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FUSARIUM HEAD BLIGHT: A SUMMARY OF THE SOUTH AFRICAN SITUATION

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ABSTRACT

In South Africa, the main causal organisms of Fusarium head blight (FHB) are *Gibberella zeae* (=*Fusarium graminearum*), *F. culmorum* and *F. crookwellense*. *Fusarium graminearum* and *F. culmorum* are associated with warmer regions, and *F. crookwellense* with cooler regions. Sporadic FHB outbreaks occur principally in the irrigation areas of the country. In favourable years significant damage is caused. Effective control has not yet been achieved through breeding for resistance or chemical control. Unsustainable crop management systems are currently aggravating the problem and extensive FHB research is required.

INTRODUCTION

Head blight of wheat was first noted in South Africa in 1980. Since then, the use of center pivot irrigation, increasing no-till practices and continuous wheat / maize (corn) cropping systems have resulted in epidemic outbreaks of FHB in 1985, 1986 (Scott, De Jager and Van Wyk, 1988), 1994 (Scott and Smith, 1995) and 2000 (unpublished data). FHB can cause yield reduction of up to 70% under high inoculum pressure and favourable environmental conditions. The aim is to give an overview on the status of research on FHB in South Africa and the challenges it present.

SUMMARY OF RESEARCH

The predominant organism associated with FHB in South Africa is *G. zeae*, comprising between 48.4% (Boshoff, Pretorius and Swart, 1998) and 83.9% of total isolates studied (Minnaar-Ontong and Kriel, 2005, unpublished data). According to O'Donnell (personal communication) there are four clades of *F. graminearum* in South Africa, of which two, *F. graminearum* and *F. boothii*, are associated with FHB. Molecular screening using Amplified Fragment Length Polymorphisms (AFLPs) to distinguish between a representative collection of isolates is currently in progress. The AFLPs have already been standardised for reference isolates of *F. graminearum*, *F. crookwellense*, *F. avenaceum*, and *F. culmorum*, with outgroups including *F. sambucinum*, *F. pseudograminearum* and *F. equiseti* (Philippou, Herselman and Kriel, 2005, unpublished data). The results have shown that it is possible to use AFLPs to distinguish between these species which are difficult to differentiate morphologically. Current morphological data show *F. culmorum* to be the 2nd most important species in warmer regions (Minnaar-Ontong and Kriel, 2005, unpublished data), and *F. crookwellense* in the cooler regions (Boshoff et al., 1999a). Fusaria associated with maize stalk and cob rots include *F. verticillioides*, *F. subglutinans* and *F.graminearum* (Rheeder, Marasas, and Van Schalkwyk, 1993). Since *F. graminearum* is pathogenic on maize and wheat, disease control under current crop production systems in the irrigated areas are difficult.

Chemical control has proven to be ineffective in the reduction of FHB in the irrigation areas of South Africa. This could be due to varying flowering periods of wheat under large centre pivot irrigation systems (some exceeding 64 ha), thus complicating the timing of fungicidal spays. The efficacy of chemical control is also influenced by insufficient coverage obtained with aerial application and low efficacy of fungicides under field conditions. Boshoff et al. (1999b) found prochloraz (EC_{50}=0.027-0.337 μg/ml), bromuconazole (EC_{50}=0.415-1.126 μg/ml) and tebuconazole (EC_{50} = 0.45 μg/ml) to be the most effective against *F. graminearum* and *F. crookwellense* *in vitro*, but differences were noted in the sensitivity of isolates.

It has been claimed that infected wheat seed is responsible for the introduction of *Fusarium* spp. in new wheat irrigation areas. The control of seedborne *Fusarium* spp. was tested with six seed treatment fungicides at three different dosages. The chemicals included two concentrations of tebuconazole (15 g/L and 60 g/L), two different formulations of carboxin/thiram (200/200 g/L), difenoconazole (30 g/L) and guazatine/tebuconazole (300/15 g/L). Results indicated a reduction of *Fusarium* colonization of the seed from 77.5% in the control to an average of 12.3% in the treated seed. Identification of the remaining isolates revealed the treatments to be ineffective against the Discolor section of *Fusarium*, including *F. graminearum* and *F. culmorum*. *Fusarium* spp. in the Liseola section, including *F. proliferatum* and *F. verticillioides* were controlled by the seed treatments (Kriel and Minnaar-Ontong, 2005, unpublished data).

Scanning electron microscopy studies revealed no differences in the infection processes employed by *F. graminearum* and *F. crookwellense*(Boshoff et al., 1999a). The fungus colonizes the anthers extensively, establishing itself in the floret. This is followed by penetration of the lemma and palea through stomata or wounds. The glumes, rachis, grain and peduncles are only colonized later. Bleached, necrotic symptoms can be seen on infected florets 4 days after inoculation. *Fusarium graminearum* is more pathogenic than *F. crookwellense*, with more extensive colonization of the head shown in artificial inoculation studies on the wheat cultivar Palmiet (Boshoff et al., 1999a).

Mycotoxin research in South Africa is performed by the Medical Research Council. Isolates of *G. zeae* (Group 1 and 2) and *F. crookwellense* were tested for mycotoxin production (Sydenham et al., 1991). Two chemotypes were identified within *G. zeae* Groups 1 and 2. Most isolates from wheat (crowns and scabby kernels) produced deoxynivalenol (DON), but none produced nivalenol (NIV) or fusarenon-X (FUS-X). Isolates from maize did not produce DON, but most produced NIV and / or FUS-X. All but one isolate of *G. zeae* produced zearalenone (ZEA). In the *F. crookwellense* isolates tested, none produced DON, all produced NIV and ZEA, and the majority produced NIV.

Suitable crop rotation systems for irrigation areas of the country are limited due to socio-economic factors. A possible rotation crop suggested by many agriculturalists is barley. Data from the US and Canada stated that FHB is more severe on barley than on wheat. FHB of barley has not been noted in SA before. Greenhouse trials were conducted to determine the relative susceptibility of SA barley cultivars, along with a susceptible wheat control, to *F. graminearum* cultures isolated from wheat (De Villiers, Kriel and Pretorius, 2004, unpublished data). Results indicated SA barley cultivars to be susceptible to FHB after artificial inoculation under controlled conditions, although the disease did not spread as fast as in wheat heads. The lack of symptoms in production fields could be attributed to morphological differences between the heads of barley and wheat.

Current SA cultivars do not have genetic resistance to FHB, but differences in tolerance have been noted (Scott, De Jager and Van Wyk, 1988). Some cultivars escape disease due to flowering windows not corresponding with favourable environmental conditions. Results of greenhouse trials of cultivar resistance were met with scepticism by many role players in the industry. Long term field data along with the introduction of resistant germplasm are necessary to clarify the status of commercial cultivars, but the sporadic nature of the disease and unfavourable conditions for disease development during the last three seasons have hampered progress in this regard. Some seed companies are breeding for resistance to FHB and the first cultivars with resistance incorporated from Sumai 3 sources should be available for commercial production within the next year or two (Koekemoer, Monsanto, personal communication).

REFERENCES

Boshoff, W.H.P., Pretorius, Z.A. and Swart, W.J. 1998. *Fusarium* species in wheat grown from head blight infected seed. S. Afr. J. Plant Soil 15:46-47.

Boshoff, W.H.P., Pretorius, Z.A. and Swart, W.J. 1999a. A comparison of head infection and blight development caused by *Fusarium graminearum* and *Fusarium crookwellense* in wheat. S. Afr. J. Plant Soil 16:79-84.

Boshoff, W.H.P., Pretorius, Z.A. and Swart, W.J. 1999b. *In vitro* differences in fungicide sensitivity between *Fusarium graminearum* and *Fusarium crookwellense*. African Plant Protection 5:65-71.

Rheeder, J.P., Marasas, W.F.O. and Van Schalkwyk, D.J. 1983. Incidence of *Fusarium* and *Diplodia* species in naturally infected grain of South African maize cultivars: A follow up study. Phytophylactica 25:43-48

Scott, D.B., De Jager, E.J.H. and Van Wyk, P.S. 1988. Head blight of irrigated wheat in South Africa. Phytophylactica 20:317-319.

Scott, D.B. and Smith, J. 1995. Aarskroei – 'n nuwe bedreiging vir koring onder spilpunt besproeiing langs die Oranjerivier (*Head blight – a new threat for wheat under centre pivot irrigation adjacent to the Orange river*). In: Course in small grain production for agricultural advisors. Small Grain Institute, Bethlehem, South Africa. 109-110.

Sydenham, E.W., Marasas, W.F.O., Thiel, P.G., Shepard, G.S. and Nieuwenhuis, J.J. 1991. Production of mycotoxins by selected *Fusarium graminearum* and *F. crookwellense* isolates. Food Additives and Contaminants 8:31-41.

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