Improved early-warning of yellow and stem rust on wheat

Mogens Støvring Hovmøller et al.
Professor, Dept. Agroecology, Aarhus University
Global Rust Reference Center
mogens.hovmoller@agro.au.dk

New races of wheat rust fungi emerge and spread at increasing distance and speed

Sveriges lantbruksuniversitet
Swedish University of Agricultural Sciences

ENGLISH | STUDENTWEBB | MEDARBETARWEBB | BIBLIO

Utbildning Forskning Miljöanalys Samverkan Om SLU

start ew / Svartrostangrepp på vete i Uppland tyder på att en besegrad fiende är tillbaka

SLU-nyhet

Svartrostangrepp på vete i Uppland tyder på att en besegrad fiende är tillbaka

PUBLICERAD: 01 NOVEMBER 2017

Svartrost har länge setts som en veteodlingens böldpest - en tidigare fruktad skadegörare som har oskadliggjorts och inte längre behöver uppmärksammas. Sommaren 2017

NEWS IN FOCUS

PHYSICS Inside the lesser-known lab in Italy hunting for gravitational waves p.146

DISEASE Biological-resources treaty could threaten supply of flu vaccine p.148

EPIDEMIOLOGY US child study rises from ashes of failed attempt p.149

BIOLOGY How to eavesdrop on a developing baby p.156

PASCAL ROSSIGNOL/REUTERS

Wheat crops in Europe — the world's largest wheat-producing region — have not been seriously troubled by stem-rust fungi since the 1950s.

AGRICULTURE

Wheat rust back in Europe

and could spread.

-grown strains of wheat, including
ties that are usually highly resistant
The team is now studying whether
l crops are just as susceptible.
urther concern, the centres say that
rains of another wheat disease, yel-
ave been spotted over large areas
t time — one in Europe and North

GRRC GLOBAL RUST REFERENCE CENTER

You are here: wheatrust.org News and events **News item**

SEVERE EPIDEMICS OF WHEAT YELLOW RUST IN ARGENTINA

In 2017, Argentina faced the worst epidemics of yellow rust since the 1930s. Based on samples collected at 22 epidemic sites in September, the Global Rust Reference Center (GRRC) has identified at least three distinct yellow rust genotypes. Two of these were identical to genotypes first detected in Europe and North Africa in 2015-16.

2018.02.09 | JENS GRØNBECH HANSEN

Figure 1. Rust contaminated machinery early in the growing season, September 2017, Los Cisnes, La Carlota, Cordoba province, Argentina. Photo: Ing. Agr. Juan Pablo Ioele. Click on the photo to enlarge.

The Argentina epidemic in 2017

The epidemics affected more than three million hectares resulting in high inoculum load that could pose a threat to surrounding wheat areas in the forthcoming 2018 crop season, in case of rust-conducive environmental conditions.

For the first time, yellow rust epidemics spread to warmer areas such as Santa Fe, Córdoba, Entre Ríos and Buenos Aires provinces in 2017. Seven of the most susceptible wheat varieties had average leaf coverage of almost 50% already at early crop growth stages. Field trials in epidemic areas showed average yield losses of 3.7 t/ha (53%) and up to 4.7 t/ha (71%) in severe cases, where the disease was not controlled.

In recent years, the occurrence of yellow rust in Argentina has only been

- 2018
- February 2018: 2 articles
- 2017
- December 2017: 1 item
- September 2017: 1 item
- June 2017: 2 articles
- May 2017: 1 item
- March 2017: 1 item
- February 2017: 2 articles
- 2016
- October 2016: 1 item
- March 2016: 2 articles
- January 2016: 1 item
- 2015
- July 2015: 1 item
- January 2015: 1 item
- 2014
- August 2014: 3 articles
- 2013
- June 2013: 1 item
- May 2013: 1 item

GRRC GLOBAL RUST REFERENCE CENTER

e here: wheatrust.org News and events **News item**

SESSING THE STEM RUST SITUATION IN VESTERN SIBERIA

Up to 2014 wheat stem rust was not considered of major importance in Western Siberia, but severe epidemics in 2015 and 2016 has changed the situation. New research to resolve stem rust epidemiology in the region and additional efforts in breeding for rust resistance is urgently needed.

2017.09.04 | JENS GRØNBECH HANSEN

Photo2. Prof . Vladimir Shaminin (Omsk Agrarian State University) inspecting wheat plots at Omsk Agrarian State University with Dr Alexey Morgunov (CIMMYT) and Prof. Mogens Hovmøller (GRRC, Aarhus University)

Based on report by: Dave Hodson, Mogens Hovmøller, Alexey Morgunov, Elena Salina and Vladimir Shamanin

During the period 14-18th Aug 2017 a field trip was made to the Omsk, Novosibirsk and Altai Krai regions of Western Siberia, Russian Federation by CIMMYT and the Global Rust Reference Center, Aarhus University.

- 2018
- February 2018: 2 articles
- 2017
- December 2017: 1 item
- September 2017: 1 item
- June 2017: 2 articles
- May 2017: 1 item
- March 2017: 1 item
- February 2017: 2 articles
- 2016
- October 2016: 1 item
- March 2016: 2 articles
- January 2016: 1 item
- 2015
- July 2015: 1 item
- January 2015: 1 item
- 2014
- August 2014: 3 articles
- 2013
- June 2013: 1 item
- May 2013: 1 item
- February 2013: 1 item

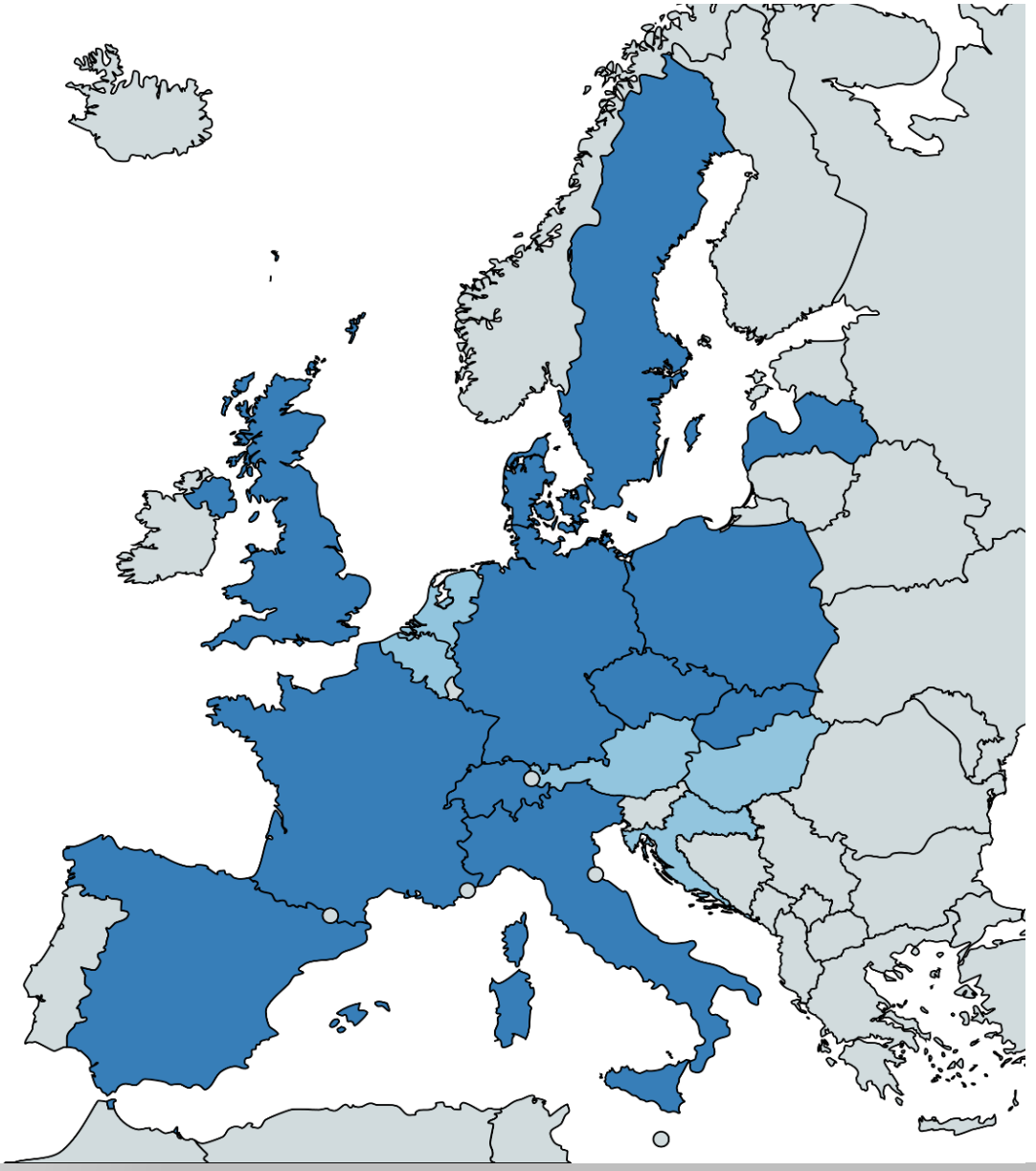
Contact GRRC

The Borlaug Global Rust Initiative Network

Cornell University

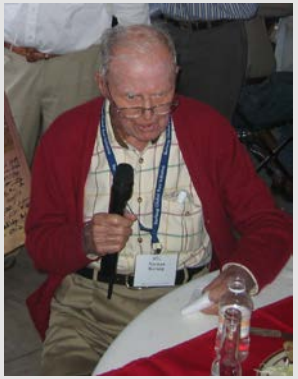
BGRI
Borlaug Global Rust Initiative

RustWatch – A new European early-warning system for wheat rust diseases (2018-2022)

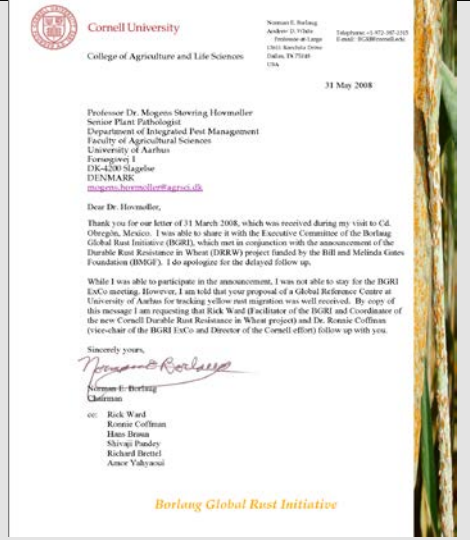


RUSTWATCH
WHEAT RUST EARLY WARNING

Global Rust Reference Center, www.wheatrust.org, - a key rust diagnostic facility in the Borlaug Global Rust Initiative (BGRI) www.globalrust.org



Dr. Borlaug – Marts 2009
Cd. Obregon, Mexico



Cornell University
College of Agriculture and Life Sciences

31 May 2008

Professor Dr. Mogens Skovring Howmøller
Senior Plant Pathologist
Department of Integrated Pest Management
Faculty of Agricultural Sciences
University of Aarhus
Forsøgsvej 1
DK-4200 Slagelse
DENMARK
mogens.howmoller@agrsci.dk

Dear Dr. Howmøller,

Thank you for our letter of 31 March 2008, which was received during my visit to Cd. Obregón, Mexico. I was able to share it with the Executive Committee of the Borlaug Global Rust Initiative (BGRI), which met in conjunction with the announcement of the Durable Rust Resistance in Wheat (DRRW) project funded by the Bill and Melinda Gates Foundation (BMGF). I do apologize for the delayed follow up.

While I was able to participate in the announcement, I was not able to stay for the BGRI ExCo meeting. However, I am told that your proposal of a Global Reference Centre at University of Aarhus for tracking yellow rust migration was well received. By copy of this message I am requesting that Rick Ward (Facilitator of the BGRI and Coordinator of the new Cornell Durable Rust Resistance in Wheat project) and Dr. Ronnie Coffman (vice-chair of the BGRI ExCo and Director of the Cornell effort) follow up with you.

Sincerely yours,

Norman E. Borlaug
Chairman

cc: Rick Ward
Ronnie Coffman
Hans Braun
Shivaji Pandey
Richard Brettel
Amor Yahyaoui

Borlaug Global Rust Initiative

- Global Rust Reference Center (GRRC) hosted by Aarhus University, DK, established in 2008 on request from CIMMYT, ICARDA and the BGRI.

- GRRC (original) mandate: Receive samples of rust infected wheat at any time of the year from any country - to provide a global view of race diversity and dynamics of yellow/stripe rust and black/stem rust.

- GRRC has expanded scientifically and technically: ~ 1 - 1½ M € /year (2011-2018),10-12 full-time scientists/technicians/students, unique rust quarantine facilities, stock isolate collections, online data management by the Wheat Rust Toolbox.

- GRRC hosts world-wide collection of > 25,000 stock isolates of rust fungi (including the ”Stubbs-collection”) and has access to year-round rust quarantine facilities.

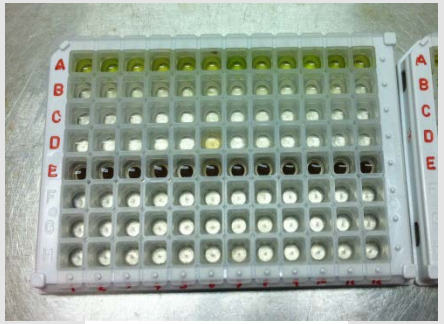
AARHUS UNIVERSITY

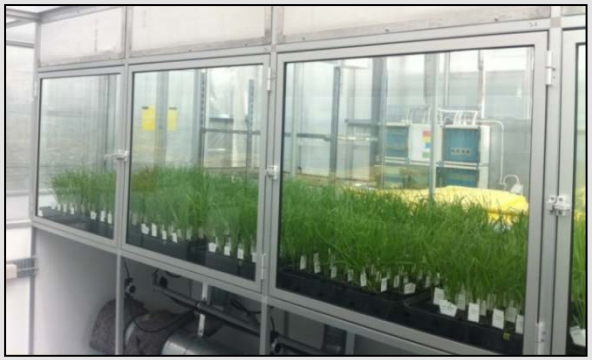
GRRC

Race typing and genotyping of rust isolates:
Handling of incoming samples of rust infected wheat

Rust in previous resistant wheat variety

Spore multiplication





Race test in quarantine green house

Fasttrack

DNA-genotypning

Results analysed in European/global context: Wheat Rust Toolbox www.wheatrust.org

DNA-genotyping using SSR in lab

Impact of new races on rust susceptibility in wheat

Inoculated nurseries in field or green house

Exotic (new) race: Adult plant susceptibility in quarantine green house

DK race: Adult plant susceptibility in field nurseries

Smitteforsøg af sorter i marken forår/sommer

DISEASE SURVEY MAPPER

Year: ○ 2018 ◉ 2017 ○ 2016 ○ 2015 ○ 2014 ○ 2013 ○ 2012 ○ 2011 ○ 2010 ○ 2009 ○ 2008 ○ 2007

Country: ☑ All ☑ Argentina ☑ Azerbaijan ☑ Bangladesh ☑ Bhutan ☑ Eritrea ☑ Ethiopia ☑ Georgia ☑ India ☑ Iraq ☑ Islamic Republic of Iran ☑ Italy ☑ Kenya ☑ Morocco ☑ Nepal ☑ Pakistan ☑ Russian Federation ☑ Rwanda ☑ Tajikistan ☑ Tanzania ☑ United States of America ☑ Uruguay ☑ Uzbekistan

Disease: ○ Stem rust ○ Leaf rust ◉ Yellow rust

Severity: ☑ All ☑ N/A ☑ None (0) ☑ Low (less than 20 %) ☑ Moderate (20 - 40 %) ☑ High (more than 40 %)

Growth stage: ☑ All ☑ Tillering ☑ Boot ☑ Heading ☑ Flowering ☑ Milk ☑ Dough ☑ Maturity ☑ N/A

Legend: None (0) Low (< 20 %) Moderate (20 - 40 %) High (> 40 %) N/A

Show Help

Number of observations: 4652

To many observations to show details for ecah observation. Consider filtering to show less observations.

Wheat Rust Toolbox

Home | Wheat Rust survey | Wheat Rust isolates | Wheat Rust samples | Barberry | Trap nurseries | Country overview | Partners | Developer

Welcome Mogens S. Hovmøller logout

Survey

Overview | Survey mapper | Importance of Rust in surveys

Year: ○ 2018 ○ 2017 ◉ 2016 ○ 2015 ○ 2014 ○ 2013 ○ 2012 ○ 2011 ○ 2010 ○ 2009 ○ 2008 ○ 2007

Country: ☐ All ☐ Argentina ☐ Azerbaijan ☐ Bangladesh ☐ Bhutan ☐ Ecuador ☐ Eritrea ☐ Ethiopia ☐ India ☐ Iraq ☐ Islamic Republic of Iran ☐ Kenya ☐ Lebanon ☑ Morocco ☐ Nepal ☐ Pakistan ☐ Tanzania ☐ Turkey ☐ Uruguay ☐ Uzbekistan

Disease: ○ Stem rust ○ Leaf rust ◉ Yellow rust

Severity: ☑ All ☑ N/A ☑ None (0) ☑ Low (less than 20 %) ☑ Moderate (20 - 40 %) ☑ High (more than 40 %)

Growth stage: ☑ All ☑ Tillering ☑ Boot ☑ Heading ☑ Flowering ☑ Milk ☑ Dough ☑ Maturity ☑ N/A

Legend: None (0) Low (< 20 %) Moderate (20 - 40 %) High (> 40 %) N/A

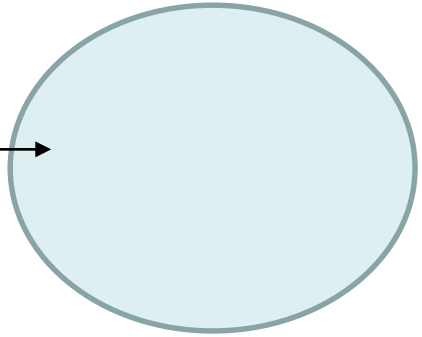
Show | Help

Number of observations: 95

2016

One unique genotype/ race

2017



GRRC

Wheat Rust Toolbox

Home | Wheat Rust survey | Wheat Rust isolates | Wheat Rust samples | Barberry | Trap nurseries | Country overview | Partners | Developer

Welcome Mogens S. Hovmøller logout

Survey

Overview | Survey mapper | Importance of Rust in surveys

Year: ○ 2018 ◉ 2017 ○ 2016 ○ 2015 ○ 2014 ○ 2013 ○ 2012 ○ 2011 ○ 2010 ○ 2009 ○ 2008 ○ 2007

Country: ☐ All ☑ Argentina ☐ Azerbaijan ☐ Bangladesh ☐ Bhutan ☐ Eritrea ☐ Ethiopia ☐ Georgia ☐ India ☐ Iraq ☐ Islamic Republic of Iran ☐ Italy ☐ Kenya ☐ Morocco ☐ Nepal ☐ Pakistan ☐ Russian Federation ☐ Rwanda ☐ Tajikistan ☐ Tanzania ☐ United States of America ☐ Uruguay ☐ Uzbekistan

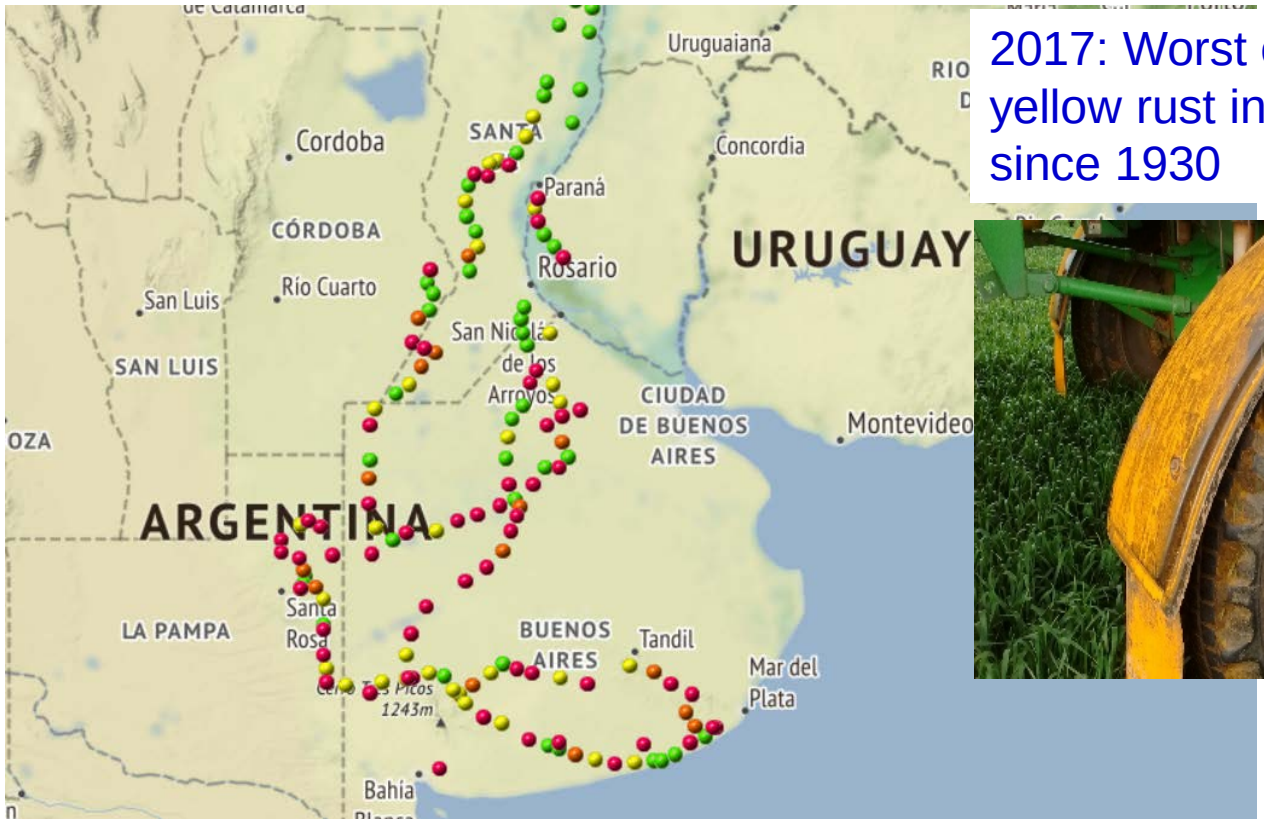
Disease: ○ Stem rust ○ Leaf rust ◉ Yellow rust

Severity: ☑ All ☑ N/A ☑ None (0) ☑ Low (less than 20 %) ☑ Moderate (20 - 40 %) ☑ High (more than 40 %)

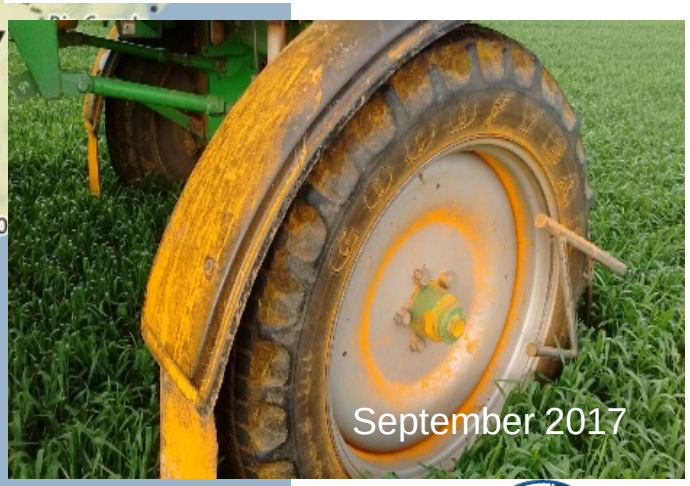
Growth stage: ☑ All ☑ Tillering ☑ Boot ☑ Heading ☑ Flowering ☑ Milk ☑ Dough ☑ Maturity ☑ N/A

Legend: None (0) Low (< 20 %) Moderate (20 - 40 %) High (> 40 %) N/A

Show



2017: Worst epidemic of yellow rust in South America since 1930

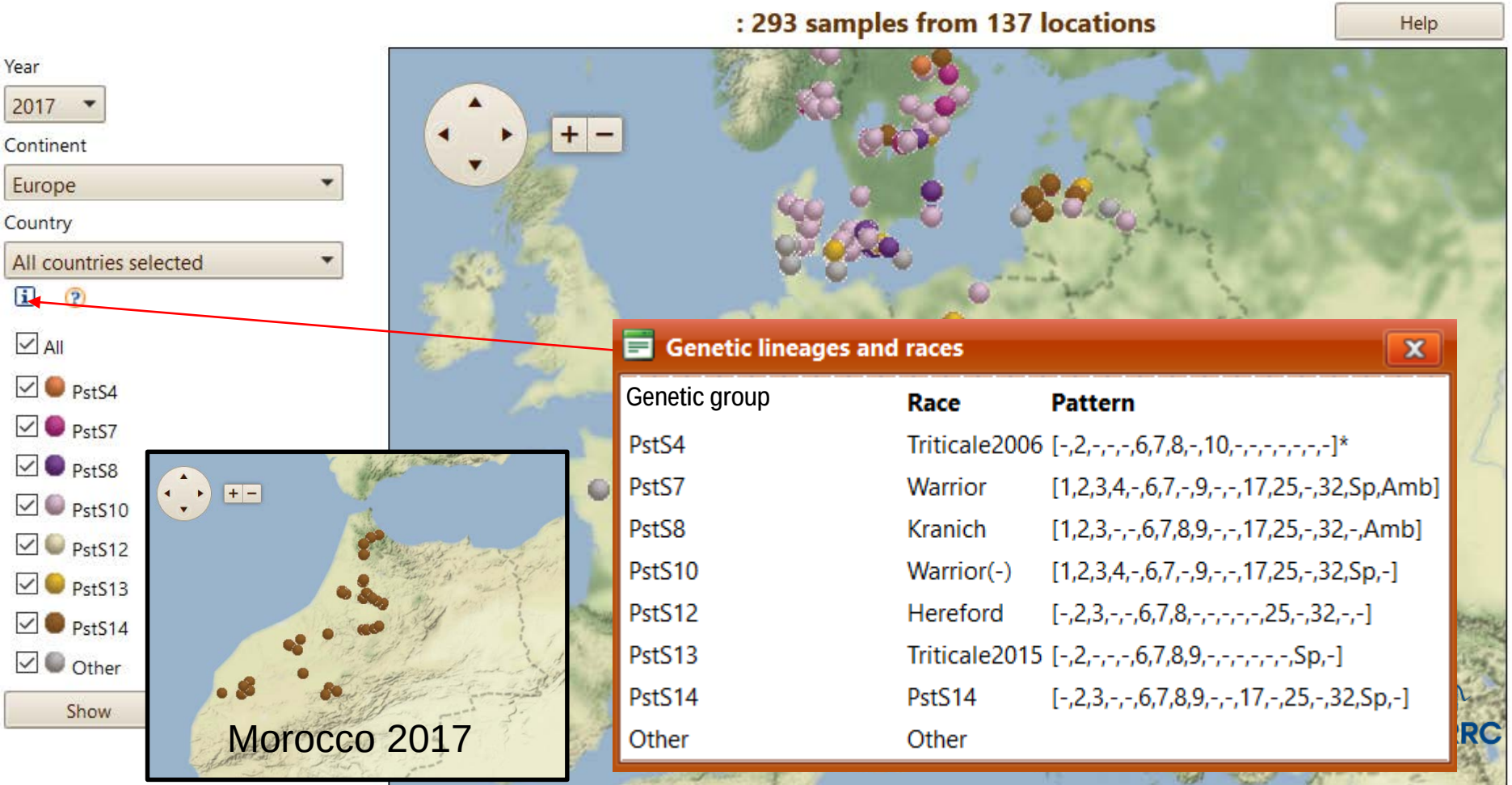


GRRC

Races and genotypes in Europe

You are here: wheatrust.org Yellow Rust Tools - maps and charts **Genetic lineages on single locations**

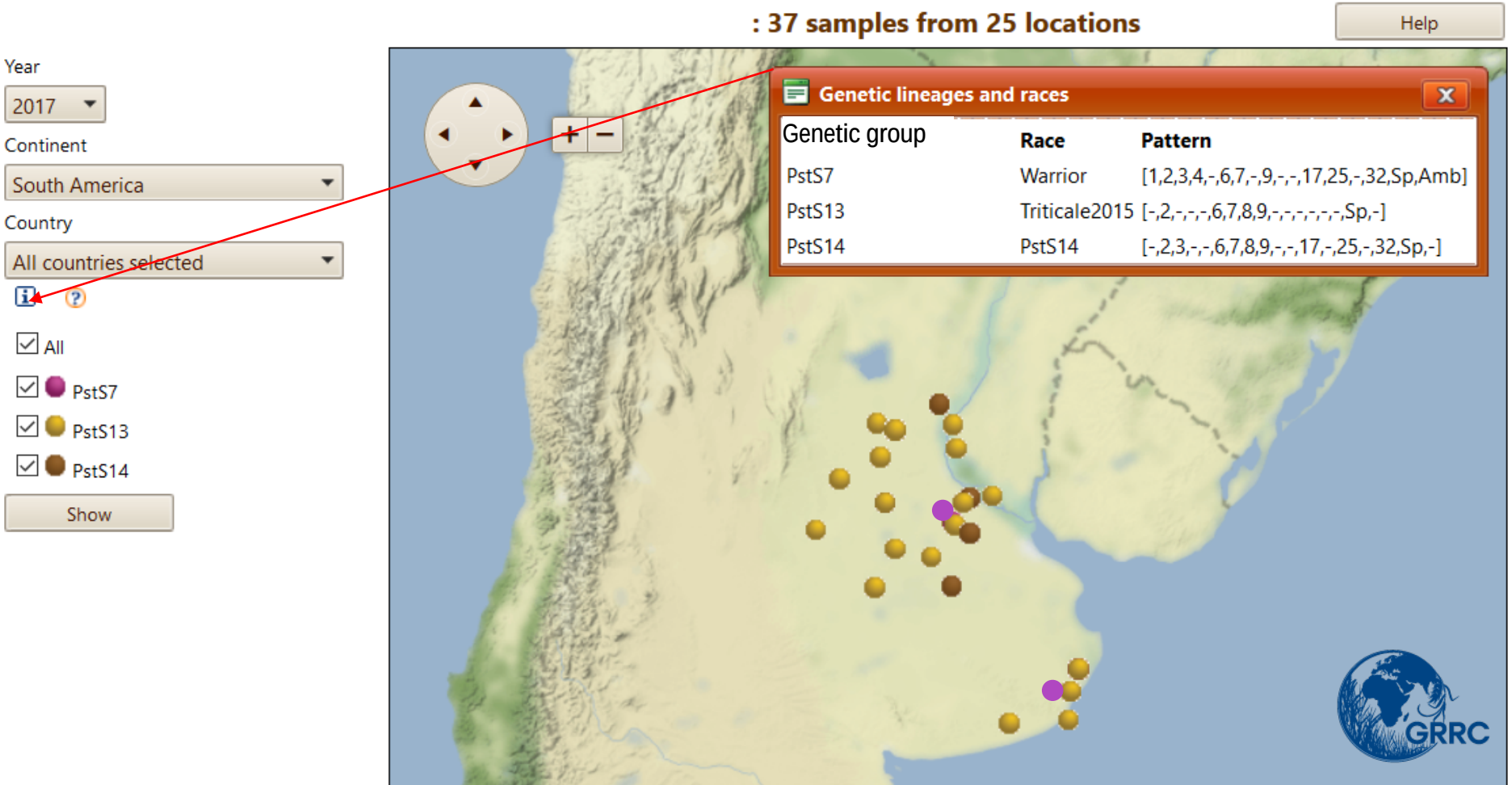
GENETIC GROUPS ON SINGLE LOCATIONS



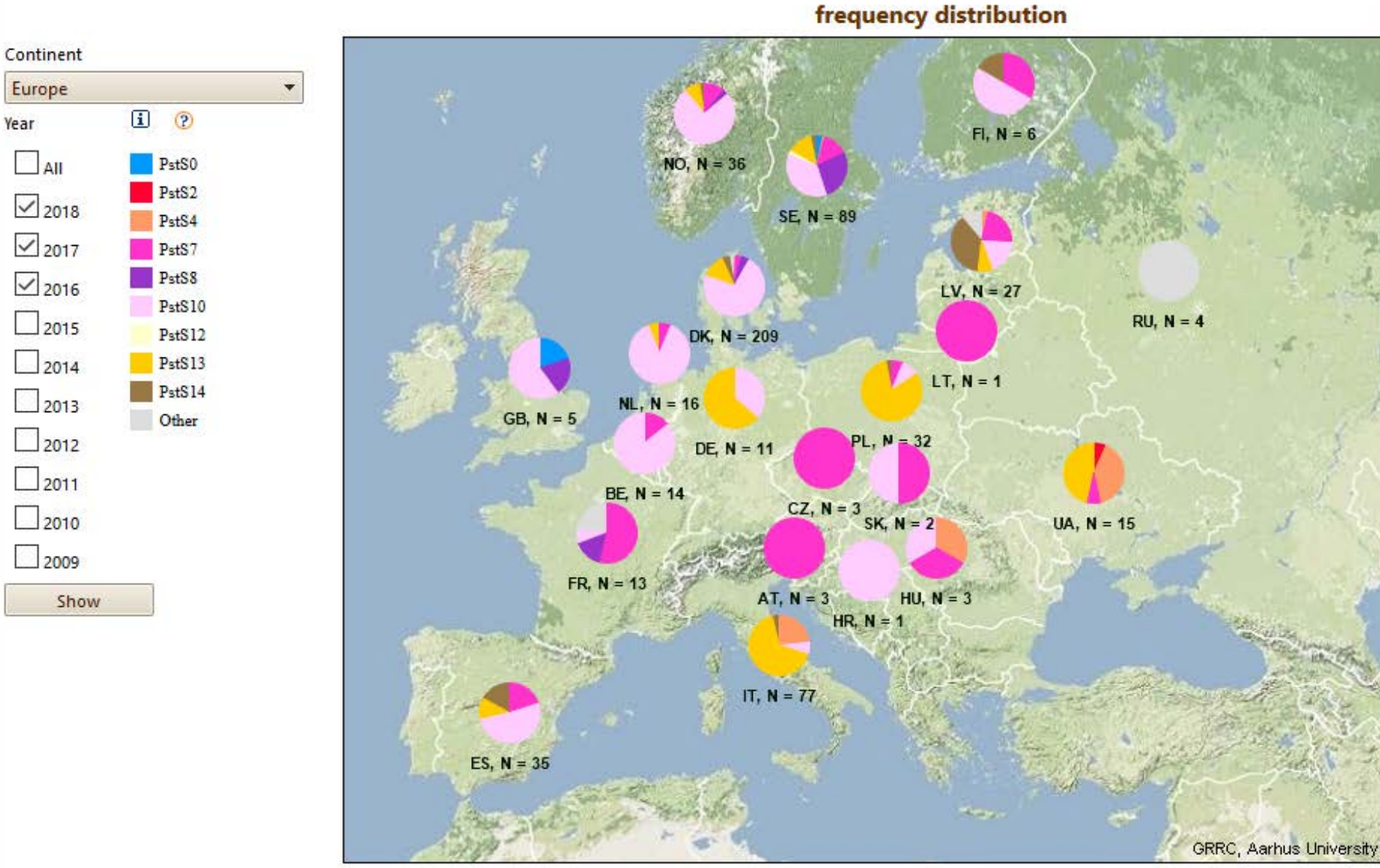
Global yellow rust update: Highlights 2017

You are here: wheatrust.org Yellow Rust Tools - maps and charts **Genetic lineages on single locations**

GENETIC GROUPS ON SINGLE LOCATIONS



Genetic groups of yellow rust in Europe



Inoculated nurseries with for Swedish cultivars, 3 races 2018

	Kalmar race		Oakley race		PstS14 race	
Sort	29.05.2018	16.06.2018	29.05.2018	16.06.2018	29.05.2018	16.06.2018
Anja	7.5	7.5	4.3	4.3	21.3	21.3
Oakley	25.0	25.0	12.5	17.5	25.0	25.0
Substance	9.2	9.2	8.3	9.2	11.7	11.2
Brons	0.0	0.0	0.0	0.0	0.0	0.0
Ceylon	0.0	0.0	0.0	0.0	0.0	0.0
Ellen	0.0	0.1	0.0	0.0	0.0	0.0
Ellvis	4.3	5.2	0.0	0.3	0.0	0.0
Etana	0.0	0.0	0.0	0.0	0.0	0.0
Festival	0.0	0.0	0.0	0.0	0.0	0.0
IMPOSANTO	0.0	0.0	0.0	0.0	0.0	0.0
Informer	0.0	0.0	0.5	2.3	0.0	0.0
Julius	8.3	8.3	0.0	1.7	0.5	0.7
KWS Ahoi	3.3	4.2	0.0	2.0	0.1	0.1
KWS Kerrin	1.0	1.0	0.0	0.0	0.0	0.0
KWS Talent	0.0	0.0	0.0	0.0	0.0	0.0
Linus	0.0	0.0	0.8	0.8	0.0	0.0
Mariboss	0.0	0.0	0.0	0.0	0.0	0.0
Memory	0.1	0.1	0.0	1.0	1.8	1.8
Nordh	0.0	0.0	0.1	1.3	0.0	0.0
Norin	0.0	0.0	0.0	0.0	0.7	0.7
Praktik	0.0	0.0	0.2	0.2	0.0	0.0
RGT Reform	0.0	0.0	0.7	0.7	0.0	0.0
RGT Treffer	0.0	0.0	0.2	0.2	0.0	0.0
Rockefeller	0.0	0.0	0.2	0.2	0.0	0.0
SJ L632	0.0	0.0	1.7	4.3	0.0	0.0
Stava	0.2	0.4	0.0	0.0	0.0	0.0
Stinger	0.0	0.0	1.5	2.8	0.3	0.3
SW 15394 (Inese)	0.0	0.0	0.0	0.0	0.0	0.0
SW 15423 (Hacksta)	1.4	2.3	0.0	0.3	0.0	0.0
SW 15541 (Hellas)	0.0	0.0	0.0	0.0	0.0	0.0
SW 15646 (Hallfreda)	0.0	0.0	0.0	0.0	0.0	0.0
Torp	0.3	0.3	5.2	7.5	0.0	0.0

Wheat stem rust back in Sweden

Uppland 2017

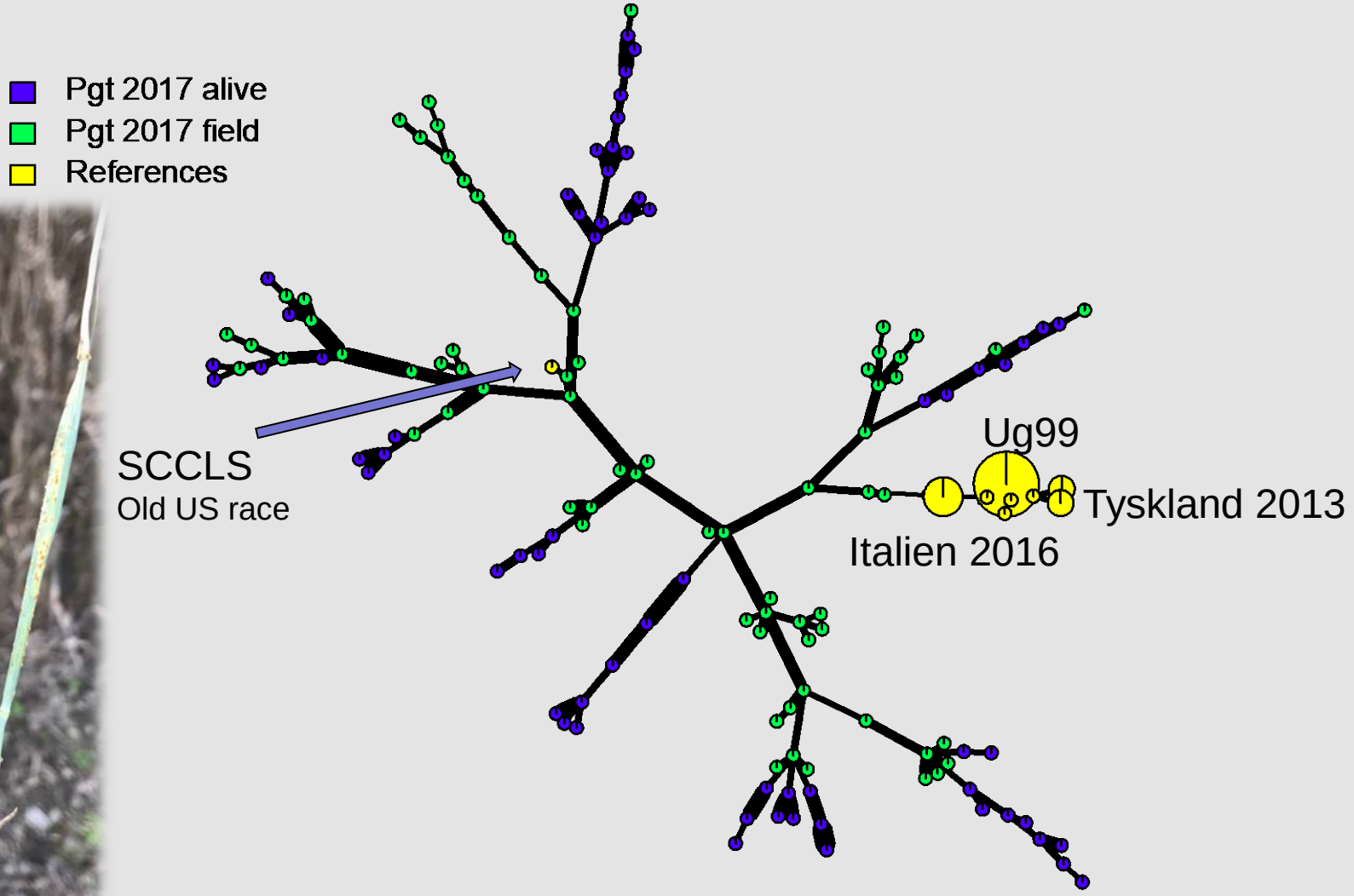
- **Sent sått vårvete, Diskett**
- **Symptom hittades på höstvete, korn och vilda gräs i omgivningen**
- **Ytterligare en lokal ca 20 km bort –symptom på höstvete**
- **Inga andra fynd**

Vårvete med telia, September 2017

Anna Berlin, SLU

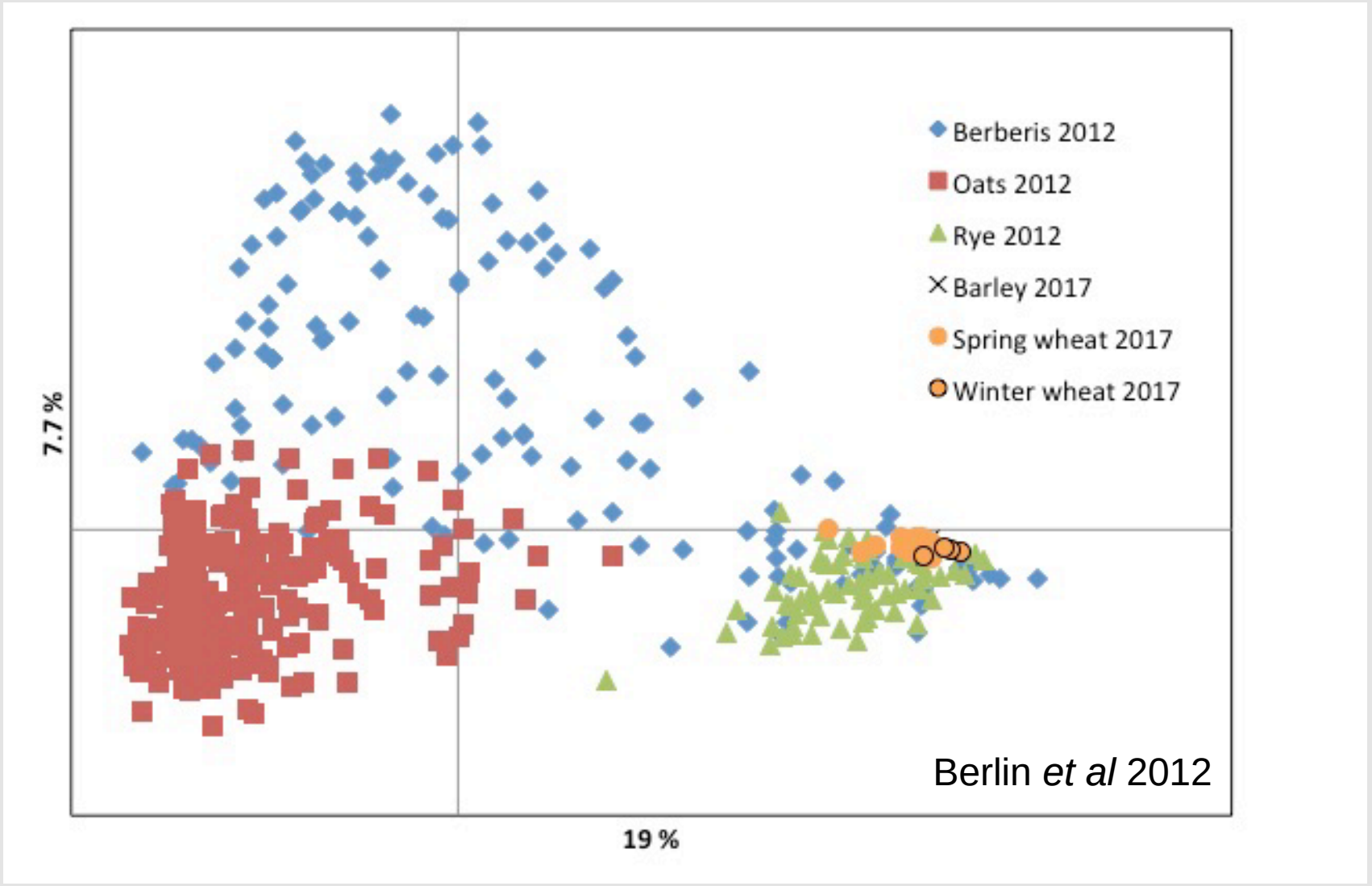
Genetic diversity and relationship with ”known” races

MSN Bruvo distance, boostrap 1000



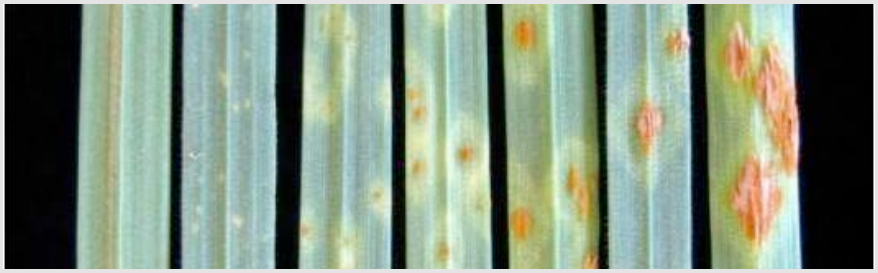
Anna Berlin, SLU

Jämförelse med studien från 2012



Huge diversity of races

20 North Americal differential lines ++



- Identified races
- Fixed virulences: *Sr5, Sr8a, Sr9a, Sr17, SrMcN*
- Fixerade avirulences: *Sr9e, Sr11, Sr24, Sr30, Sr31, Sr36, SrTmp*

LDCSC	Sr9d, Sr10
LFCLC	Sr9g
LFCNC	Sr9g, Sr10
LFHLC	Sr9b, Sr9g
MFCNC	Sr7b, Sr9g, Sr10
MKCNC	Sr6, Sr7b, Sr9g, Sr10 ⇦
QFCLC	Sr9g, Sr21
QFCSC	Sr9d, Sr9g, Sr10, Sr21 ⇦
QKCNC	Sr6, Sr9g, Sr10, Sr21
RFCNC	Sr7b, Sr9g, Sr10, Sr21
RFCSC	Sr7b, Sr9d, Sr9g, Sr10, Sr21
RKHNF	Sr6, Sr7b, Sr9b, Sr9g, Sr10, Sr21, Sr38 ⇦
QDCNC	Sr10, Sr21

		Populationer och enkelt raser fra Uppland 2017					Kenya (Ug99)	Sicilien (2016)
Typ	Sort	Popula-tion	Popula-tion	QFCSC	MFCNC	RKHNF	TTKST	TTRTF
Höstvete	Axioma	R	R	R	R	R	S	S
	Brons	S	S	S	S	S	S	S
	Ceylon	S	S	S	S	S	S	S
	Ellen	R	R	R	R	R	S	R
	Ellvis	S	S	S	S	S	S	S
	Etana	R	R	R	R	R	S	R
	Festival	S	S	S	S	S	S	S
	IMPOSANTO	S	S	S	S	S	S	S
	Informer	S	R	S	S	S	S	S
	Julius	S	S	S	S	S	S	S
	Kalmar	S	S	S	S	S	S	S
	KWS Ahoi	S	S	S	S	S	S	S
	KWS Finn	S	S	S	S	S	S	S
	KWS Kerrin	S	S	S	S	S	S	S
	KWS Talent	S	S	R	S	S	S	S
	Linus	S	S	R	S	R	S	S
	Mariboss	S	S	S	S	S	S	S
	Memory	R	R	R	R	R	S	R
	Nordh	S	R	S	S	S	S	S
	Norin	S	S	S	S	S	S	S
	Praktik	S	S	S	S	S	S	S
	RGT Reform	S	S	S	S	S	S	S
	RGT Treffer	S	S	R	S	S	S	S
	Rockefeller	S	S	S	S	S	S	S
	Schotch	S	S	R	R	R	S	R
	SJ L632	S	S	S	S	S	S	S
	SJ M1090	R	R	S	R	S	S	S
	Stava	S	S	S	S	S	S	S
	Stinger	S	S	S	S	S	S	S
	SW 15394 (Inese)	S	S	S	S	S	S	S
	SW 15423 (Hacksta)	S	S	S	S	S	S	S
	SW 15541 (Hellas)	S	S	S	S	S	S	S
	SW 15646 (Hallfreda)	S	S	S	S	S	S	S
	Torp	S	S	S	S	S	S	S
Vår-korn	Flair	S	R	R	R	R	S	S
	KWS Chrissie	R	R	R	R	R	S	R
	KWS Irina	R	R	R	R	R	R	R
Vår-vete	WPB Oryx	R	R	R	R	R	R	R
	WPB Skye	R	R	R	R	R	R	R
	Zenon	S	S	R	S	S	S	S

Seedling respons to of Swedish cultivars to new stem rust population:

2 bulk populations, 3 single raes and 2 reference isolates

Key features of RustWatch

Management and networks



Project Coordinator

Management support team:

- Emilia Alegria: Admin & budgets
- Annemarie F Justesen: Science
- Jens G Hansen: Communication & data management

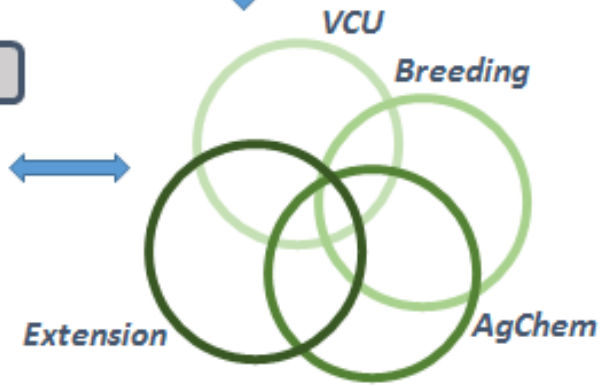
ExCom
WP leaders and network coordinators

Work packages

1	2	3	4	5

Denmark
UK
Sicily
Switzerland
Spain

Case study regions



Stakeholder networks

Key collaborators

- R. Singh, CIMMYT MX; D. Hodson, CIMMYT ET.
- K. Nazari, ICARDA
- Y. Jin, L.Szabo, CDL-Minnesota, US
- S. Ali, Agr. Univ. Peshawar, PK
- Rust diagnostic labs FR (C. Pope), DE (K. Flath), UK (S. Holdgate), PL (P. Czembor), +
- A. Berlin, J. Yuen, Uppsala University, Gunilla Berg (Jordbruksverket), HIR Malmöhus
- J.K.M. Brown, C. Uauy, D. Saunders, JIC (UK)
- Australian National University & CSIRO: B. Schwessinger, M. Ayliffe
- H. Thordal-Christensen (DK, KU)
- Sejet Plant Breeding, Nordic Seed A/S
- Agr. Advisory Services, DK, SE, ES, LV
- 24 partners H2020 initiative (2018-2022)
- > 50 people submitting wheat rust samples from Asia, Africa and South America

GRRC-team Aarhus University Flakkebjerg

BILL & MELINDA GATES foundation

UKaid from the British people

The Danish Council for Strategic Research

gudp

Sejet Planteforædling

ICARDA CIMMYT

AARHUS UNIVERSITY

BGRI Borlaug Global Rust Initiative

Jordbruksverket

Nordic Seed