Summary

*Fusarium* ear blight (*Fusarium* spp.) is seen as an increasing problem in many parts of Europe. The disease is of major concern due to the production of mycotoxins by the fungi involved. It is a disease which is highly linked to crop rotation and tillage methods. The risk is particularly high in regions where maize is a widely grown crop in the rotation and reduced or minimum tillage is practiced.

Genetic resistance is available with effective levels of control available in some cultivars. Application of good agricultural practices can help significantly to keep the disease and mycotoxin levels low. In seasons with high rainfall levels during flowering combined with high risk situations (normally maize and minimal tillage) specific fungicide programmes need to be applied during flowering.

For further information please contact: Bill Clark, Broom’s Barn Research Centre, Higham, Bury St Edmunds, Suffolk IP28 6NP, UK
Tel: (+44) 1284 812201
E-mail: bill.clark@bbsrc.ac.uk.
Strategies to Control *Fusarium* Ear blight and Mycotoxin Production in Wheat

*Fusarium* ear blight is an increasing problem in many parts of Europe, and understanding the factors which influence the severity of the attack is key. *Fusarium* ear blight (*Fusarium* spp.) is seen as an increasing problem in many parts of Europe, including Germany, France, Denmark, Italy and Hungary. The disease is of major concern due to the production of several mycotoxins by the fungi involved which pose a threat to the health of both humans and animals.

There are several species of *Fusarium* that affect wheat, the main species being *F. avenaceum*, *F. culmorum*, *F. graminearum*, *F. poae* and *F. langsethiae*. *Microdochium nivale* and *M. majus* also affect wheat and may cause ear blight. However, *Microdochium* species do not produce mycotoxins; they are the main cause of seedling blight. Often several species can infect the same ear and the severity of attack depends mainly on weather conditions during flowering and a combination of agricultural factors.

Manipulating the agricultural factors can contribute strongly to reducing this risk, without the need for fungicides. Fungicides applied to the ear during flowering can reduce the incidence and severity of *Fusarium* ear blight but in high-risk seasons high levels of control are unlikely.

### Fusarium mycotoxins

*Fusarium* mycotoxins are toxic chemicals produced by some species of *Fusarium* which attack the ears of wheat and other cereal crops. *Fusarium* mycotoxins are produced in the field as part of the fungal colonisation of the ear and rarely increase after harvest.

Infection of ears by *Fusarium* species occurs when the weather conditions during flowering are warm and wet. Wheat crops infected at flowering often have individual bleached spikelets or partially bleached ears, resulting in pink or chalky-white shrivelled grains at harvest.

Levels of ear blight seen in the field do not always correlate with mycotoxin occurrence. Legal limits exist for *Fusarium* mycotoxins (deoxynivalenol (DON) and zearalenone) in wheat intended for human consumption (see table 1) and there are guidance limits for grain for feed (see table 2).

**Table 1:** Legal limits for mycotoxins (ppb) in grain intended for human consumption.

<table>
<thead>
<tr>
<th></th>
<th>DON</th>
<th>Zearalenone</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unprocessed soft wheat and barley</td>
<td>1250</td>
<td>100</td>
</tr>
<tr>
<td>Unprocessed durum wheat and oats</td>
<td>1750</td>
<td>100</td>
</tr>
<tr>
<td>Flour</td>
<td>750</td>
<td>75</td>
</tr>
<tr>
<td>Finished products</td>
<td>500</td>
<td>50</td>
</tr>
<tr>
<td>Infant food</td>
<td>200</td>
<td>20</td>
</tr>
</tbody>
</table>

**Table 2:** European Union guidance on mycotoxin levels (ppb) in grain intended for animal feed.

<table>
<thead>
<tr>
<th></th>
<th>DON</th>
<th>Zearalenone</th>
</tr>
</thead>
<tbody>
<tr>
<td>Feed grains</td>
<td>8000</td>
<td></td>
</tr>
<tr>
<td>Complete feedstuffs for</td>
<td>900</td>
<td>250 (100*)</td>
</tr>
<tr>
<td>- Pigs</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Calves, Lambs and Kids</td>
<td>2000</td>
<td>500</td>
</tr>
</tbody>
</table>

* Feed intended for piglets or gilts

### Reducing the risk of Fusarium by management

The risk from *Fusarium* is strongly linked to crop rotation and tillage methods. The risk is particularly high in regions where maize is a widely grown crop in the rotation. Direct drilling and reduced tillage leaving debris on the surface as a source of inoculum at field level also increase the risk of fusarium ear blight.

Figure 1 (overleaf) illustrates that maize as the preceding crop strongly increases the risk of DON-contamination in the following wheat crop. Minimal or reduced tillage increases this risk still further. Conversely, ploughing can significantly reduce the risk, even when maize is the previous crop. In some countries wheat after wheat in combination with minimal tillage has also been found to increase the risk of *Fusarium* ear blight.
Reducing the risk of Fusarium by choice of cultivar

No cultivar gives 100% control of Fusarium ear blight but cultivars with high levels of resistance are available. So cultivar resistance to Fusarium ear blight is a key factor when trying to minimise the risk of mycotoxins in grain. DON levels from the most susceptible to the most resistant cultivar can be reduced by a factor of three (see figure 2). Several countries rank each year the relevant cultivars for susceptibility to Fusarium ear blight (see figure 3).

Resistant cultivars may become infected in situations with high disease pressure and even where fungicides are applied to the ear, infection can still result. Thus, under high disease pressure (crop following maize, minimum tillage, wet weather during flowering) resistant cultivars will not be sufficient to give high levels of control. Equally, under similar conditions, fungicides alone will not give high levels of control.

Figure 1: Mean DON levels for different preceding crops and tillage practices in Boigneville, France, from 1999-2004.
(Source: Arvalis, France)

Figure 2: Mean levels (over six trials, 2001-2004) of DON accumulation in cultivars as % of the median value.
(Source: Arvalis, France).

Figure 3: Resistance to Fusarium ear blight. A high figure equates to low levels of disease.
(Source: HGCA Recommended List 2008, UK).
Decision key for Fusarium risk assessment

The risk of Fusarium ear blight and mycotoxin production can be estimated in a number of ways and several published risk tools exist in different European countries. The common high-risk factors in each of these risk tools are the inclusion of maize in the rotation, particularly as the preceding crop, reduced or minimal tillage and rainfall during flowering.

The risk of Fusarium ear blight can normally be reduced by adjusting crop rotation, tillage methods and choice of resistant cultivars. If for various reasons these factors cannot be adjusted there can be a need for fungicide treatment to minimise disease levels. Application of fungicides are most effective during flowering but even at high doses they generally give only 50-60% control.

An example of a decision key in evaluating the risk level for DON in a given field is given in figure 4. In this example we can see that a combination of agricultural practices can drastically reduce the DON risk without the use of fungicides. The quantification of these risk levels is represented in figure 5. In some European countries wheat after wheat in combination with no ploughing also gives rise to an increase risk of Fusarium ear blight.

Grain sampling procedures for testing

It is good practice to sample every trailer load coming into a store, taking samples of at least 1kg. Composite samples, representing a given bulk, can be obtained by thoroughly mixing individual samples. Effective sampling for mycotoxins is essential as the distribution is not likely to be uniform within a stored bulk. If composite samples were not obtained as the store was loaded, it is important to take as many sub-samples of the bulk as possible to obtain a representative aggregate sample. For official control purposes, one hundred incremental 100g sub-samples are taken from any lot exceeding 50 tonnes (Commission Regulation 401/2006).

Typical life cycle of Fusarium species in wheat.