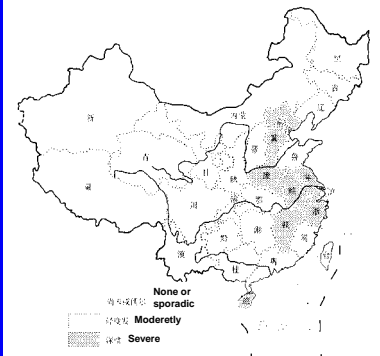


# Genetics and Improvement of Resistance to Bacterial Blight in Hybrid Rice

Chinese Academy of Agricultural Sciences  
ZHANG Qi 2008



BB was 1st found in China in 1930s. Now, it has spread nationwide, except in XJ, Tibet & northern part of Northeast China



## A. Improvement of BB R in hybrid rice in China

- In early 1970s, the national program “Rice breeding for high yield, good quality, & R to diseases” was established, BB R has been rapidly improved.

### 1. Three-line comb. with BB R registered at national or provincial level (1973~2006)<sup>a</sup>

Period	Total	Resistant	R percentage (%)
1973~1986	87	31	35.6 (ind.)
	43	26	60.0 (jap.)
1996~2005	169	18	10.7 (ind.)
2006	6	4	66.7 (jap. South)
	64	5	7.8 (jap. North)

<sup>a</sup> Combinations with an annual acreage of more than 6.667 ha<sup>2</sup>

### Comb. with high yield, good quality, R to BB or more dis.

- \* Before 1980s, Weiyou 64, Weiyou 6, & Shanyou 6 had reached an annual area of 1.333 M ha<sup>2</sup>.
- \* Up to 2005, Jiyou 084, Shanyou 77, Guofeng 1.
- \* Recently, Jiyou 1511, Yixiang 2408, & sup. H.R Zhongzheyong 1 ( area reached 0.067 M ha<sup>2</sup> ) exhibiting R to BB & BL.
- Jap. H. Youyou, Jiayou & Xiyouyou 5 exhibiting multiple- R to diseases & insects.

**2. Two-line hybrid with BB R registered at national or provincial level (1994~2006<sup>a</sup>)**

Period	Total	Resistant	R perc. (%)
1994~2000	32	17	53.1
2001~2006	21	6	28.6

\* Combinations with an annual acreage of more than 6.667 ha<sup>2</sup>

**• Comb. with high yield, good quality & R to BB or more dis.**

\*After 2000, Peiza-shanqing, Peiza-maoxuan, Peiliangyou-teqing, & Yunguang 8.

\*Up to 2006, Liangyou- peijiu, accumulated area reached 4.681 M ha<sup>2</sup>(2005), Peiza-shuangqi, & jap. 70 you 9.

\* In 2007, 2 Sup. rice comb. Fengliangyou 4, Xinliangyou 6380 & Peiza 35, Xinliangyou 6, Xinliangyou 98 with HR-MR to BB & BL .

Breeders succeeded in providing many good comb. with BB R for farmers, the dis. has been effectively controlled for 20 years in China



**BB emerged prevalently in Yangtze River Vally (Donghai, JS 2005)**

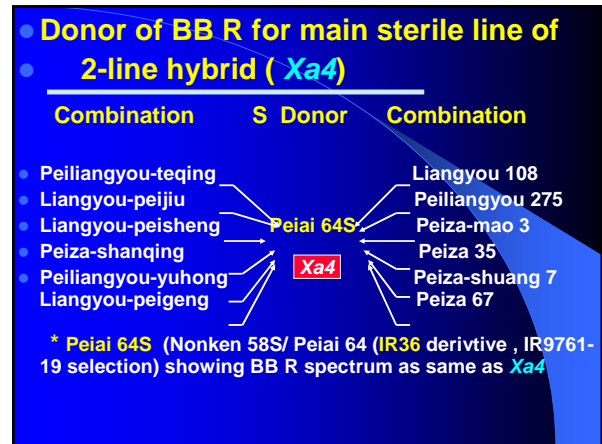
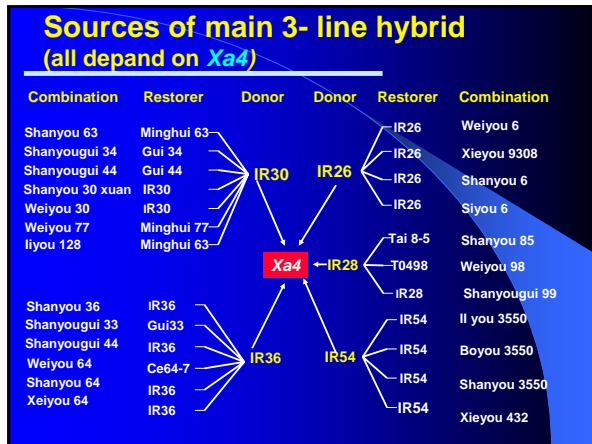


**B. Discussion of the actual & potential damage situation**

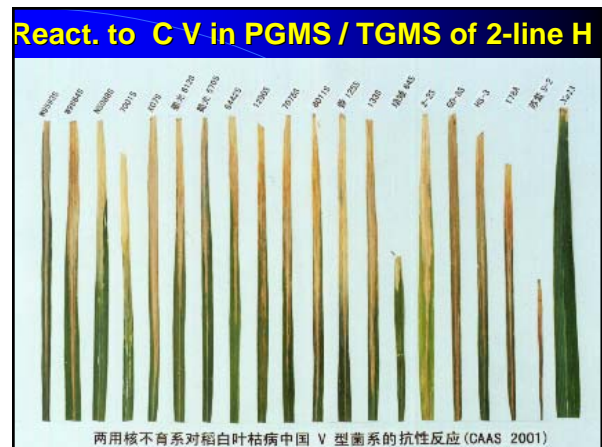
Resurgence of BB after 20 years of “quietness” appeared danger from the dis. in China

**• 1. Reduced rice variation for BB R**

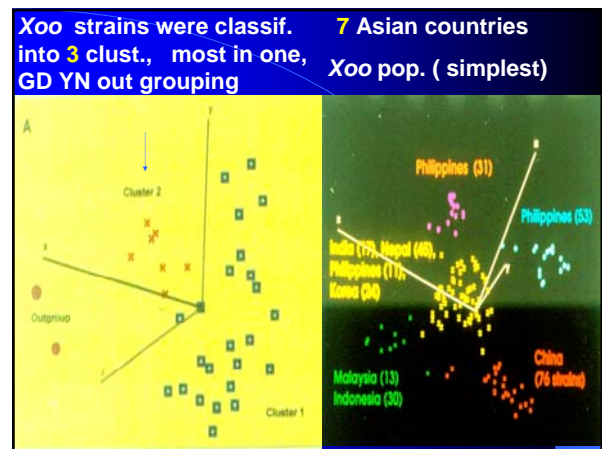
Studied on pedigree of 287 BB R cultivars & donors, inheritance of 100 ones, and tested genitic allelism of 52 cultivars, indicated that gene *Xa4* was mainly used in indica rice breeding.



- ### A new BB strain (C patho. V) virulent to *Xa4*
- \* Such genetic uniformity must make rice vulnerable to dis. epidemics, which often results in shifts of virulence in *Xoo* popul.
  - As early as in 1985, WU & XU first found a new BB strain (patho. V) in GD, was virulent to IR26 (*Xa4*). It made a warning, the host cult. carrying R gene *Xa4* had been cultivated extensively for the last 15 years



- ### 2. *Xoo* genetic popul. in China
- \* Genetic popul. struct. of *Xoo* (1984-2000), showed very simply, most strains were grouped in clusters 1 or 2, only str. from GD & YN were distinct from the others.
  - \* As expected, YN *Xoo* popul. contained some new patho., 9 & 8 out of the 14 races are virulent to cultivars carrying *Xa4* & *Xa21*, respectively (Ji et al., 2003).
  - \* In GD, another new strain is virulent to *Xa1, 2, 3, 4, 10, 11, 14, 21, xa8, & xa13*, except *xa5, Xa7 & Xa23* tested (Zeng, 2005,2007).



## C. Approaches to improve BB R in breeding hybrid rice

### 1. Broaden genetic basis of BB R

- Up to 2006, 30 BB R genes were ident., 18 mapped.
- Tightly linked PCR-based markers of *Xa4*, *Xa7*, *Xa21*, *Xa23*, *xa5*, & *xa13* were identified;
- Xa1*, *xa5*, *xa13*, *Xa21*, *Xa26* (Minghui 63) & *Xa27* (*O. minuta*) were cloned.

## 2. Alternate BB R genes

- In early 1980s, Zhu et al. developed TD series lines (carrying *Xa7*), which were used to develop indica restorers Kanghui 63, 98, & D205
- Using these restorers, BB R comb., Kangyou 63, 98, II You 205, & Fengyou 205 were developed & popularized in BB epidemic fields in JS, ZJ, AH, YUN, JX, HEN, HUB, & HUN 9 Provinces. The accumulated area of 2.50 M ha<sup>2</sup> had reached (Ding 2005).

## Xoo patho. distribution in China

- A smart use of R genes should be based on information of host-patho. interaction .
- \* Patho. II I dominate in Northern China (jap. )
- \* Patho. IV, II, V in Southern China (ind. )
- \* Patho. IV, II, V (spread. threshold value approach. 20% in Yangtze Valley ( ind. Jap. )
- \* Available broad-spect. R genes, *Xa23* (*O. rufipogon*), *Xa22*, *Xa21*, *Xa7*, & *xa5* can be used to overcome the dependence of limited genetic sources.

## Attacked & effective BB R genes in Asian

(tested on Philii. & Japanese. diffe. culti. (Noda et al. 1996)

Country	Race (str.)	R gene attacked	Effective R gene
Bangladesh	12 (74)	<i>Xa1</i> , 2, 3, 4, 7, 10, 11, <i>xa5</i> , <i>xa8</i>	<i>Xa3</i> , 12, <i>Pyra.</i>
India	5 (58)	<i>Xa1</i> , 2, 3, 4, 10, 11, 12, <i>xa5</i>	Pyramiding line
Nepal	16 (45)	<i>Xa1</i> , 2, 3, 4, 10, 11, 12, <i>xa5</i>	<i>xa5</i> , <i>Xa7</i> , <i>Pyra.</i>
Myanmar	7 (27)	<i>Xa1</i> , 2, 4, 10, 11, <i>xa5</i>	<i>Xa7</i> , <i>Pyra.</i>
Tailand	5 (35)	<i>Xa1</i> , 2, 10, 11, <i>xa5</i>	<i>Xa4</i> , 7, <i>Pyra.</i>
Indonesia	8 (78)	<i>Xa1</i> , 2, 3, 10, 11, <i>xa8</i>	<i>xa5</i> , <i>Xa7</i> , <i>Pyra.</i>
Philippines	5 (61)	<i>Xa1</i> , 2, 4, & 11	<i>xa5</i> , <i>Xa7</i> , 12
Malaysia	2 (11)	<i>Xa1</i> , 2, 10, 11, <i>xa8</i>	<i>Xa4</i> , 7, 12 & <i>xa5</i>
China (sou.)	6 (24)	<i>Xa1</i> , 2, 3, 4, 10, 11, 12, <i>xa8</i>	<i>xa5</i> , <i>Xa7</i> , <i>xa23</i> , <i>xa21</i>



## 3. Hybrid rice with BB R devel. by MAS

(Xu J., 2005)

R combination / restorer bred	Restorer need improv.	R donor	Mol. marker	Bred by
Zhonghui 218	Zhonghui 218	<i>Xa21</i> (IRBB21)	pTA248	CNRR
Guodao 1	R8006	<i>Xa21</i> (IRBB60)		CNRR
Guodao 3	R8006			
Zhongyou 1176	R1176			
Xieyou 218	Fuhuei 838	<i>Xa21</i> (IRBB21)	pTA248	CNRR
Minghui 63 (carrying <i>Xa21</i> )	Minhui 63	<i>Xa21</i> (IRBB21)	pTA248	HZAU
93-11( <i>Xa21</i> )	93-11	<i>Xa21</i> (Minhui 63, B/ <i>Xa21</i> )	pTA248	HZAU
93-11				
II You 8220	Miyang 46 / Minghui 63	<i>Xa21</i> (IRBB21)		ZJAU
T71, T81	Minghui 63	<i>Xa21</i> (IRBB21)	pTA248	ZJAU
Suhuei 527 improved	Shuhuei 527	<i>Xa21</i> (IRBB60)	pTA248	SCAU

## ● D. Problems to be addressed in the future

- \* The **R** new comb. released gradually reduce since later 90s, **the questions are :**
- **a)** were the comb. not screened prior to their release?
- **b)** the BB R breeding **is still** one of the main objectives?
- \* Thus, we are faced with two challenges:
- **a)** how to deal with the changing pathogen?
- **b)** design & develop durable R

## ● Conclusion

- \* Composed of traditional and molecular methods should bring a new era to the BB R in hybrid rice breeding program.
- \* **Gene** pyramiding, or rotation, where genes are effective (spatial & temporal deployment)
  - \* Adopting "**horizontal R**".
- \* **Pathogen** : identify tester strains for screening breeding lines for different regions
- \* **Collaborative** researches should be strengthened further. (**Intern.** breeding, pathol. entomol. ....)

