Wheat Rust surveillance and monitoring activities

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Ethiopia WHEAT CRP Review, Nov 2017
Outline

• Races of current concern
• 2017/18 Season
• Early Warning / Forecasting
• New Directions
Races of Concern

- **Stem Rust**
- *Sr 24* virulent race **TKFTP** detected in 2016 (variant of Digalu race?)
- **TTTTTF** (4TF) races
  - Different entities under same name!
  - new incursion into the region with implications for durums+

- **Yellow Rust**
- Af2012 Yellow rust detected in 2016
- Several varieties susceptible – Digalu, Huluka++
- (New complex virulence in Kenya?)
Pgt population structure

Les Szabo
Genotyping: *P. graminis* TTTT isolates

- **Italy (Sicily 2016) race TTTTTF**
  - Genotype: Clade III-B (TTRTTF)
    - Egypt, Eritrea, Georgia, Iraq and Italy

- **Kenya (2015) race TTTTTF**
  - Genotype: Clade IV-B (TKTTF)
    - Egypt, Eritrea, Ethiopia, Kenya, Tanzania and Yemen

- **U.S. (2001) race TTTTTF**
  - Genotype: New clade
    - Brazil and U.S.
Dispersal Patterns

Much better understanding of migration routes and probabilities

Quantifying airborne dispersal routes of pathogens over continents to safeguard global wheat supply

M. Meyer\(^1\*\), J. A. Cox\(^1\), M. D. T. Hitchings\(^1\), L. Burgin\(^2\), M. C. Hort\(^2\), D. P. Hodson\(^3\) and C. A. Gilligan\(^1\*\)

Infectious crop diseases spreading over areas pose a threat to food security. One of the obligate pathogenic fungus *Puccinia graminis* f. sp. *tritici* (*Pgt*), causing the crop disease wheat scab, has been detected in East Africa and the Middle East, leading to substantial economic losses and threatening the livelihoods of farmers. The majority of commercially important wheat cultivars worldwide are susceptible to the disease which poses a risk to global wheat production. Airborne fungal spores transmitting the disease can cover regions and even continents\(^1\text--}^3\). To reduce the risk, we need to better understand how spores are dispersed from commercially suitable landscapes. We quantify how spores are dispersed from suitable landscapes using comprehensive modeling and field surveys in Africa, the Middle East and Central/South America. The results provide insights into the environmental suitability of landscapes and the spore dispersal rate, which in turn suggests strategies to minimize the risk of disease spread.
2017/18 Season
2017/18 Season

- High incidence of yellow rust in Belg / early season surveys
- Early warning given
- Frequent Rust Advisories
- Good control in many areas
- Pockets of yellow rust - on Digalu with no control
- Stem rust low incidence

Wheat Rust Advisory No. 2
7 Aug 2017

Wheat Rust Advisory – risk assessment of wheat rust outbreaks and spread in Ethiopia

Summary Period: 21 July – 7 Aug 2017

Summary:
- Surveys undertaken in Arsi Robe district (2-3 Aug 2017) indicate yellow rust is widespread on early growth stage (tillerine) crops.
- Yellow rust was observed on 10 out of 10 fields surveyed in Arsi Robe
- Varieties infected included: Ogolcho, Huluka, Sanate, Lemu (all susceptible with high infection of yellow rust), plus Danda’a, and Hidasse also infected. Ogolcho was the most widely planted variety in Arsi Robe.
- **Yellow rust is building up at a very early growth stage and is likely to be an early and significant source of inoculum for the main Meher season.**
- Dispersal forecasts (1st Aug through to 12th Aug 2017) from Jeju district, Arsi

Belg Surveys - Yellow Rust Incidence (Late July - Early Aug)
No rust
Tillering-Boot

YR: Trace (2 fields)
14-15 Sept

SR: Trace –20% Inc/Sev
YR: Trace -5%
13-16 Sept
11 Districts, 54 fields
Tillering

YR: 5MS – 20S

YR: Trace-5%
Tillering-Stem elongation

SR: Trace (11-15 Sept)

SR: 10% Inc, 5% Sev
YR: Trace (11-15 Sept)
Boot

YR: Trace

No rust
15 districts, 72 fields (17-25 Sept)
Tillering – Boot (S Wello)
Tillering-Heading (N Wello)

YR: Trace

SR: Trace

YR: Trace

YR: Trace-30%

YR: Trace-60%

YR: Trace-5%
Emergence

SR: Trace (11-15 Sept)
Inc, 5%
Sev

YR: Trace

13-16 Sept

11 Districts, 54 fields
Tillering
Early Warning Framework - Ethiopia

Spore dispersal for weekly forecast

Dispersal + Suitability → Risk

Extension
Crowdsourced
2 million subscribers

Field Survey

Near real-time data

EIAR Central Unit (17 centres)

MoA
Regions
Ext

Early warning for action
Real-Time Phone Surveys - YR

Yellow rust incidence (%)
- N/A: 4
- None (0%): 83
- Low (1-20%): 49
- Medium (21-40%): 13
- High (>40%): 32
- Not Specified: 6

Display options without data
Real-Time Phone Surveys - SR
Real-time Dispersal Forecast Example
New Directions

- DNA Fingerprinting – host
- Real-time Diagnostics
DNA Fingerprinting
2016/17 Wheat Sampling

- 432 kebeles from four regions (253 kebeles also sampled in 2014/15)
- Final samples + surveys = 3771 (90% of original target!)
- Large, representative sample of main wheat growing areas
  - Varieties
  - Traits
  - Environments
Major Wheat Varieties: Where are they?

- Variety genotype data
- Focus on most prevalent varieties sampled
- Kakaba; Kubsa; Danda’a; Digalu
DNA vs Farmers' Report - Variety Count per Kebele - KAKABA

DNA Sequencing report

Farmers' Report

Variety Count Per Kebele
Kakaba
- 1
- 2
- 3
- 4
- 5
- 6
- 7
- 8
- 9
- 10

- Kakaba: No. 1 Prevalence (DNA samples)
- Released 2010 – Rust Resistant (APR)
- Mismatch in distributions (e.g., Amhara)
Kubsa: No. 2 Prevalence (DNA samples)
- Released 1995 – Rust Highly Susceptible
- Huge mismatch in distributions
- Major implications
• Danda’a: No. 3 Prevalence (DNA samples)
• Released 2010 – Rust Resistant (APR)
• Mismatch in distributions (e.g., Amhara)
Digalu: No. 4 Prevalence (DNA samples)
• Released 2005 – Rust highly susceptible
• Match in distributions (distinctive variety)
Durum Prevalence (DNA samples)

Large Mismatch in distributions

NB: Most DNA durum – Arendato (old landrace). Very few new releases detected
Unclassified samples – majority mix of tetraploid and hexaploid
Stem Rust Resistance Gene – Sr24

- Major concern
- Increasing prevalence, due to increasing number of varieties with Sr24
- Race virulent to Sr24 detected in Ethiopia in 2016/17
- Those in risk zone priority for replacement / fungicide awareness
The Pathogen: 
*Puccinia Striiformis f.sp Tritici*
“a shifty, changing, constantly evolving enemy”

The Technology: MinION mobile sequencing + Field Pathogenomics

Welcome to the Future of Pathogen Diagnostics
Innovation – Mobile, Pathogen diagnostics real-time

Usability – Low $, in-country deployment

Data Driven Diagnostics

Early Warning Alert + Control

New!

Impact

Scalability

Other pathogens, countries, crops

Risk Forecast

Data Integration
Summary

• Identifying races of concern
• Better understanding of movements / incursion potential
• Surveillance working well + improving
• Forecasting options being implemented + good information flows
• New Tools to add value
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