World climate change and mycotoxins in food and water

Plenary Keynote Lecture

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Climate change challenges food production. There will be massive problems in already hot countries in relation to obtaining food and water. However, mycotoxins are a crucial aspect of food safety affecting all countries, although only one paper referred directly to this in relation to climate change as reported in the first comprehensive review [1]. More specific predictions will be made in this current presentation on how climate change, as described in the 2007 Intergovernmental Panel on Climate Change (IPCC) report, will affect mycotoxins.

Temperature and water activity are crucial for fungal growth and mycotoxin production, although the optima for both are different. There are naive assumptions being made that warmer and more humid weather will increase all fungal growth and mycotoxin contamination: The situation is much more complicated than that. What can be said about how different climate change in the major areas of the world will affect mycotoxins in the crops? Some regions (e.g. tropical countries) may become too hot and dry for the survival of mycotoxigenic fungi. Could this lead to the extinction of *Aspergillus flavus* due to the near pasteurization temperatures? Certain crops may become liable to aflatoxins (AF) in currently cool climates and cold regions more susceptible to temperate problems, e.g. ochratoxin A (OTA), deoxynivalenol or patulin. In general, mycotoxigenic fungi with high temperature optima for growth will not be replaced by those with low. Fungi with low optima may be outcompeted by organisms with higher temperature ranges (e.g. *Fusarium verticillioides* may dominate most other toxigenic fungi as the growth optimum is high, as are the maxima for fumonisin production). AF contamination is unlikely to be replaced, to any large extent, by any of the other mycotoxins on this basis alone. The *Alternaria* toxins could be replaced by other mycotoxins as the optima for these compounds are particularly low. What other sensible predictions can be made?

Newly-introduced crops may be subject to fewer mycotoxin producing fungi as is known to occur with other pests on such plants (i.e. the 'Parasites Lost' phenomenon)? We may find peanuts being grown in parts of Europe without a concomitant AF problem. Which states in the United States of America will be able to grow novel crops and hence inherit (or not) the associated mycotoxin problem? The IPCC report states that soybeans will be grown much more frequently in Latin America as a result of climate change in a particularly specific prediction. Mycotoxins associated with this crop from that region will be required to be monitored much more closely: However, the crop is somewhat resistant to *A. flavus* and hence AF may not be problematic.

The issues in relation to humidity are even more complex as some regions will experience drought, and yet others greater precipitation. For example, the optimal temperatures for *A. flavus* and AF production are higher than *Aspergillus ochraceus* and OTA. *A. ochraceus* grows at lower water activities on soybeans and peanuts. In some regions the climate will become hotter and dryer and so which fungi would persist?

The mycotoxin issue also involves post-harvest scenarios and the general situation described above will also apply, although some fungi are restricted to the post harvest niche. Regions which can afford to control the environment of storage facilities by, for example, refrigeration, may avoid post-harvest problems although at high additional cost. Will the altered pre- and postharvest conditions lead to completely novel mycotoxins becoming a

threat? How will we detect these before they cause diseases? An important issue for investigation is the effect of mycotoxins *per se* on the succession of fungal invasion of crops. We need to determine definitively whether extensive AF production will inhibit other toxigenic fungi from growing on particular crops.

An area which has not been given sufficient consideration is that of the use of mycotoxigenic fungi and mycotoxins as bioweapons [2,3]. Regions, or countries, will be susceptible where climate change will allow growth of 'purposefully introduced fungi' (e.g. *A. flavus*), which can take advantage of the new conditions and ruin crops and/or cause human disease from ingestion of mycotoxins. Also, the introduction and natural growth of mycotoxigenic fungi in drinking water systems needs to be considered [4] as growth and mycotoxin production have been demonstrated conclusively in this commodity [e.g. 5]: How will climate change affect these possibilities? Furthermore, many fungal mycotoxins are mutagenic which may cause fungi to mutate on crops into strains which produce quantitatively or qualitatively different mycotoxins [1,6]. What will be the consequences with respect to novel strains if there will be more mycotoxins and at higher concentrations in the future? Many of these issues have not been considered and will be discussed in this presentation. In conclusion, action is required urgently to begin to address some of these complex issues.

References

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