

Safety quality of barley and oat crops

Research on the toxins T-2 HT-2 is progressing

The European Commission is currently working on a regulatory project for the toxins T-2 and HT-2. Still poorly understood within the industry, these Fusarium toxins – mostly found in spring oats and barleys – are now the subject of numerous studies.

A European regulatory project which has been in place for several years

Since 2003 the mycotoxins T-2 and HT-2 have been the subject of a regulatory project by the European Commission. It was suspended because of a lack of a sufficiently precise method of measuring the actual levels in the grain. The regulatory limits proposed were then 500 µg/kg for oats and 100 µg/kg for other raw cereals. Talks began again in 2007. Many unknowns still remain, notably the real level of exposure of the population to these toxins. In spite of the numerous research programmes which are underway, gaps in our understanding and knowledge have been pointed out: knowledge of the flora and competition phenomena between Fusarium species, preventative measures in the field to limit and manage the risk, sampling and analysis methods, both standard and rapid. Initially announced for July 2008, then for July 2009, the European regulation for these toxins does not seem to be ready, but the ball is now in the court of the Commission and the experts of the member states.

There are no fusariotoxins without Fusarium. Among them, the toxins T-2 and HT-2, which affect particularly oats, and to a lesser extent spring barley, are less well-known. Several studies are underway to determine the fungi which produce them. *Fusarium langsethiae*, a recently identified species, seems to be the main fungus causing the contamination in the countries of northern Europe. This Fusarium is also present in our fields, but is perhaps not the only one responsible: other species which produce it (*F. poae* and *F. sporotrichioides*) have also been identified. Given the importance of this problem for the barley industry, the research is concentrated mainly on the relationship *F. langsethiae* / spring barley, in order to better understand the biology of the fungus, its method of dispersal, the infection stage, and the effect of weather.

A difficult visual diagnosis

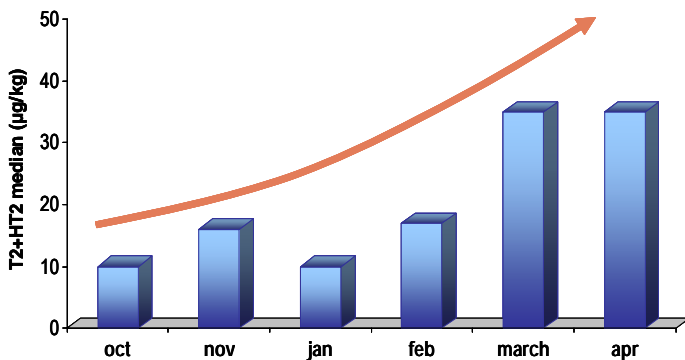
Numerous symptoms on the ears of barley were observed in 2008. Although they were not all attributable to the presence of Fusarium, the appearance of raised orange lesions on several ears could indicate the presence of a Fusarium, without however giving us any indication of the species. It is difficult to make a diagnosis from simple visual expertise: microbiological analysis and molecular characterisation are essential tools here, especially because these mycotoxins also occur in ears without symptoms, which seems to be the case for *F. langsethiae*.

The regulatory project envisages maximum regulatory limits for the sum of T-2 and HT-2.



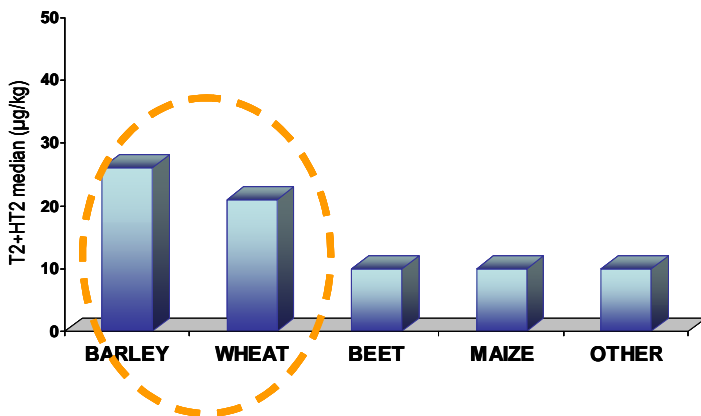
The importance of hygiene standards in barley is urging the brewing industry to investigate the production of the toxins T-2 and HT-2.

T-2 + HT-2 toxin content of barley crops according to sowing date (431 data values) (fi g. 1)



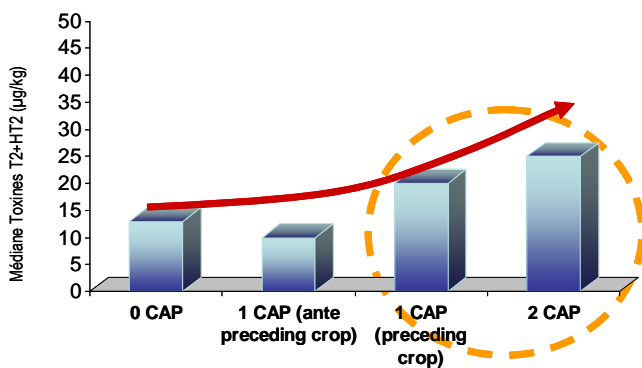
The effect of sowing date, observed over the 3 years of the surveys, seems to be a major trend.

T-2 and HT-2 toxin contents of barley crops related to the preceding crop (434 data values) (fi g. 2)



Barley crops are more infected when the field has grown a succession of small grain cereals.

T-2 and HT-2 toxin contents of barley crops related to the preceding crop and the one before that (N = 432 data values) (fi g. 3)



Agronomy: what preventative measures should be put in place ?

Since 2006, 450 barley fields, mainly spring barley, were surveyed by ARVALIS - Institut du végétal in collaboration with partners from the barley industry, mostly storage firms. Each field is characterised by its agronomic history, together with the analytical results for DON (deoxynivalenol) and the T-2 and HT-2 toxins, using liquid chromatography.

Unlike spring barley, winter barley crops are hardly, if at all, infected by T-2 and HT-2. There are two hypotheses to explain this difference: better genetic tolerance, or a liberation of *F. langsethiae* spores which could take place later in the season, coincident with the later flowering of spring barleys. Hence the sowing date seems to be important, as barley crops are more infected when they are sown late in the season (figure 1). Also, this hypothesis was confirmed by the results of a variety trial carried out at Ouzouer-le-Marché (41 – Centre region) in 2008 comparing six spring barley varieties sown in autumn and spring, where the spring barleys sown in autumn were only half as infected as those sown in spring.

The highest contents of the T-2 and HT-2 toxins were recorded in the barley plots following a barley or wheat crop. The barley plots following other preceding crops, including maize, were significantly less infected with the toxins T-2 and HT-2, as opposed to DON (figure 2). Barley crops are more infected when the field has grown a succession of small grain cereals (figure 3). The residues of such crops, in particular barley, certainly favour the development of the Fusarium which produces the toxins T-2 and HT-2.

The difference in infection between winter and spring barley crops could be explained by the liberation of spores of *F. langsethiae* coincident with the later flowering of the spring barley.

Unlike DON, a preceding small grain cereal crop is an aggravating factor.

Ploughing can reduce the level of contamination with T-2 and HT-2, the use of min-till techniques and direct sowing. This follows a well-known principle: anything which favours the decomposition of tissues restricts the substrate on which the Fusarium grows, thus limiting the development of the fungus on the following crop. The management of the residues of the preceding crop however seems to be less important for the toxins T-2 and HT-2 than for DON.





Anything which favours the decomposition of residues limits the development of the fungus in the following crop.

BARSAFE: a dedicated research program within the barley-malt-beer industry.

Financed by the National Research Agency (ANR), the BARSAFE project, begun in 2008 for three years, brings together ARVALIS – Institut du végétal, INRA and CNRS under the coordination of the French Institute for Brewing and Malting (IFBM).

The aim of this project is to set up experiments to better understand and manage every aspect of the health risks linked to *F. langsethiae* throughout the supply chain from the malting barley field to the final products (monitoring the different stages of beer brewing).

Managing DON and the T-2 and HT-2 toxins

When we talk of the control of safety standards in small grain cereals, we often think of the control of DON (deoxynivalenol), mainly produced by *F. graminearum*, the mycotoxin most frequently found on cereals, and already

regulated (1 250 µg/kg on barley and 1 750 µg/kg on oats). A batch sold in future will have to observe the regulatory limits for both DON and T-2 and HT-2. Then it will be necessary to ensure that good practices put in place to limit one toxin do not favour the other, especially as monitoring of barley fields shows an opposition between DON on the one hand and the T-2 and HT-2 toxins on the other (figure 4). This opposition is not surprising as the *Fusariums* responsible are different. It can be explained by competition between the species or differing optimal weather conditions, or even different times of establishment of the disease.

Sowing date, preceding crop and soil tillage are agronomic factors influencing the contents of T-2 and HT-2.

After first identifying the agronomic factors influencing the contents of T-2 and HT-2, several years of studies will be needed to better identify and rank the high-risk cultural practices, and to define weather sequences which determine risk-prone seasons.

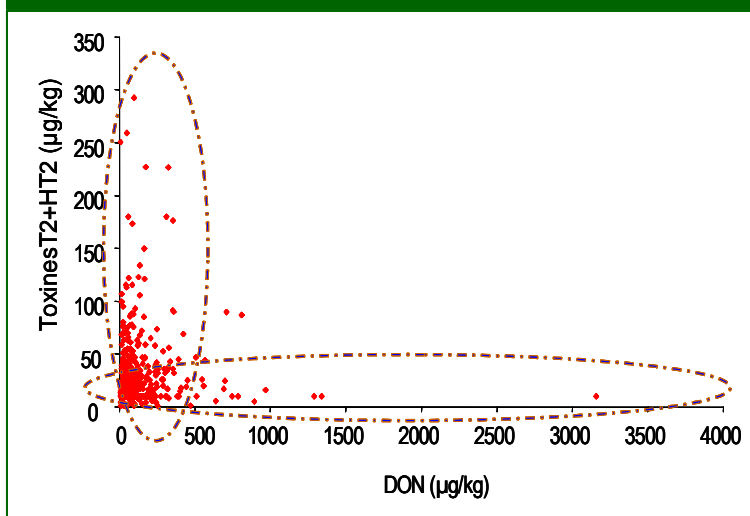
The Creully cooperative carried out a study in 2008 on 34 oat fields in collaboration with ARVALIS – Plant Institute

In order to better anticipate future regulation, the cooperative at Creully (Calvados – Normandy) carried out a first evaluation in 2008 of the T-2 and HT-2 problem in oats. Although the contents found were on average higher than in barley, the levels were nevertheless acceptable as they did not exceed 210 µg/kg. This study, carried out in a specific area of production, has supported the results observed on barley over three years, namely:

- the effect of sowing date on the levels of T-2 and HT-2.
- the importance of the preceding crop, and notably the precautions to take when cropping repeatedly with small grain cereals on a given field.
- the importance of soil tillage, and notably ploughing to reduce the risks.

In view of these encouraging results, the study will be repeated on the 2009 crop.

Opposition between DON and the T-2 and HT-2 toxins in barley (451 data values) (fig. 4)



One must ensure that the good practices put in place to limit one toxin do not favour the other.

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