Fusarium Head Blight in South America – an Argentinean perspective of breeding for resistance and future prospects

Virginia L. Verges, MSc.
Outline of Talk

A brief introduction to the Don Mario wheat breeding program
Background to Fusarium in Argentina
Current status – varietal resistance
Historical strategies for deploying resistance
Current strategies
Future prospects
Argentina has 5 million hectares of wheat planted every year.

The area with the greatest surface of wheat, the “pampas”, has a temperate climate with the main rainfall events during autumn and spring.

The Pampas region has intensive agriculture, with a typical three year (and thus very short) rotation,
Year 1 maize (corn)
Year 2 soybean
Year 3 wheat-soybean (double crop)

70% of the annual crop production in Argentina is carried out under no/low till conditions.

The presence of the previous crop stubble on the soils, provides an ideal environment for sustaining different pathogens. In the case of Fusarium the pathogen that colonizes the stubble will survive for 1-2 years.
Argentina Wheat Yields 1910-2012
Don Mario Wheat Breeding

Relatively young program – Don Mario started testing third party material in 2002

Initiated own breeding program in 2007

Collaborative agreements for germplasm exchange and development with European breeders

Recognises the value of public:private partnerships to develop new varieties for Argentina
Historical Perspective – 1

FHB is a problem every year but severe epidemics occur every 8-10 years – 1945/6, 1978, 1985, 1993, 2001, 2012

Yield losses per year average 20-30%

In severe epidemic years losses can exceed 50%

Consequential grain quality degradation – loss in confidence by growers and damage to export opportunities
Argentina has a long history of exporting high quality wheat to the world market

Increased levels of maize (corn) cultivation > increased levels of inoculum

The introduction of semi dwarf European wheat varieties with low resistance to *Fusarium spp* enhanced the threat

Short rotations increased pressure

Min/ No till further increased pressure
Historical control measures

Genetics:
Historically good levels of resistance in local varieties (Inta-Klein)
Era of good resistance of material sourced from Brazil (2003)

Chemistry:
No routine use of fungicides > demands for new and more resistance in high yielding varieties
Historical perspective of breeding for FHB resistance in Argentina

Assessments carried out on an annual basis in the Estacion Experimental Agropecuaria Marcos Juarez (INTA). First reported in 1997.

Assessments carried out using artificial inoculations of local isolates of \textit{F graminearum}.

Varieties screened from global collections and information made publicly available for the wheat breeding community in Argentina.
Introductions with high resistance
China 7, Fan 1, Ning 8343, Nobeoka Bozu, Nyubai, Pekin 8, Shanghai≠5, Sumai 3, Suzhoe≠6, YMI≠6

Germplasm from CIMMYT and South America
Catbird, CEP 75203, Chum/Seri, Frontana
Kvz/3/Tob/Cfen//Bb/4/Blo/F35.70/Mo/Nac/6/Bow, Kvz-K 4500
L.A.4 OC 813, Pampeano, Pel 73101, Pel 74142, PF 7815,
WRM/Ptm/Coc/Ning 68026

Old and modern local cultivars
Biointa 2005, Buck Charrúa Cargill Trigal 706 Don Mario Cronox
Klein Atlas, Klein Cacique Klein Orión, Klein Pegaso, La Paz
INTA, Las Rosas INTA, Prointa Federal, Prointa Federal, Prointa
Granar, Prointa Granar, Prointa Molinero, Vilela Sol

Based on Galich 2004 with modifications
Current state of knowledge

QTLs for FHB resistance have been found on all chromosomes – confirming the complexity of resistance

Some QTLs were found in several mapping populations indicating stability and therefore useful for breeding programs

The most validated QTL is *Fhb1* on chromosome 3BS from Sumai 3

First hybridizations in Argentina believed to be at INTA in 2004

Ref: Bainotti et al 2013
Deployment of *Fhb1* in Argentina

Local cultivars with good levels of resistance were used in order to ‘pyramid’ the resistance factors.

In 2006 four F2-BC2 populations were assessed to detect homozygous plants and material progressed using field selection > lines for trial.

In 2012 3 lines from Prointa Puntal, 27 from Prointa Oasis, 4 from Biointa 3000 and 19 from Prointa Granar backgrounds > Yield trials.

2 lines based upon Prointa Oasis have been advanced to Regional yield Trials in Argentina.

Ref: Bainotti et al 2013
Deployment of Other resistance factors in Argentina

Crosses with material based upon Prointa granar but which did NOT have *Fhb1* showed lower levels of infection than Sumai 3

Suggests the presence of second source of FHB resistance from Prointa granar but additive to *Fhb1*

QTL mapping projects are being carried to confirm this hypothesis

In addition additional mapping populations are being carried out with other sources of resistance

Ref: Bainotti et al 2013
Current Use of different resistance sources in the Don Mario program

Sumai 3 material: Segregating populations
South America/ Cimmyt material (Brazilian sources)
Cronox crosses at different evaluation levels: Some lines in advanced trials close to registration process.
New Initiatives

University of BA: marker development for Don Mario marker laboratory (based in Brazil)

University of La Plata: Collaboration with a PhD thesis project.

Author: Ing. Agr. Sebastián Staltari¹

Advisors: Dr. María del Carmen Molina¹ and Dr. Jose Costa².

1. Phytotechnical Institute of Santa Catalina (NU of LP, Argentina).
2. University of Maryland - USDA (USA).
New Initiatives

Objectives

Identify molecular markers linked to scab resistance genes using recombinant inbred lines (RILs) derived from a cross between an Argentine resistant wheat (exp. Line from INTA with a new source of resistance) and a susceptible Indian cultivar Sonalika.

Experiments

• Are being carried out simultaneously in three conditions.
  Field evaluation in Chacabuco (Don Mario Semillas, Chacabuco, Argentina).
  Field evaluation in Salisbury (UMD, USA).
  Evaluation under controlled conditions at University of La Plata.

Molecular analysis

• Currently being processed data from 8555 SNPs markers (USDA – NCSU).
Future Prospects - Conclusions

Complete genetic control of Fusarium spp in a high pressure environment such as Argentina is unlikely in the short term.

There are known resistance sources from a wide range of material but the genetics are complex with a high number of QTLS spread across the wheat genome.

Molecular markers provide a valuable opportunity to enhance resistance.

Field selection will continue to play a significant role in the Don Mario wheat program – aligned to research on QTL discovery and MAS.

Growers should look to control measures used elsewhere in the world including an integrated approach using genetics and chemistry.

Don Mario see this integrated approach as being the most efficient and effective control mechanism in the short to medium term.

A GM approach to controlling this problem would be welcomed for long term control.
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