

Update on Ug99 (race TTKS) of Wheat Stem Rust

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Stem Rust in North America

Last major epidemic was in the 1950's (race 15B);
40% losses in Northern Plains

The pathogen population has been very stable

QFCS (>90%) 2003-06

RCRS & QFCS (>90%) 1998-2002

TPMK 1971-97

QCCJ 1989-93

QFCS 1978-83, 88-94

Factors contributing to the stability:

- Widespread use of resistant cultivars
- Reduction in population size
- A lack of sexual recombination (Barberry eradication)
- The bottleneck of overwintering

Ug99 is TTKS

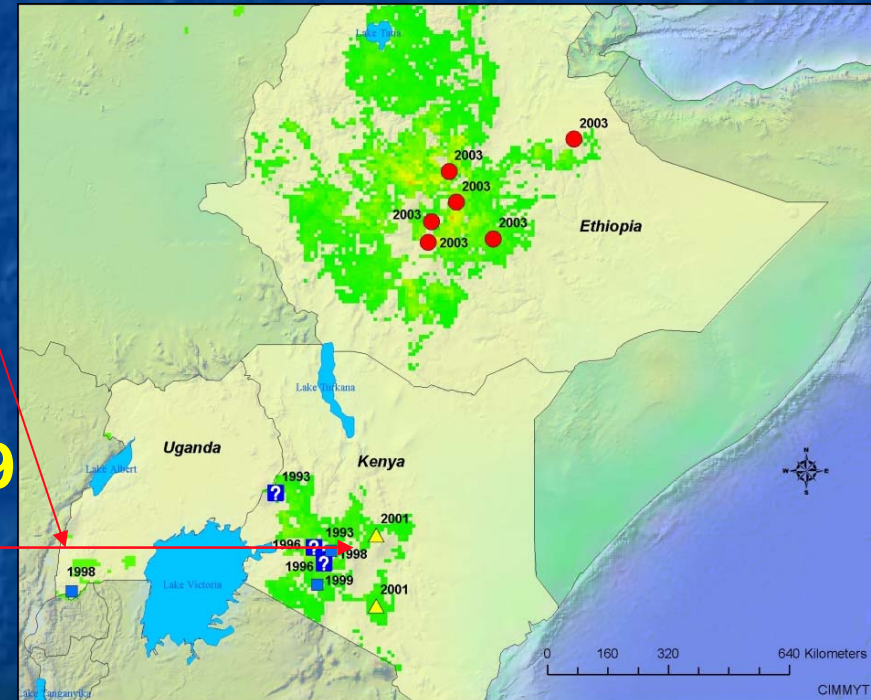
**Ug99 was discovered in 1999 in Uganda
Being the 1st known race virulent on Sr31**

Pretorius, Singh, Wagoire, Payne 2000 *Plant Dis* 84:203

**Stem rust race TTKS in Kenya
(since 2001) was identical to Ug99**

Wanyera, Kinyua, Jin, Singh 2006 *Plant Dis* 90:113

**Now confirmed in Yemen; possibly
Sudan (2007)**



Singh, Hodson, Jin, Huerta-Espino, Kinyua,
Wanyera, Njau, Ward 2006 *CAB Review*

Wheat Production Practices and Rusts in Kenya



Mau Narok
2,900m (9,514ft)
6.5-24.0°C (43.7-75.2°F)



Factors in East Africa that may contribute to the rapid evolution of new races

- Wheat production in the highlands (>2000m or higher).
- Wheat is present year-around due to staggered planting dates or volunteers.
- Daily dews and mild temperatures permit continued survival of the fungus and re-infections on host plants.

Why the concern?



Wheat consumption
per capita: 185kg (\approx 400lb)

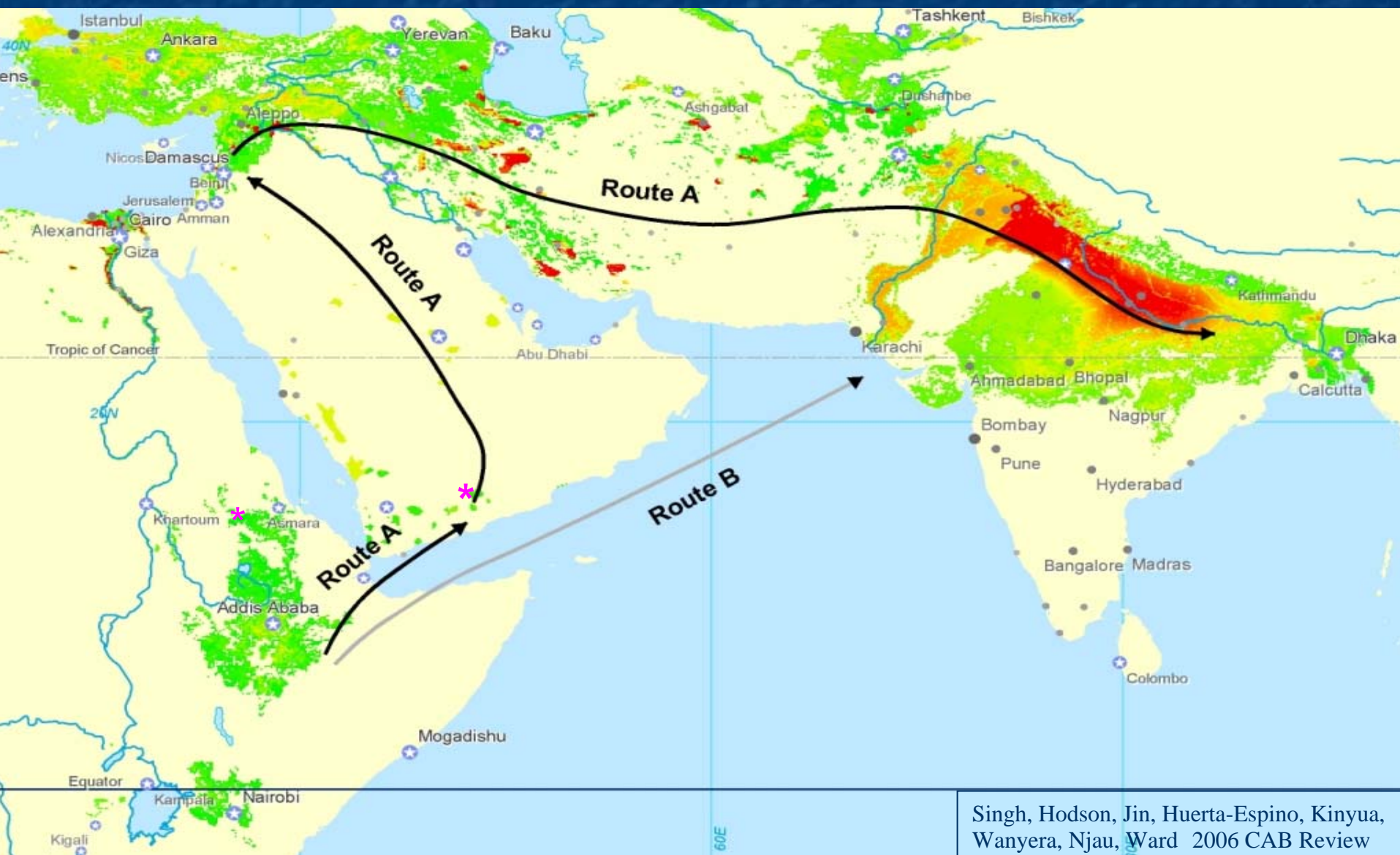
Results from 2006 Kenya:

<u>Country</u>	<u>%R</u>
ICARDA-WANA	9
Egypt	2
Iran	2
Pakistan	8
Nepal	2
India	9
Bangladesh	6
Kazakhstan	2

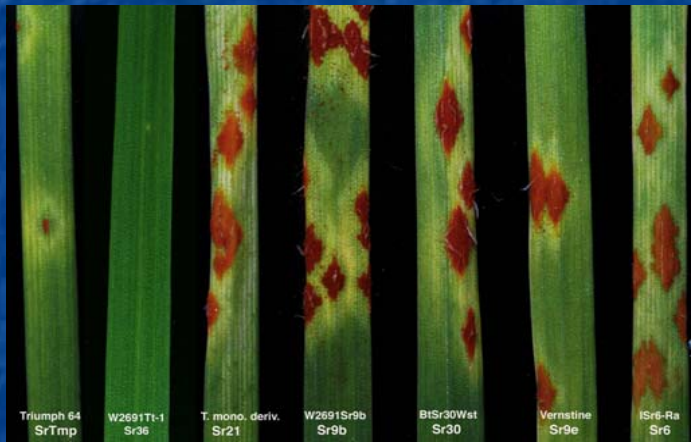
*** Ug99 (or TTKS) is considered to be a serious threat for food security in developing countries**

Potential migration routes for TTKS based on prevailing air-flows and regional wheat production areas.

Route A is considered to have a higher probability



Sr36 is highly resistant to TTKS, easily detected in seedling (0 to 0;) and adult plant stages (0). Thus, backcrossing of Sr36 is probable for achieving resistance to Ug99 rapidly.



Resistance to TTKS in US & CIMMYT Wheat

-Based on seedling & 2005 Kenyan nursery

Class	05KEN adult	% resist. (≤ 20 MS)	06TTKS seedling	% resist. ($\leq IT 2$)	Genes
HRS-breeding lines & cvs	103	12			Chris-type, <i>Sr24</i>
HRS-germplasm	466	19	89	82	Unknown
HRW-breeding lines	121	31	368	46	<i>Sr24</i> , 1RS-Am, <i>Tmp</i> , 36, unk.
SRW-breeding lines	92	27	148	22	<i>Sr36</i> , <i>24</i> , 1RS-Am, <i>Tmp</i> , unk
CIMMYT-breeding lines	2500	11	270	89	APR, <i>Sr24</i> , 25, unk.

Results of 2006 Kenyan Stem Rust Screening

<u>Country</u>	<u>Entries</u>	<u>% R or MR</u>
Bangladesh	84	3.6
India	102	22.5
India AKJ	100	9.0
Nepal	105	1.9
Pakistan	105	5.7
China	1118	1.7
Iran	100	2.0
Khazakstan	86	3.5
Russia	35	2.9
Turkey	85	18.8
US HRS-breeding	97	22.7
Canada	233	38.2
Australia	52	46.2
CIMMYT-combined	886	25.5

Genes remain effective in the 2006 Kenyan stem rust nursery based on CDL single gene lines (genes in **yellow** are in adapted background):

- **Sr13**, 22, **24***, **25**, **26**, **27**, 28, 29, 32, 33, 35, **36**, 39, 40, 44, **Tmp**, **1A.1R**, Tt-3
- **Sr9e**, **14** and 21 were not completely susceptible at the adult plant stage
- **Sr2** complex remains effective (based on CIMMYT lines)

Some anomalies in the 2006 nursery in comparison with the 2005 nursery:

- Sr13 was higher, in excess of 50 MS in some plots
- Thatcher was higher, up to 40 MR-MS
- Pavon 76 was higher, up to 30 MR-MS
- MS-S pustules were found on Sr24 lines with low frequencies

New Developments in 2006

- Sr24 Virulence
- Spread of Ug99 to Yemen

Sr24 Virulence

Sr24 was highly effective against Ug99, showing up to 20MR under high stem rust pressure in Kenya in 2005.

It is the major component for Ug99 resistance in adapted germplasm, occurring in a high frequency in wheat worldwide. Approximately, 60% Ug99 resistance in hard wheat in US is due to Sr24.



Scattered MS to S pustules with low frequency were seen in many Sr24 lines in the 2006 Kenyan stem rust nursery. Sr24 virulence was suspected and is now confirmed.

Variant within race TTKS

Seedling test indicated that the variant has an identical virulence pattern with race TTKS except for producing high infection types (IT 2+ to 3) on Sr24

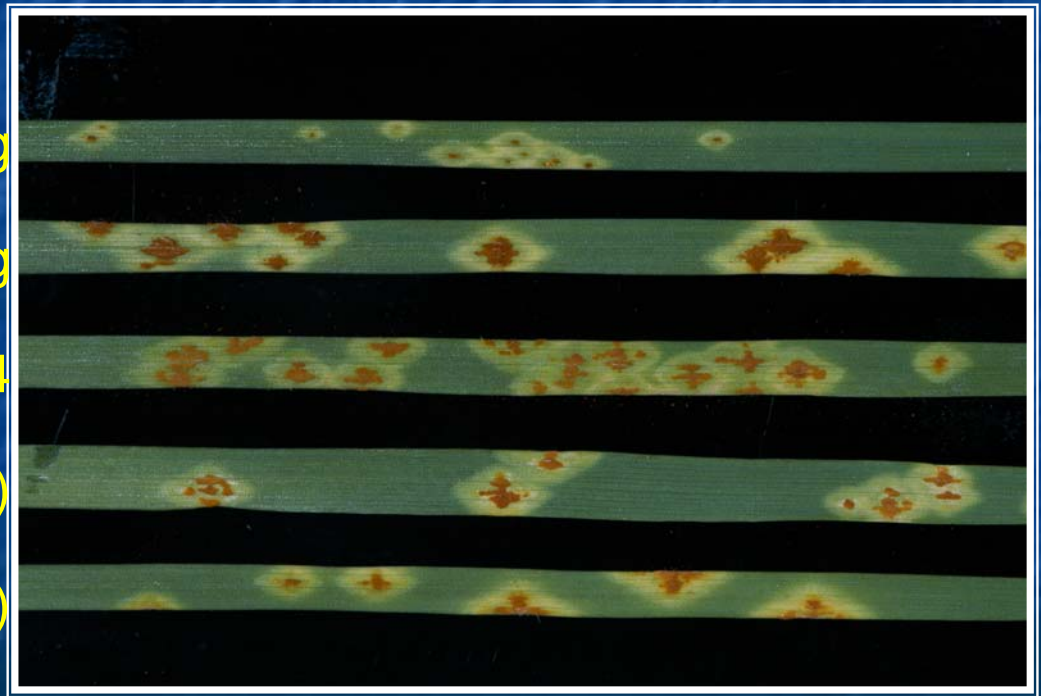
TTKS on LcSr24Ag

Sr24V variant on LcSr24Ag

LMPGSr24

Ivan (Sr24)

Siouxland (Sr24+31)



International Stem Rust Monitoring

East Africa

Kenya
Ethiopia
Eritrea

South Asia

India
Pakistan
Nepal
Bangladesh

Central Asia

Uzbekistan
Tajikistan
Kyrgyzstan
Kazakhstan

North Africa

Sudan
Egypt
Tunisia
Algeria
Morocco
Yemen

West Asia

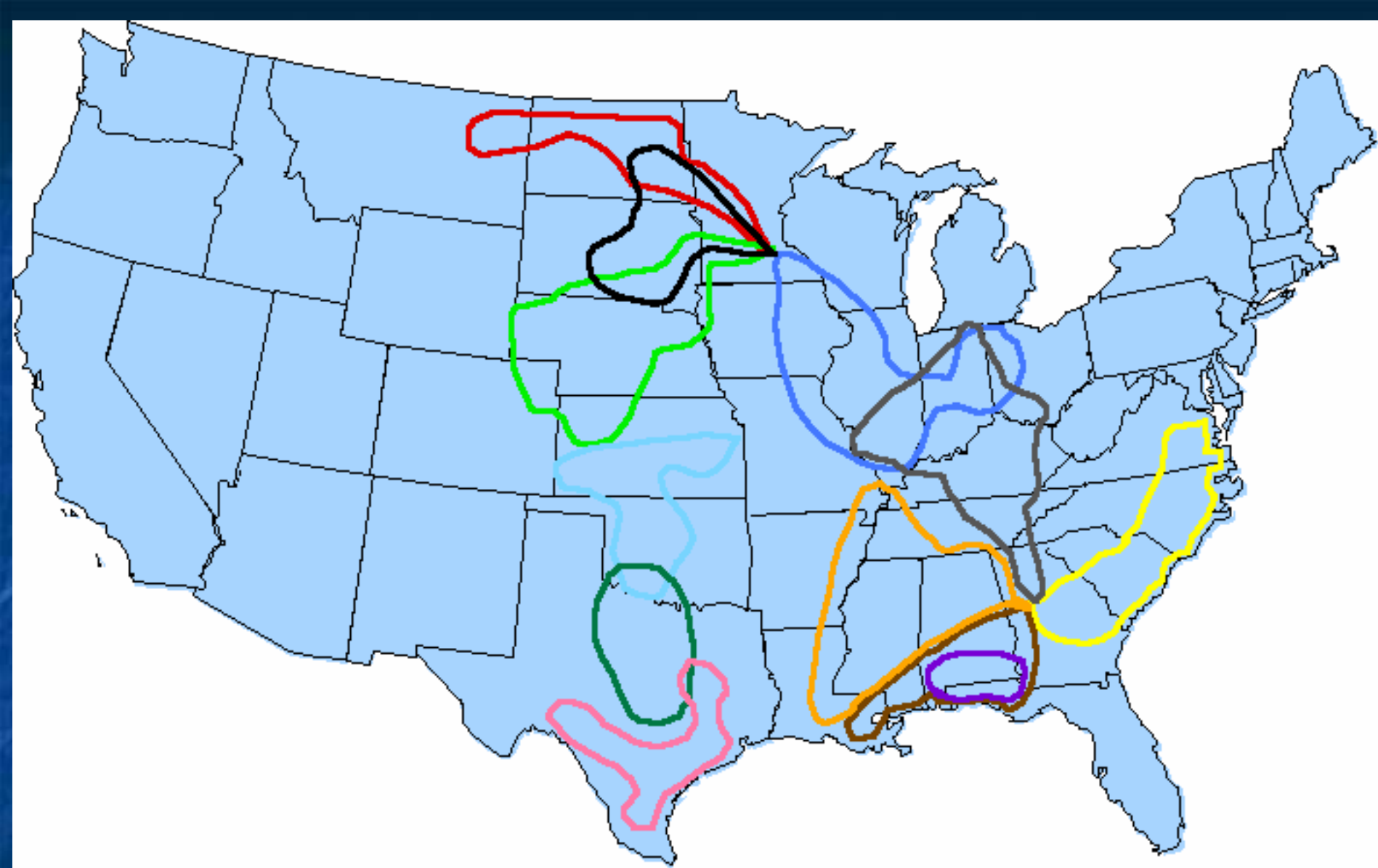
Jordan
Syria
Turkey
Iran

Latin America

Chile
Uruguay

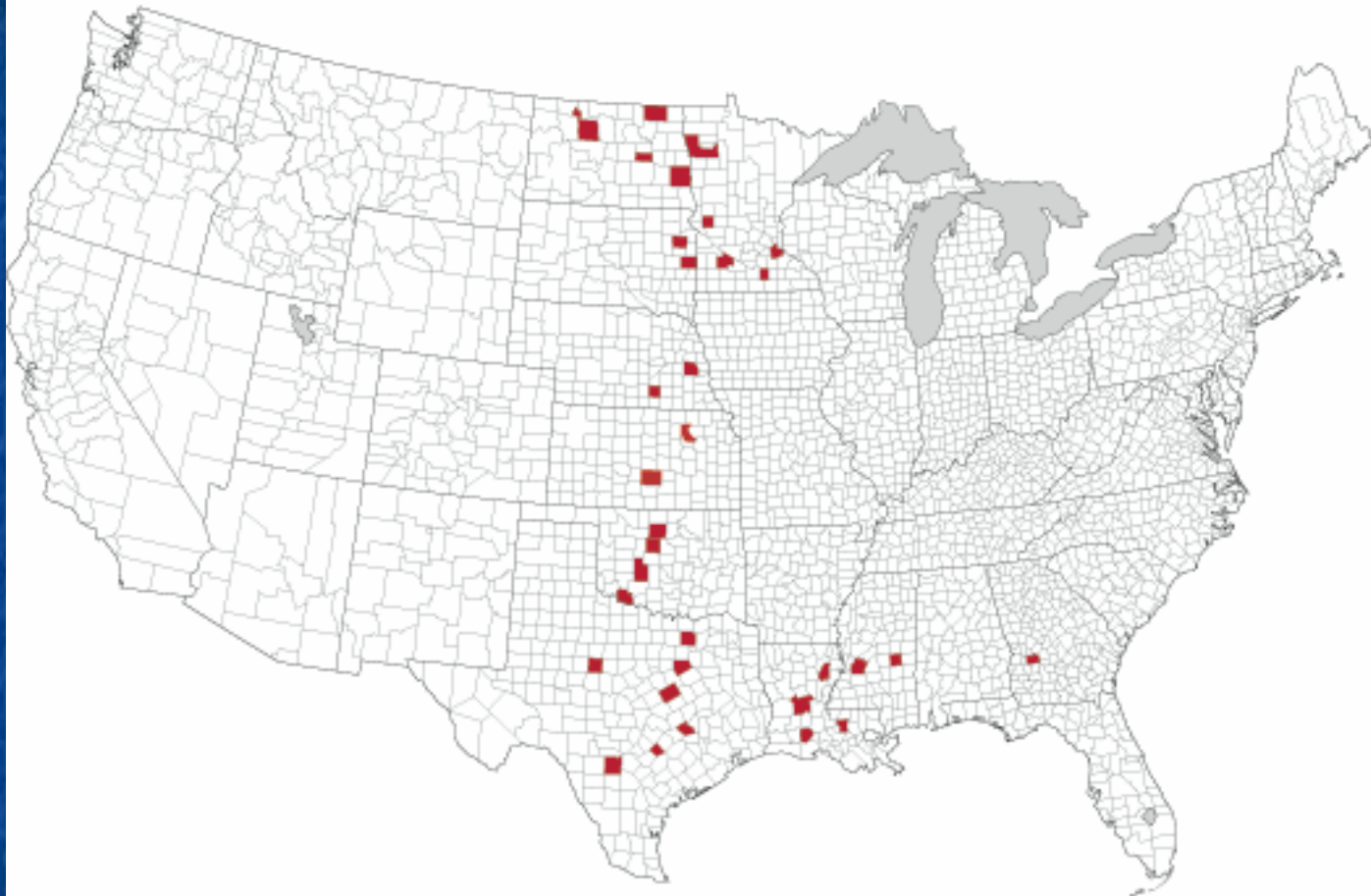
(Others not in the GRI system:
US, CAN, Aus, Isr.)

Number of locations/country varies, ranging 4 to 6 (or maybe more)



Past Annual Rust Survey Routes

2007 Rust Detection Plots



Rust Collections Received at the CDL

	<u>Stem Rust</u>	<u>Leaf Rust</u>
1997	96	541
1998	116	547
1999	241	648
2000	260	599
2001	182	364
2002	164	563
2003	161	376
2004	93	534
2005	115	523
2006	82	421
Total	1510	5116

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Welcome to the Cereal Disease Laboratory

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[Directions to the lab](#)

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Recently expanded Cereal Disease Laboratory

Mission:

The mission of the Cereal Disease Laboratory is to reduce losses in wheat, oat, and barley to major diseases including leaf rust, stem rust, and Fusarium head blight. This mission is accomplished through research on the biology of the pathogens that cause these diseases and on methods to enhance disease resistance in small grains. Program objectives are to: (1) identify genes used by plants in defense against pathogens and determine their cellular and biochemical mechanisms of action; (2) elucidate molecular aspects of the expression of virulence in rust fungi; (3) identify and utilize rust resistance factors to protect small grain crops against existing and future pathogenic races in rust populations; (4) analyze population genetics of cereal rust fungi and devise strategies to enhance durability of resistance against diverse rust populations; (5) identify and characterize resistance in wheat and barley to Fusarium head blight and determine impacts of partial resistance on pathogen populations in crop residue; and (6) identify genetic factors for pathogenicity in Fusarium and explore ways to block their activity and minimize pathogen attack in small grains.

Spotlights



North American Cereal Rust Workshop

Rust surveys; population genetics, biology, and epidemiology; host resistance; genomics and molecular biology; taxonomy, phylogenetics and more.



Detection of fungal rust spores in rain

Using molecular techniques to detect spores before crops become infected.



Ug99 and emerging virulent stem rust race

An emerging virulent stem rust race and vulnerability of wheat in the U.S. and worldwide.

Last Modified: 01/16/2007

Cereal Disease
Lab website:

www.ars.usda.gov/mwa/cdl



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Cereal Rust Situation Reports and Cereal Rust Bulletins

[Reports on the Current Rust Situation in the U.S.](#) (from the [Cereal Rust Survey mail list](#))

2006 Cereal Rust Bulletins:

Stem rust observation maps
(maps are updated as observations are received)
Please be aware these are large files.

2007

- [Wheat](#) (no reports yet in 2007)
- [Oat](#)

2006

- [Wheat](#)
- [Oat](#)

Archived Cereal Rust Bulletins

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- [1995 \(Final Bulletin - summary of the year\)](#)
- [1994 \(Final Bulletin - summary of the year\)](#)

Puccinia Pathway



Last Modified: 01/11/2007

Cereal Rust Bulletin

Issued bi-weekly,
March - August

Reports on the Current Cereal Rust Situation in the U.S.

1/23/2007

For the latest reports on the cereal rust situation in the U.S., posted below are messages received from cooperators and our staff. If an email address is provided with a report, feel free to contact the cooperator if you like. We welcome any information you can provide, but are particularly interested in the following information:

- Rust (leaf rust, stem rust, stripe rust, crown rust)
- Host (wheat, oat, barley, etc.)
- Cultivar or line name if known
- Severity and prevalence
- Growth Stage - when rust likely arrived, when infection first noted and current stage
- Where rust is found on the plants, e.g., lower leaves, flag leaf, etc.

Please email your observations to Mark Hughes (markh@umn.edu) and David Long (davidl@umn.edu). Thank you for your interest and cooperation. We continue to provide Cereal Rust Bulletins which are a summary of the information we gather.

Rust collections

We appreciate receiving collections of these rusts from cooperators around the U.S. If you would like to contribute, please contact David Long (davidl@umn.edu) or Mark Hughes (markh@umn.edu), and they will send you a packet of collection envelopes and forms.

Please note: stripe rust collections should be sent to Xianming Chen (xianming@mail.wsu.edu).

Select year of interest:

[All messages](#) [2007](#) [2006](#) [2005](#) [2004](#) [2003](#) [2002](#) [2001](#) [2000](#) [1999](#) [1998](#) [1997](#) [Cereal Rust Bulletins](#)

1/11/2007	Oat stem rust in Texas	Click to see message
1/6/2007	Oat crown rust - Louisiana	Click to see message
11/18/2006	Oat stem rust in Louisiana	Click to see message
11/16/2006	Wheat disease update - Oklahoma	Click to see message
7/25/2006	Rust update - Minnesota, North Dakota	Click to see message
7/20/2006	Rust update - South Dakota	Click to see message
7/19/2006	Barley rusts - NW Minnesota	Click to see message
7/18/2006	Cereal Rust Bulletin #9 - click bulletins button above	Click to see message
7/10/2006	Rust update - Minnesota	Click to see message
6/28/2006	Cereal Rust Bulletin #8 - click bulletins button above	Click to see message
6/28/2006	Rust update - South Dakota	Click to see message
6/27/2006	Stripe rust update - Montana	Click to see message
6/24/2006	Rust update - New York	Click to see message
6/23/2006	Leaf rust update - North Dakota	Click to see message
6/23/2006	Rust update - South Dakota	Click to see message
6/20/2006	Stripe rust update - Pacific Northwest	Click to see message
6/19/2006	Leaf and stripe rust in Ohio	Click to see message
6/14/2006	Stripe rust in Winnipeg, Canada	Click to see message
6/14/2006	Cereal Rust Bulletin #7 - click bulletins button above	Click to see message
6/13/2006	Rust update - Montana	Click to see message
6/9/2006	Rust update - North Carolina	Click to see message
6/9/2006	Leaf rust in Pennsylvania	Click to see message
6/9/2006	Rust update - New York	Click to see message
6/9/2006	Summary of Arkansas wheat and diseases	Click to see message
6/9/2006	Rust update - Indiana	Click to see message

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