

Lecture 2

Puccinia graminis f. sp. *tritici* race
Ug99 and the re-emergence of
stem rust research



Why re-emergence?

- Stem rust was a major disease of wheat in the first half of the C20th
- Its decline was attributed to barberry control (?), changed agronomy (early maturity), and resistance
- Inoculum levels declined
- Leaf rust and stripe rust were then seen as more important wheat diseases

Sr31

- Originated from a wheat X Petkus rye cross made in Germany in the 1930s
- **Material divided between West and East Germany at the end of WWII**
- Varieties developed in both the West and East
- **Material moved to Russia and China and from Russia to CIMMYT Mexico where it was used in winter x spring wheat crosses**
- Common in CIMMYT-distributed germplasm

Sr31 - 2

- Although *Sr31* probably followed the decline of stem rust, its widespread use probably had an effect of maintaining low inoculum levels
- The occurrence in 1998 and spread of Ug99 from 2003 exposed a world vulnerability to stem rust
- Ug99 was identified as race TTKS (later TTKSK) on the North American differentials

	Four gene differential sets			
	<i>Sr5</i>	<i>Sr21</i>	<i>Sr9e</i>	<i>Sr7b</i>
	<i>Sr11</i>	<i>Sr6</i>	<i>Sr8a</i>	<i>Sr9g</i>
	<i>Sr36</i>	<i>Sr9b</i>	<i>Sr30</i>	<i>Sr17</i>
	<i>Sr9a</i>	<i>Sr9d</i>	<i>Sr10</i>	<i>SrTmp</i>
Pgt letter	<i>Sr24</i>	<i>Sr31</i>	<i>Sr38</i>	<i>SrMcN</i>
B	L	L	L	L
C	L	L	L	H
D	L	L	H	L
F	L	L	H	H
G	L	H	L	L
H	L	H	L	H
J	L	H	H	L
K	L	H	H	H
L	H	L	L	L
M	H	L	L	H
N	H	L	H	L
P	H	L	H	H
Q	H	H	L	L
R	H	H	L	H
S	H	H	H	L
T	H	H	H	H

Is TTKSK really TTKSK, or is it PTKSK?

- Diploid lines with *Sr21* appear to give intermediate seedling responses
- Hexaploid lines with *Sr21* give high intermediate seedling responses and are resistant in the field in Kenya

Why was TTKSK feared

- Virulence for *Sr31*
- **Virulence for other important resistance genes in wheat**
- Ability to spread, with appearances in Kenya, Ethiopia, Yemen and Iran
- **Overall aggressiveness and epidemics**
- Predicted movement to areas growing a significant proportion of the world's wheat, and eventually, India

Addressing the Ug99 threat

- World attention had to be focused – the Borlaug call for attention
- **The need for funding and infrastructure in Kenya and Ethiopia**
- Global Rust Initiative (later BGRI)
- **Durable Rust Resistance in Wheat project led by Cornell University**
- Additional support from FAO

Research projects of DRRW

- Surveillance – relating on-ground surveys, trap plotting and monitoring with world climatic data
- **Searching for resistance in wheat and wheat relatives; genetic analysis**
- Chromosome engineering to improve currently available introgression lines
- **Identification of potential resistance donors, and transfer of resistance to wheat**
- Potential of using non-host resistance
- **Identification and use of minor additive APR genes**

Some effective resistance genes

- *Sr13, Sr22, Sr26, Sr32, Sr33 Sr37, Sr44, Sr45, SrTmp*. Mutants virulent for *Sr24* and *Sr36* have already occurred in Kenya
- Many resistant accessions of wild 2X and 4x wheats, and *Aegilops*, *Thinopyrum*, and *Secale* spp. identified

Longer-term targets

- Potential for genetic engineering
- **Non-host resistance**

Infrastructure – research and breeding

- Greenhouses in Kenya and Ethiopia to enable pathotyping
- **Improved laboratory facilities**
- Screening facilities in Kenya and Ethiopia for 2 generations per year
- **Training and workshops**

Infrastructure – seed production and distribution

- Review of national and international facilities enabling more rapid seed production and distribution within and between countries
- **Training**

Discussion