusariums* ; nevertheless research should continue to provide a clearer explanation. Finally, the variety is the least important factor identified as influencing the levels of contamination with T-2 and HT-2 toxins. In parallel with the network of field surveys, ARVALIS - Institut du végétal has used its programme of trials for agronomic testing of spring barley varieties. 89 results of mycotoxin analyses were collected over 4 years from 17 different varieties. This study has shown differences in the accumulation of T-2 and HT-2 toxins

between varieties, with a ratio ranging from 1 to 3.5

between the least and most affected. However until now no susceptibility list has been published. We need to add to the results obtained so far, especially as we don't yet have an effective method for conducting trials in conditions favouring the toxins.

This first evaluation obtained on variety trials has been tested in a survey: we find that the varieties most affected are even more contaminated when sown late.



Three species of *Fusarium* are currently known to produce T-2 and HT-2 on barley.

Evaluation table for the risk of T-2 and HT-2 on spring barley (Figure 3)

Precedent	Fate of preceding crop residues	Variety	Sowing date	
			January February	March April
Others <i>(*)For example : grain maize, oilseed rape, sugarbeet(*)For example : forage maize</i>	Non exported (*)		A	B
	Exported (*)		B	C
Small-grain cereals	Non exported	Little affected	B	C
		moderately affected		D
		More affected	C	E
	Exported	Little affected	C	D
		moderately affected		E
		More affected	D	

A Low risk to **E** high risk

Source : ARVALIS – Institut du végétal, table drawn up from spring barley field surveys 2006-2009

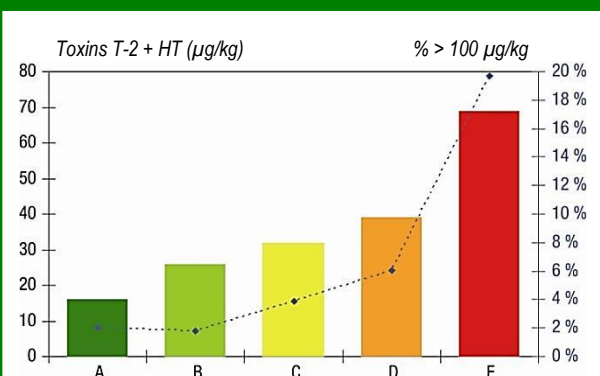
An evaluation table of the risk of T-2 and HT-2

The risk of T-2 and HT-2 on spring barley crops should henceforth be evaluated from the agronomic table offered by ARVALIS – Institut du végétal (figure 3). This table is able to classify every crop management protocol according to five risk categories (from A, the lowest, to E, the highest).

It takes account of sowing date, the preceding crop and the management of its residues, as well as the variety. Just as for the DON problem on wheat, one should avoid accumulating agronomic factors, especially in seasons with weather favourable to the disease (figure 4).

At present, no varietal list is available, but it is possible to anticipate the problem from

Mean content of T-2 and HT-2 toxins and percentage of fields exceeding 100 µg/kg for each class of agronomic risk (Figure 4)



On average, the fields are more contaminated when the agronomic risk is high.

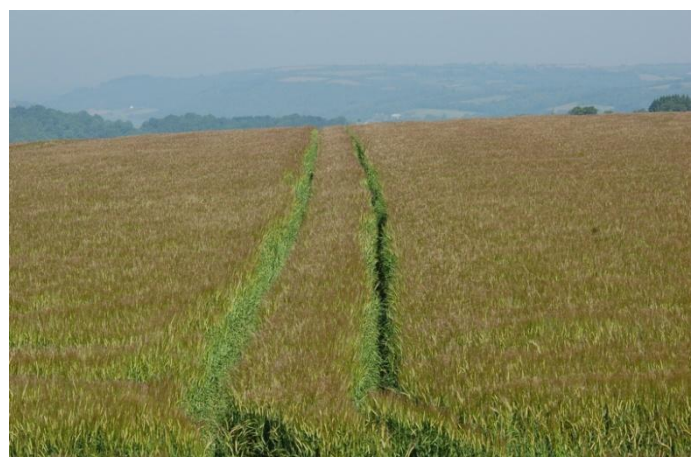
the time of sowing, for example by favouring early sowing on fields where the preceding crop was a small-grain cereal.

The main prevention tool available is the evaluation table of the agronomic risk for the T-2 and HT-2 toxins.

And the weather!

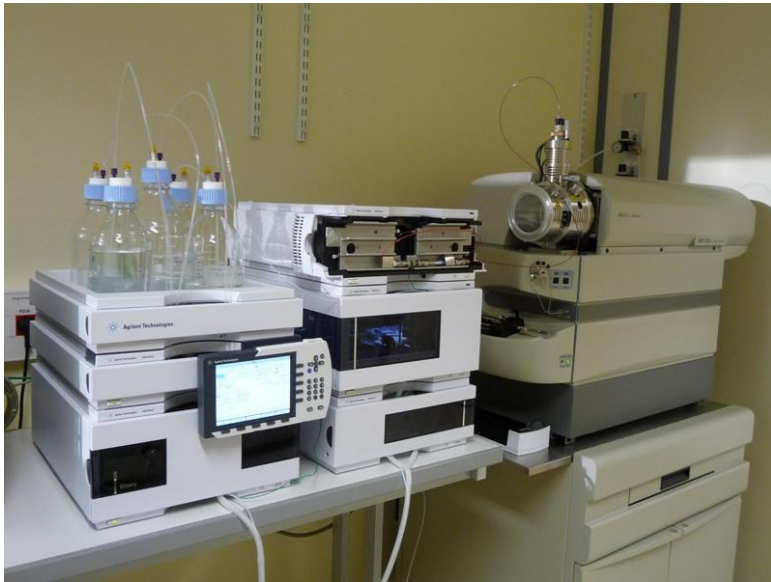
Let us not forget that the weather has a big effect on the average levels of contamination of toxins in every harvest. Although there is plenty of evidence for this assertion for DON on wheat, it is not yet proven for T-2 and HT-2 toxins on spring barley.

Studying the weather is indispensable to refine the risk prediction, but so far there is very little evidence about the dynamics of infection by the different pathogens. Future harvests should provide enough weather scenarios to allow us to enrich the results already obtained.



Just like DON on wheat, contamination of T-2 and HT-2 on barley crops can be explained in terms of agronomy (e.g. sowing date, preceding crop, varieties etc.), but also by the weather.

Developing a standardised method for measuring T-2 HT – 2 mycotoxins



A liquid chromatograph (left) coupled with a mass spectrometer (right) is able to measure several mycotoxins at once with a precision of 10 µg/kg.

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At present no standard method exists to quantify the T-2 and HT-2 toxins. Faced with the imminent introduction of statutory limits for these two mycotoxins, it is considered necessary to know the analytical performance of the laboratories. This is why IRTAC (Research Institute for Cereal Agrofood Technologies) has set up a working group whose objective is « to improve LC/MS/MS chromatographic methods for measuring T-2 et HT-2 toxins on cereal» . Apart from the Analysis and Methods team of ARVALIS – Institut du végétal and the Capinov laboratory which assures the introduction of the project, this working group brings together six French laboratories with expertise in this domain.

In the course of this programme, methodological studies were carried out on the critical points identified. They will lead to the drawing up of an analytical method whose performance will be judged by an inter-laboratory trial. These results will then be submitted to the European Commission for Standardisation to make use of them in a future analytical standardisation project.

This project, which began in April 2009 and will end in October 2011, is supported financially by FranceAgriMer and various unions and associations of the cereal sector.