G20 MACS Initiated 2019 Project

Prevention of Wheat Blast Disease Pandemic

(2019- March 2024)

Japan International Research Center for Agricultural Sciences

Masahiro Kishii

International Consortium for Wheat Blast Control
International collaboration research on transboundary plant pests and diseases

No border exists for diseases and insects
Once it appears, it can affect the entire world

Global efforts are necessary
Enough Wheat = World Stability

2.5 billion people in 89 countries

World trade
211 million tons
(27% of global production)

Six countries export about 80% of global trade

WHEAT PROVIDES 19% OF OUR TOTAL AVAILABLE CALORIES
and 20% of all PROTEIN
Importance of Disease Resistance Genes

[Image of wheat field with text annotations: Resistance gene #1 → New race → New disease → Susceptible → Yield loss]
Wheat Blast (A New Emerging Disease)

- 1996 Bolivia
- 2002 Paraguay
- 2007 Argentina
- 1985 Brazil
- 2018 Zambia
- 2016 Bangladesh
Characters and Problem of Wheat Blast

- Up to 100% yield loss
- Cross-infect different hosts and break host resistance
- Fungicide: partially effective under low to medium WB pressure
- Ability to develop fungicide resistance
- Areas of rains & warm temperatures

Bleached spikes, no grain sets
Losses from Wheat Blast Simulated for Climate Change for 2040-

WB threatens 6.4 million ha currently → 13 million ha by mid-century.

WB alone could reduce global wheat production by 13%.

South America most, then East Africa, South Asia and East Oceania
Ministry of Agriculture, Forest and Fishery (MAFF) Japan Funded Project

Project title:
Development of technology to prevent wheat blast pandemic (2019 – March 2024)

Project leader:
Dr. Yukio TOSA
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International Consortium for Wheat Blast Control

**Basic science:**
identify resistance genes and tools

**Japanese group**
Kobe University
Kyoto University
Kyoto Prefectural University
Hyogo Prefecture

**Wheat breeding**
CIMMYT (Mexico)

**Field evaluation**
Bangladesh (BWMRI), Bolivia (INIAF) with CIMMYT
Only One Resistance Gene Available in Elite Wheat Varieties against Wheat Blast in 2019

- **2NS**
  
  Currently, all resistance in almost all ‘elite wheat varieties’ relays on this resistance gene.

- **Rmg8** (from landrace=old wheat)
  
  ‘Old wheat lines’ have this resistance gene, but not utilized in current elite wheat varieties.
Cloning of *Rmg8*

- Scientific insight of wheat blast resistance
- Molecular markers for wheat breeding
Combine Two Resistance Genes by Markers in CIMMYT, Mexico

Rmg8 Rmg8

F1

Rmg8
2NS
–

F2

Rmg8
2NS
–

– –

– –

2NS 2NS

– –

Rmg8
2NS
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2NS 2NS

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Rmg8
2NS
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2NS 2NS

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Rmg8
2NS
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2NS 2NS

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Field Evaluation in Bangladesh and Bolivia

To check resistance and enough grain yield in actual wheat field
Advantage of Multiple Resistance Genes

Resistance gene #1 (2NS) → Susceptible
New race → Yield loss
New disease → Risks for world stability
Advantage of Multiple Resistance Genes

Resistance gene #1 (2NS)
Resistance gene #2 (Rmg8)

Still resistance
New race
New disease
Advantage of Multiple Resistance Genes

Resistant

Resistance gene #1 (2NS)
Resistance gene #2 (Rmg8)

New race
New disease

Susceptible
Yield loss
Risks for world stability

Rare, but it can happen
Advantage of Multiple Resistance Genes

Resistant

Damaged

Resistance gene #1 (2NS)
Resistance gene #2 (Rmg8)
Resistance gene #3 (New 1)
Resistance gene #4 (New 2)

Durable resistance
New race
New disease
Search of Additional Resistance Gene from Wild Relatives, Ancient Wheat & Local Wheat Wheat

**Evolution of wheat**

10,000 years ago

1900-1950's

After 1960's

Wild relatives

Ancient wheat

Landrace (Local wheat)

Modern wheat

Screening for Japan’s genebank collection (NBRP and NARO)

From more than 3,000 lines

63 resistant lines

18 resistant lines

4 resistant lines
Identified New Resistance Genes

*Rmg10*
from ancient wheat

*Rmg11*
from wild relatives

Molecular markers developed, ready for use

Six additional candidate genes are under analysis
Future Perspective

Sequential deployment of each resistance gene should be avoided.
Pathogens defeat each resistance gene. (happened many times in human history)

Accumulation of four resistance genes for durable resistance against wheat blast.

Done by this project

Overcome wheat blast disease

Hopefully in the future
Thank you very much