

PREVENTION TO IMPROVE risk control



*Crop residue constitutes a reservoir of insect larvae and a perfect substrate for *Fusarium* and *Aspergillus* to develop.*

Weather conditions are a determining factor in the management of safety risks for grain maize. The use of agronomic action levers and of analysis tools is imperative in order to guarantee maize quality, from sowing to harvest.

The fungal complex that is likely to develop on maize includes some commonly found species at our latitude, such as *Fusarium*, but also *Aspergillus*, the presence of which is more sporadic. Those fungi can produce toxins, some of which are regulated. Access to animal feed and food for human consumption markets is subject to controlling the grain's safety quality.

Flowering time and the end of the maize cycle are susceptible stages

With optimum growth at 27°C, *Fusarium graminearum*, which produces DON (deoxynivalenol) and zearalenone, favours mild and damp conditions. *Fusarium verticillioides*, which produces fumonisins, favours drought and heat (optimum > 30°C). Finally, *Aspergillus*, which produces aflatoxins, best develops at 34°C. So far it has been very rare in the South of France, but it has become quite common in neighbouring Italy and Spain.

Weather conditions at flowering time, but also between 1st September and harvest, have a major impact on safety

quality. Besides optimal temperatures, rain is another factor of pathogen development that needs to be monitored. If it rains at flowering time, the risk analysis may be adjusted for September onwards, to help determine in advance which harvest strategy to adopt.

Likewise, rain at the end of the cycle provides pathogens with the moisture they need to continue their toxicogenic activity, with a greater impact if the maize has not yet fully matured.

ARVALIS-Institut du végétal, in partnership with the maize industry, carried out a survey of 2400 fields on farms all over France between 2003 and 2014. The agronomic history, pests found, and analysis of regulated *Fusarium* toxins at harvest time were characterised for each parcel. By 2007, the main factors responsible for the development of those toxins had been identified.



Giving yourself the best possible chance

The tunnels created by borers in the ears act as entry routes for *Fusarium* and *Aspergillus*. It is therefore imperative to protect the fields from European and Mediterranean corn borers when infestation levels warrant it. Depending on the location, vigilance is crucial if sowing is late or if a late variety is being used.

In order to stop the proliferation of pathogens, and therefore the accumulation of toxins in the grain, harvest must take place as soon as possible after maturity has been reached. The risk of compromising safety quality is undeniable if harvest takes place after 1st November. Until maize has been properly dried, the flora will keep developing and may produce mycotoxins. Harvest and drying work must therefore be coordinated in order to reduce the storage of wet maize to a minimum. A batch of wet maize should not be kept for more than 2 days.

ARVALIS has developed a DON and zearalenone risk assessment grid that helps estimate the safety quality of a grain maize parcel. It was produced by combining and prioritising the agronomic factors that have an impact on contamination levels. It allocates an agronomic risk category to each set of cropping techniques. In order to refine the risk analysis during the season, weather conditions, which are one of the main factors of mycotoxin production, must be taken into account. Unlike wheat, for which everything hinges around the flowering period, the month before harvest is when the final mycotoxin content of maize is determined. The end of the cycle often coincides with favourable conditions for the development of fungi and toxin production. The harvest date must therefore be optimised around those safety quality factors and adjusted accordingly in order to minimise risks.

First step: reducing crop residue

The management of the previous crop's residue is an essential agronomic action lever in order to control the safety quality of maize. Early chopping and incorporation of maize residue speeds up its decomposition before sowing, especially with direct drilling. It is a key step and has the advantage of making sowing easier (machines are less hampered) and of notably reducing the amount of substrate available for the development of *Fusarium* and *Aspergillus*. It limits the contamination level in the field. This operation also destroys European corn borers' and Mediterranean corn borers' larvae, which is a crucial benefit in monoculture rotations.

Varietal choice is the second action lever available to minimise the risk of *Fusarium graminearum* contamination. In order to acquire reference data, ARVALIS has established a specific research procedure: visual observations in varietal trials carried out for post registration and trials onto the Standing Committee on Plant Breeding's list (CTPS); trials in favourable conditions, in appropriate cropping areas and with varieties chosen for their appropriate earliness. A minimum of three trials is necessary for a variety to evaluate. Those ratings are used as the first *Fusarium graminearum* risk management tool in the field. However, so far there is no characterisation available for *Fusarium verticillioides*, as the diversity of possible sources of contamination affects the trials repeatability. At the moment, *Aspergillus* does not present enough of a challenge to warrant characterising varieties.

Varietal choice must also be adapted depending on the location. Cycle lags should be avoided and the earliness of the variety should be adapted to the region in question and an early harvest. This means making sure that the sowing date and the temperature expectations for that area will allow the chosen variety to reach physiological maturity.



Two contamination channels

Female flowering, just after silks have emerged, is a critical stage for maize; all the different *Fusarium* and *Aspergillus* species present at the time are likely to enter the ear through the silk channel. Weather conditions and the competitive dynamics within the fungal population are both determining factors.

Ear contamination can also be "opportunistic": *Fusarium verticillioides*, as well as *Aspergillus*, will establish even more easily if the plant is stressed. Water deficiency, lesions inflicted by borers, hailstones, and fungal infections already established on the grain are all potential points of entry for both pathogens.

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