Wheat Stem Rust – Ug99

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Ug99 Action Plan for Possible Establishment of Ug99 in the U.S. (www.ars.usda.gov/Ug99)

Partners: APHIS, ARS, NIFA, OPMP, and USAID
National Wheat and Barley Improvement Committees
National Assoc. of Wheat Growers, Barley Growers, American Phytopathological Society

Goals

1. **Cereal Stem Rust Assessment and Pathology**
2. **Detection and Identification**
3. **Monitoring and Reporting**
4. **Germplasm Enhancement, Gene Discovery, Development of Molecular Markers**
5. **Regional Variety Development, Evaluation and Implementation**

ARS partnership with U.S. wheat & barley breeding programs to develop Ug99-resistant varieties

ARS, Raleigh – N. Carolina State, U. Georgia, Louisiana State, and Virginia Tech

ARS, Manhattan – Texas A&M, Oklahoma State, Kansas State, Colorado State

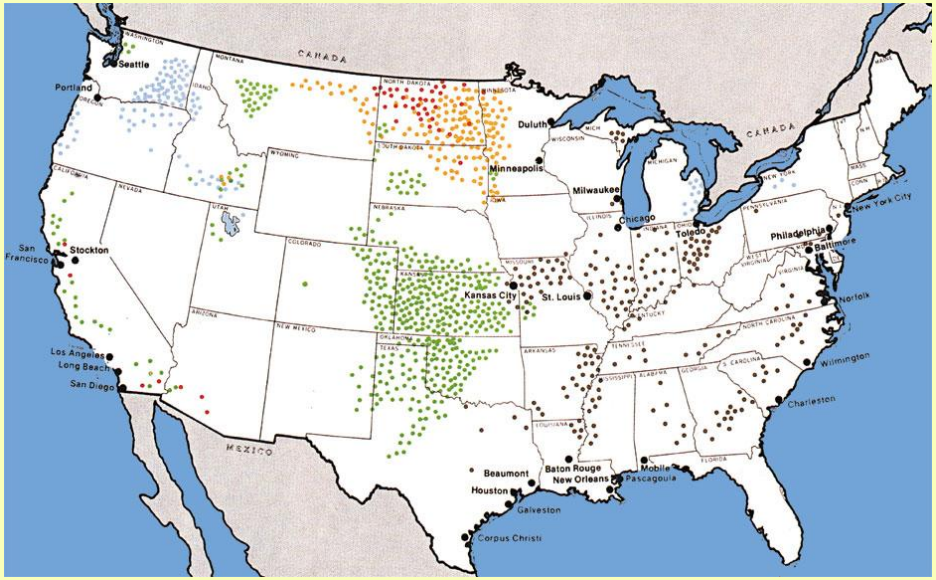
ARS, Lincoln – U. Nebraska.

ARS, St. Paul – U. Minnesota.

ARS, Fargo – N. Dakota State.

ARS, Aberdeen – U. Idaho, Oregon State, U. California-Davis.

ARS, Corvallis – Oregon State.



Ug-99 Spread

1998-Uganda

2000-Kenya

2003-Ethiopia

2006-Sudan

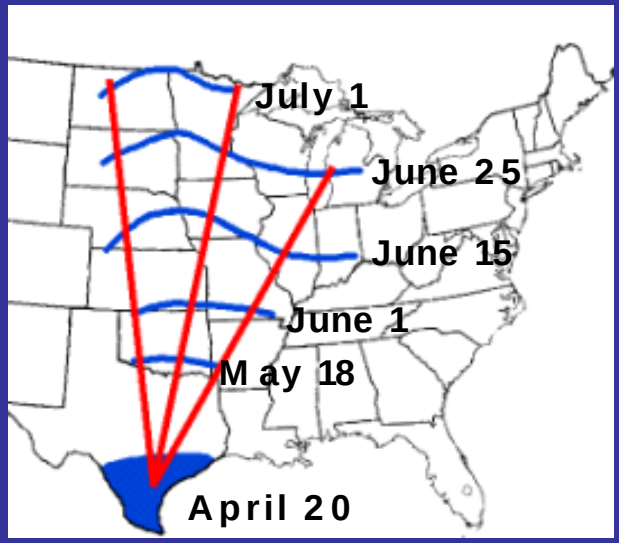
2006-Yemen

2007-Iran

2010-South Africa

Spore Dispersal

- Plant-to-plant
- Field-to-field
- Stepwise within a region
- Regional spread
- Long distance dispersal
- Human-mediated dispersal



Unified Concept of Pathogen Movement and Disease Development

Regardless of the type of organism, successful invaders must negotiate a sequence of events that includes arriving, surviving, and thriving in a new environment.

In order to manage wheat stem rust, we must minimize or eliminate the pathogen from arriving, surviving and thriving.

Ways to Minimize Wheat Stem Rust from Arriving

- Reduce global population size of rust
- Regulatory methods – Import/Export restrictions on pathogen cultures and plant material
- Traveler Advisories
- International Cooperation

Ways to Minimize Wheat Stem Rust from <u>Surviving</u>

- Elimination of Highly Susceptible Varieties
- Growing Resistant Varieties
- Rust Monitoring - surveillance plots; race identification and surveys
- Organized communication between farmers, Extension personnel, crop advisors, and researchers; rapid response
- Fungicides – If caught early and limited occurrence

Ways to Minimize Wheat Stem Rust from Thriving

- Development and deployment of resistant varieties (reduce rate and amount of pathogen build-up); all-stage resistance and adult-plant resistance; gene pyramids; avoid high-effect single gene resistance.
- Diversification of resistance - gene deployment; varietal diversification; blends or mixtures
- Reduce or eliminate overwintering and oversummering.
- Eliminating susceptible alternate host.
- Fungicides to reduce rust population size and protect yield of susceptible varieties.


SUDAN
ETHIOPIA
Lake Turkana
Lodwar
CHALBI DESERT
SOMALIA
Marsabit
UGANDA
Wajir
KENYA
GREAT RIFT VALLEY
Eldoret
Lake Baringo
Kisumu
Lake Bogoria
Meru
EQUATOR
Mount Kenya
Lake Victoria
Nakuru
Njoro
Lake Elementeita
Garissa
Lake Naivasha
NAIROBI
Machakos
SERENGETI PLAIN
Lamu
Masai Mara National Reserve
Amboseli National Park
Lamu Archipelago
Mt Kilimanjaro
Tsavo National Park
Malindi
Watamu Bay
TANZANIA
Mombasa
INDIAN OCEAN
Shimoni
100 km
100 miles
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U.S. germplasm screening for Ug99 resistance– Njoro, Kenya 2005-2010

28 Universities (Arkansas, California, Clemson, Colorado, Cornell, Florida, Georgia, Idaho, Illinois, Kansas, Kentucky, Louisiana, Maryland, Michigan, Montana, Nebraska, North Carolina, North Dakota, Ohio, Oklahoma, Oregon, Purdue, South Dakota, Tennessee, Texas, Utah, Virginia, and Washington)

11 Companies (AgriPro/Syngenta, BARI, Genesis, Great Lakes, Kolding, Sunbeam, Pioneer, Plant Breeders, Resource Seeds, Trio, and WestBred)

8 ARS Locations (Aberdeen, Ames, Lincoln, Manhattan, Pullman, Raleigh, St. Paul, and Stillwater)

Ug99 screening in Kenya

Resistant **Susceptible**

Stem Rust Nursery – Njoro, Kenya

Spring Wheat

Winter Wheat

Njoro, Kenya Winter Wheat Nursery 2009 and 2010

2009

2010

U.S. Wheat and Barley Germplasm tested in Njoro, Kenya 2005-2010

Year	*Winter Wheat**	*Winter Barley*	*Spring Wheat***	*Spring Barley*	*Total*
2005	292	0	700	0	992
2006	1008	0	451	247	1706
2007	2395	10	2083	365	4853
2008	2000	30	1368	669	4067
2009	1688	85	1904	863+	4540
2010	2096	184	2214	1097+	5591
Total	9479	309	8720	3241	21749

** Includes triticale*

*** Includes durum*

Adult-Plant Data - Njoro

Highly effective – Sr36 (0-;R)
Effective – Sr1A.1R (R-MR)
Moderately Effective - Sr25 (R-MSS); Sr2 (MS-MR)
Ineffective – Sr24 (S-MS); Sr31 (S-MS)
Highly ineffective – Sr38 (S)

Lr34 seems to enhance Sr resistance when combined with Sr1A.1R, Sr2, Sr24, and Sr31, but has less effect when combined with Sr25 and Sr38.

Other Sr genes with effectiveness include Sr22, SrTmp, Sr26, Sr32, Sr35, Sr39, Sr42, SrCad, SrWeb and several other uncharacterized.

The 3-gene combination Sr24, Sr36, Sr1A.1R has global effectiveness.

Gene Pyramids from ARS-Raleigh

Most possible 2-way gene combinations with Sr2, Sr24, Sr25, Sr31, Sr36, Sr38, Sr1A.1R, and Lr34.

Many 3-way pyramids tested in 2010.

Some Effective Combinations tested in U.S., Kenya, Turkey, and Turkmenistan:

ARS09-755 (KS93U275/WX03ARS0417): Lr21, Lr34, Sr2, Sr24, and Sr36
ARS09-670 (NC96BGTD3/KS98U665//TAM303): Lr34, Sr25, Sr36, Sr1A.1R
ARS09-589 (KS93U6-1/B980582//PI564385): Lr21,Sr24, Sr36, Sr1A.1R
ARS09-253 (KS93U275/PI470711//TAM303): Lr21, Lr34, Sr24, Sr38, Sr1A.1R