Fusarium graminearum mycotoxins associated with grain mould of maize in South Africa

B.C. Flett¹; A-L Boutigny ² & A. Viljoen ²

¹ARC-Grain Crops Institute, Private Bag X1251, Potchefstroom, 2520, South Africa, ²Department of Plant Pathology, University of Stellenbosch, Private Bag X1, Matieland 7602, South Africa.
Fusarium graminearum
mycotoxins associated with grain mould of maize in South Africa

Two distinct aspects to this project the first (collaboration with SU) will be presented by Prof Bradley Flett ARC-GCI and the second (collaboration with ARC-PPRI and UFS) by Prof Neal McLaren UFS
SYMPTOMS OF GIBBERELLINA EAR ROT
INTRODUCTION

- Gibberella ear stalk and root rot of maize (*F. graminearum*)
- Recent studies have divided the *Fusarium graminearum* species complex (FGSC) into a number of species/lineages
- Problems increased when rotated with other graminaceous hosts
INTRODUCTION

- Produce mycotoxins: DON, NIV and ZEA
- DON and NIV – protein synthesis inhibitors and cause anaemia, immunosuppression, haemorrhage, diarrhoea and emesis.
- ZEA – non-steroidal estrogenic mycotoxins – estrogenic symptoms
- Chemotyping of FGSC isolates
Complex of 13 species (FGSC) complex

- F. aethiopicum
- F. ussurianum
- F. graminearum
- F. gerlachii
- F. asiaticum
- F. vorosii
- F. acaciae-mearnsii
- F. boothii
- F. mesoamericanum
- F. austroamericanum
- F. cortaderiae
- F. brasilicum
- F. meridionale

- O'Donnell et al., 2000
- Ward et al., 2002
- O'Donnell et al., 2004
- Starkey et al., 2007
- O'Donnell et al., 2008
- Yli-Mattila et al., 2009
AIM

1) Determine distribution and co-occurrence of four *Fusarium* species and their mycotoxins (focus on FGSC)

2) FGSC of GER of maize in South Africa
MATERIALS AND METHODS
Distribution and co-occurrence of four *Fusarium* species and their mycotoxins

- Maize samples collected from 2 cultivars from 14 representative localities
- Real-time PCR used to quantify grain colonisation by the 4 major *Fusarium* species
- Multi-toxin analysis HPLC-MS was used to quantify mycotoxins
Results: 2008

average 2 cultivars
average locations

- **F. verticillioides**
  - *F. subglutinans*
  - *F. graminearum*

- **F. graminearum**
  - *F. subglutinans*

- **F. subglutinans**

Map of South Africa showing distribution of Fusarium species.
2009
average 2 cultivars
average locations

=> Infection higher in 2009

=> *F. graminearum* infection shifting

=> Risk in DON and ZEA contamination in maize high!

- *F. subglutinans*
- *F. verticillioides*
- *F. graminearum*
RESULTS – MYCOTOXINS OF GER

Log of the sum of type B trichothecenes and zearalenone and the log of the infection coefficient of *F. graminearum* was linearly correlated ($R^2 = 0.74$)
DISCUSSION

• In 2008 *F. graminearum* was the dominant species in the eastern production areas
• In 2009 ear rots were higher and similar tendencies were noted but *F. graminearum* became predominant in the Northwest Province as well
• DON and ZEA were well correlated with *F. graminearum* grain biomass
MATERIALS AND METHODS
FGSC of GER of maize in South Africa

• 100 isolates of FGSC from GER were collected from various localities throughout the South African maize production area

• Multilocus genotyping assay were used to determine FGSC species identity and trichothecene chemotype (Ward et al., 2008)

• One isolate was analysed further using sequence analysis and compared to other published sequences
RESULTS
FGSC of GER/FHB of maize/wheat in South Africa

<table>
<thead>
<tr>
<th>Host</th>
<th>Chemotype</th>
<th>NIV</th>
<th>3-ADON</th>
<th>N =</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wheat</td>
<td>93.1</td>
<td>6.1</td>
<td>0.7</td>
<td>277</td>
</tr>
<tr>
<td>Barley</td>
<td>99.3</td>
<td>0</td>
<td>0.7</td>
<td>148</td>
</tr>
<tr>
<td>Maize</td>
<td>100</td>
<td>0</td>
<td>0</td>
<td>100</td>
</tr>
<tr>
<td>Maize (roots)</td>
<td>86</td>
<td>14</td>
<td>0</td>
<td>35</td>
</tr>
</tbody>
</table>
RESULTS
FGSC of GER of maize in South Africa

• 99/100 GER isolates were *F. boothii* which is a 15-ADON chemotype

• 1/100 GER isolate was collected in Gauteng and it was found to be a interspecific hybrid between *F. boothii* and *F. graminearum*
DISCUSSION

FGSC of GER of maize in South Africa

- GER in South Africa is caused primarily by *F. boothii* which being a 15-ADON chemotype indicates that DON is the primary trichothecene.
- The FGSC of GER differs significantly to that of maize root and crown rot as well as that of FHB of wheat and barley.
CONCLUSION

• It appears that seasonal variation may affect the primary mycotoxins in maize production areas of South Africa

• GER is predominant in eastern production areas and may predominate in the north western production areas in South Africa

• The strong correlation between *F. graminearum* incidence and DON and ZEA indicates that these mycotoxins are a real threat in local maize production
CONCLUSION

• The predominance of *F. boothii* in the FGSC in GER indicates that the predominant trichothecene should be DON.

• The difference in the FGSC of GER and FHB counters the thought that wheat and maize rotations increase both diseases

• The hybrid isolate shows that there may still be some doubt as to whether the species within the FGSC are sexually incompatible
ACKNOWLEDGEMENTS

• Maize Trust and ARC-GCI for funding
• Collaborators: Todd Ward and Kerry O’Donnell from USDA Peoria IL, USA
• Collaborators: S. Zuhlke and M. Spiteller from Dortmund University of Technology, Dortmund, Germany
• Ms Belinda Janse van Rensburg for sample collection