"Fusarium spp. on maize in the Region wallonne: biodiversity and mycotoxin production"

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Abstract
In Belgium, 8.3 million tons of maize plants are harvested annually from 222,000 hectares of farm land and mainly used as livestock feed (www.statbel.fgov.be, 2007). However, crop quality is often reduced by ear and stalk rot due to Fusarium spp., and their associated mycotoxins are a serious problem for human and animal health (Wilson et al., 1990; Rheeder et al., 1992; Chu & Li, 1994). A large number of Fusarium species has been associated with ear and stalks rots (Bottalico, 1998; Logrieco et al., 2002). Gibberella red ear rot and Fusarium stalk rot are caused by F. graminearum and F. culmorum respectively, often associated with many additional Fusarium species. Maize pink ear rot is caused by F. verticillioides and F. proliferatum, sometimes associated with F. subglutinans and F. sporotrichioides. Some of those Fusarium species are able to produce mycotoxins of which important amounts are often found in maize silages. Nevertheless, it is established that the physico-chemical pro...

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Fusarium on maize in the Region wallonne: biodiversity and mycotoxin production

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Introduction

In Belgium, 0.3 million tons of maize plants are harvested annually from 222,000 hectares of farm land and mainly used as livestock feed (www.statbel.fgov.be, 2007). However, crop quality is often reduced by ear and stalk rot due to Fusarium spp. and their associated mycotoxins are a serious problem for human and animal health (Wilson et al, 1990; Rheder et al, 1992; Chu & Li, 1994).

A large number of Fusarium species has been associated with ear and stalks rots (Botello, 1998; Logrieco et al, 2002). Ogbennze and ear rot and Fusarium stalk rot are caused by F. graminearum and F. culmorum respectively, often associated with many additional Fusarium species. Fusarium ear rot is caused by F. verticillioides and F. proliferatum, sometimes associated with F. subgubliger and F. sporotrichioides.

Some of these Fusarium species are able to produce mycotoxins of which important amounts are often found in maize stalks. Nevertheless, it is established that the physico-chemical properties existing in slages (ph. acidiosa, 1%) prevent the growth of Fusarium spp. (Soudamire and Livessy, 1998). Mycotoxins are thus produced in the field.

The present project supported by the Région Wallonne aims to understand the dynamics of the various Fusarium species development during the cultural season, their biodiversity as well as their mycotoxin production. Two partners are associated with BINC/PAUL/CIP: the CARRH (Centre d’Agroécologie des Recherches Appliquées du Hainaut) and the CIPF (Centre Indépendant de Promotion Fongitique, UCL) who are in charge of field assays. The CARRH team also performed the mycotoxin detection and quantification.

Materials and methods

Three repeated assays have been performed in five geographic situations under different tillage and crop rotations, in 2005, 2006 and 2007. A total of 225 plants from three maize varieties presenting different stages of susceptibility to fusariosis have been collected at four physiological stages (R1-flowering stage, R4-dough stage, R5-dent stage, R6-maturity stage).

Small fragments of the stalk or ear and silks (up to R4 stage) from each maize plant were surface sterilized and put on Petri dishes for isolation of the fungi. Pure Fusarium strains were preserved on PDA and SNA in glass tubes, under sterile mineral oil.

Cultural characteristics of Fusarium species were assessed macroscopically and identification of isolates at species level was achieved by sequencing of several genes.

Results and discussion

Approximately 010 Fusarium sp. strains were isolated and are preserved at BINC/PAUL/CIP. A total of 23 Fusarium species were identified during this 3-year survey of which F. graminearum, F. crookwellense, F. avenaceum, F. culmorum and Fusarium sp. sim. NRRL 25622 were the most abundant (Fig. 1). Less than 2% of strains are represented by F. oxy Morph, F. verticillioides, F. avenaceum, F. subgubliger and F. sporotrichioides, F. trichothecum, F. subflavus, F. lentinum, F. sambucinum, F. ramorum, F. poae and F. solani (section “other Fusarium sp.” in figure 1).

An important number of maize plants were already contaminated at the R1 stage (86% of plants in 2006, 79% in 2005 and 72% in 2007), while no symptoms were visible. For the three years, the mean detection frequency of F. graminearum, F. crockwellense and F. culmorum increased all along the growing season (Fig. 2). Less than 33% of maize plants were contaminated with F. avenaceum at R1 stage but the frequency decreased to 19% at R6 stage. The percentages of occurrence of all other Fusarium spp. isolated in this 3-year survey stayed or decreased along the cultural season.

The different species of Fusarium tend to develop on different parts of the plant (Fig. 3). Indeed, F. crookwellense, Fusarium sp. sim. NRRL 25622, F. culmorum and F. equiseti develop mainly on maize stalks while F. moniliforme, F. poae and F. avenaceum are almost exclusively observed on ear and silks. Nevertheless, the predominant species, F. graminearum is detected with similar percentages on both stalks and ears. Mycotoxin analyses for the years 2005 and 2006 reveals deoxynivalenol and zearalenone contamination, but under the recommended levels (Fig. 4). No fumonisin and no T-2 toxin were found in the homogenized samples, although various producing species were present. Deoxynivalenol and zearalenone levels were partially correlated with the detection of F. graminearum (DON and ZEA producer) and F. crookwellense (ZEA producer).

Conclusion

Results of this 3-year investigation revealed a wide range of Fusarium spp. present on maize crop in Belgium. Furthermore, most of them have already been detected on plants from the flowering stage. This raises the question of a possible underestimated contribution of several species to the final fungal symptoms observed on plant at harvest. F. graminearum and F. crookwellense appeared to be more and more present along the growing season and represent the two major Fusarium species recovered from maize plants at harvest.

Results of an extensive 15-yield assay in 2008 will allow to analyze and to integrate the effect of varietal, cultural and climatic factors that concurs to the final expression of fusariosis. Greenhouse experiments and mycotoxicogenic profiles description in progress at MUCCL will allow a better understanding, specifying the relationships between the Fusarium spp. involved in the pathogenic complex as well as their mycotoxin production.

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