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

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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

Background situation/context…

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

Historical Perspective – 2

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 *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 that 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.

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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 Salysbury (UMD, USA).

  Evaluation under controlled conditions at University of La Plata.

Molecular analysis

- Currently being processed data from 8555 SNPs markers (USDA – NCSU).


Current season (2013) Field selection

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


DONMARIO
SEMILLAS
TRIGO

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THANK YOU!