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Investigation of Fusarium mycotoxins in UK wheat production

by

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This is the final report of a project lasting for 60 months which started in April 2001. The work was carried out by Harper Adams University College and was funded by contracts of £56,771 from HGCA (Project No. 2452), £48,750 from the industry and £215,217 from the Food Standards Agency (Project No. CO4022), making a total of £320,738.

1.1 Executive summary

This five-year project started in 2001 to ascertain the effects of agronomic practices on concentrations of fusarium mycotoxins in UK wheat. It involved the collection of three hundred samples of wheat per year from fields of known agronomy over a number of seasons, which were analysed for ten trichothecenes, including deoxynivalenol (DON), and zearalenone. The mycotoxin content was modelled against the agronomic practices applied to each field to identify the impact of each agronomic factor (eg variety, cultivation and previous crop). The project anticipated the introduction of European Commission (EC) legislative limits for the fusarium mycotoxins, DON and zearalenone in cereals and cereal products. Legislative limits were introduced in 2006 for DON and zearalenone; a combined limit for HT2 toxin and T2 toxin (HT2+T2) will be introduced in the near future.

Fusarium mycotoxins are produced as a result of the disease fusarium ear blight caused by *Fusarium*. The most important ear blight pathogens are *F. graminearum* and *F. culmorum* which produce DON and zearalenone. It is known that weather conditions in the summer, particularly when the wheat crop is in flower in early summer, are critical for disease occurrence and severity.

Of the eleven mycotoxins analysed from field samples of wheat only seven were detected, of these only four, DON, nivalenol, HT2 and zearalenone were detected above 100 ppb. DON was the most frequently detected fusarium mycotoxin, present in 86% of samples, and was usually present at the highest concentration. The concentration of DON and the incidence and concentration of positive samples of HT2+T2 and zearalenone were modelled against agronomic practices applied to each field.

Year, region, previous crop, cultivation, variety and fungicide application all had statistically significant effects on DON concentration. Statistical tests of the predictive quality of the model indicated it may be a good predictor of new observations. There was a significant interaction between year and region, which is probably due to fluctuation in weather between years and regions. Highest concentrations were found in the south and east of England; lowest concentrations occurred in Scotland. There was also a significant interaction between previous crop and cultivation. This is probably due to the importance of crop debris in the epidemiology of ear blight. Highest predicted DON concentration occurred in wheat following maize, which is a known alternate host for *Fusarium* species. Ploughing generally reduced DON concentration; this reduction was greatest following maize, wheat and potatoes. Other recent studies in France and Germany have shown that the risk is greater after grain maize compared to forage maize, probably due to the greater amount of crop debris remaining. At the moment the acreage of grain maize in the UK is very low but it may increase in the future.

Varieties of UK winter wheat are assessed for ear blight resistance as part of the HGCA Recommended List trials. Results showed that varieties with a higher resistance had a lower predicted DON concentration. However, the current UK Recommended List has a limited range of resistance and would be classed as moderately susceptible compared to wheat varieties worldwide. There was no significant difference in the predicted DON concentration between organic and conventional samples. Within conventional samples, those which received an azole fungicide ear spray (T3 timing) had significantly lower DON than those which received no ear spray.

The effect of agronomy on zearalenone is likely to be similar to that for DON; however, owing to the low incidence of zearalenone this could not be analysed with the same statistical robustness. One difference that was identified was the significantly higher zearalenone concentration in samples of spring compared to winter wheat. This may be because spring wheat ripens slightly later in the season and zearalenone is known to be produced once the crop ripens, and therefore conditions may be more conducive to zearalenone production later in the summer.

The effect of agronomy on HT2 and T2 appeared to be different to that for DON and zearalenone. This is understandable as HT2 and T2 are produced by different *Fusarium* species than those which produce DON and zearalenone. One important difference was that high levels of HT2 and T2 occurred all over the UK with no decline towards the north, indicating that temperature is not a critical factor in HT2 and T2 production in the UK.

The percentage of samples which would have exceeded the newly-introduced legal limits varied between 0.4% and 11.3% over the five-year period. There was a good correlation between DON and zearalenone concentrations although the relative concentration of DON and zearalenone fluctuated between years, consequently more samples would have exceeded the zearalenone legal limit than the DON limit in some years but not in others. This is probably due to the fact that DON is primarily produced in early summer whereas zearalenone is produced in late summer. The wet weather in late summer of 2004 resulted in the highest relative zearalenone-to-DON ratio and the highest percentage of samples which would have exceeded both the DON and zearalenone limits.

Overall, the risk of UK wheat intended for human consumption exceeding the newly introduced legal limits is low, but the percentage of samples above these limits will fluctuate each season depending on the weather conditions during the summer months.

Results from this and other relevant studies have been used to inform the UK Code of Good Agricultural Practice to reduce fusarium mycotoxin in cereals issued by the Food Standards Agency (Anon, 2007).

The agronomic advice is summarised below:

a) Avoid maize as previous crop
b) Minimise previous crop residue on soil surface
c) Select resistant varieties
d) Consider an ear spray to control ear blight
e) Timely harvest