Bayer CropScience

BioScience

Tomorrow's Rice

Development of disease-tolerant hybrid rice,

APSA Congress,

Manila, 7 November 2007

Contents

- Introduction to Bayer CropScience Hybrid Rice and to BLB disease
- “Some” BLB-tolerance with a good rice hybrid
- “High” BLB-tolerance with further rice breeding

Bayer CropScience Seed Business: Focus on 4 Strategic Crops including Hybrid Rice

Vegetables: global market leadership in carrot, onion, melon, leek and cucumber

Cotton: superior germplasm for fiber yield and quality; access to traits portfolio

Canola: leadership in germplasm and leading technology position

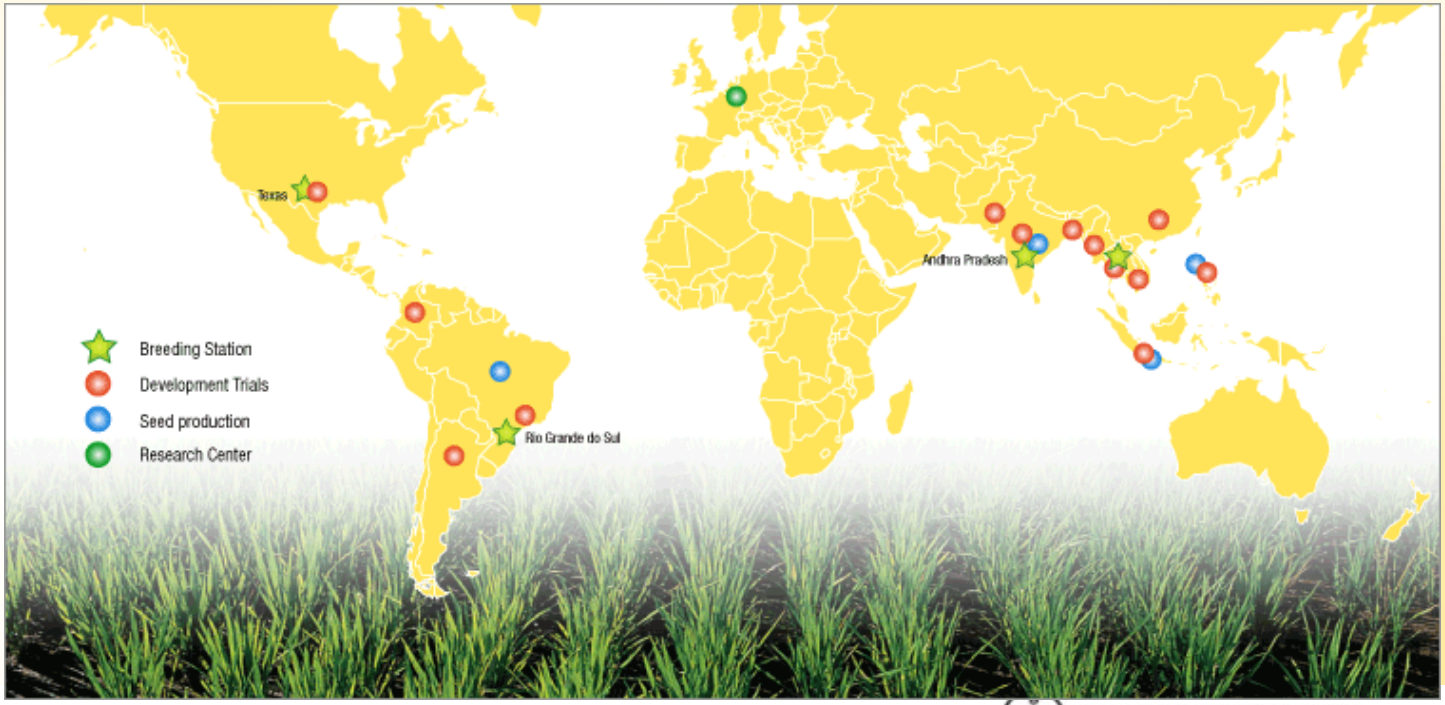
Rice : a global leader in the development, production and commercialisation of conventional hybrid rice seeds

See www.bayercropscience.com

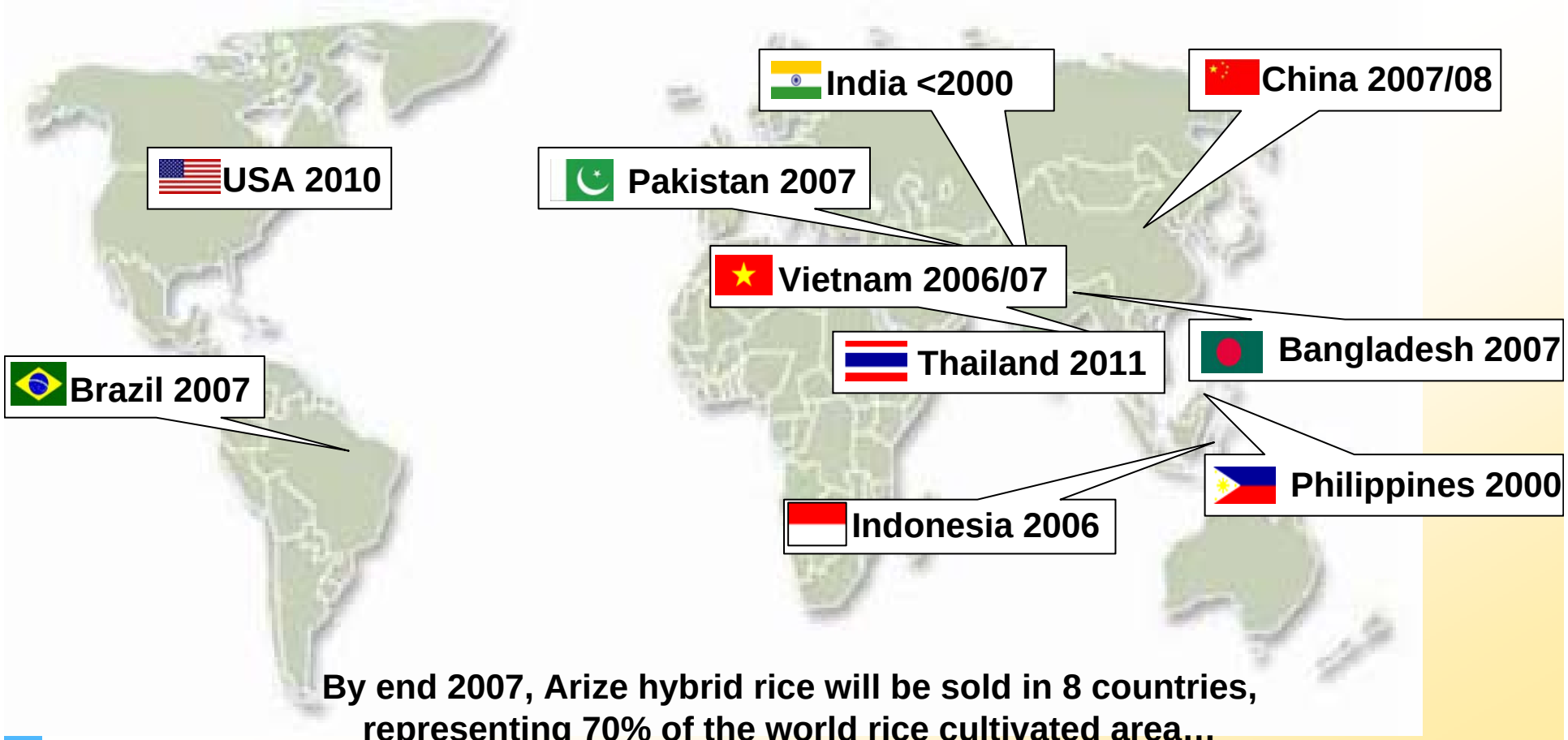
Arize® Hybrid Rice Development

- A **global leader** in the development of hybrid rice varieties with market presence in India, Philippines, Indonesia, VietNam, Brazil, Pakistan, Bangladesh and China.
- A broad germplasm base to support an **efficient breeding programme** and a **strong expertise in seed production.**
- **Extensive trials** to confirm the perfect adaptability of our paddy hybrids to the area for which they have been bred

Currently broadening our hybrid rice portfolio and also developing agronomic traits such as disease and insect resistance, and abiotic stress tolerance.



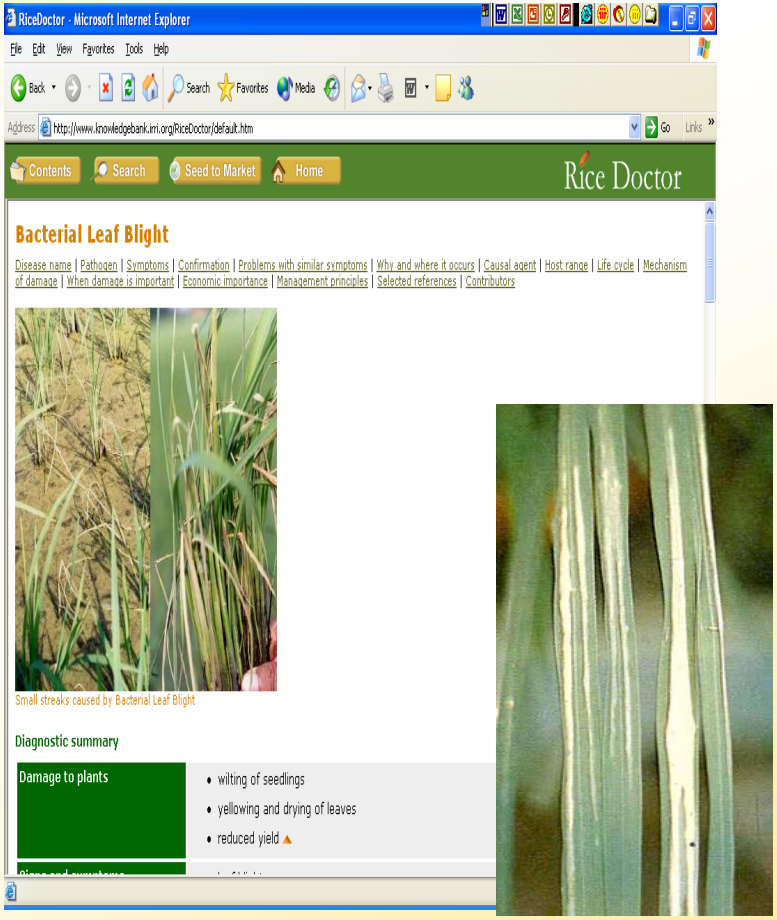
Arize® Hybrid Rice Market



By end 2007, Arize hybrid rice will be sold in 8 countries, representing 70% of the world rice cultivated area…
…and by 2011, in 10 countries, representing 80% of the word rice cultivated area

BLB – Bacterial Leaf Blight

- **Bacterial blight is one of the most serious diseases of rice, which is known worldwide**. It is common in both tropical and temperate countries.
- **Yield loss due to this disease** corresponds to the plant growth stages at which the rice plants were infected. The earlier the disease occurs, the higher the yield loss. Infection at booting stages does not affect yield but results in poor quality and a high proportion of broken kernels.
- **Damage to Plants:**
  - **wilting of seedlings**
  - **yellowing and drying of leaves**
  - **reduced yield**
- *Source: IRRI Rice Doctor (2003)*



Bayer CropScience

Bacterial leaf blight can be a real plague

Yield loss up to 30-50 %
No chemical treatment available

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Arize® Hybrid Rice in the Philippines

Arize Bigante

Launch in 2000

Maturity: 110-115 days

Average Yield: approx. 8.5 tons/ha

Grain Quality: Medium slender grain, excellent eating quality

Tolerant to Bacterial Leaf Blight ➔ Can be planted in wet and dry seasons, both with high yields

Arize H64

Launch in 2007

Maturity: 105 days

Average Yield: approx. 7.5 tons/ha

Grain Quality: Long slender grain, excellent eating quality, high milling quality

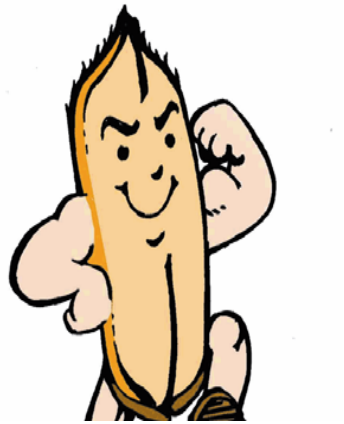
Hybrid Rice Performance, WS 2007

Hybrid	Yield (kg/ha)
Arize Bigante	**6,837**
Commercial Hybrid 1	3,655
Commercial Hybrid 2	4,187
Commercial Hybrid 3	3,453
Commercial Hybrid 4	4,207

Source: BCS Philippines field trials, WS 2007

BLB-tolerance, a plus for the farmers

Arize BIGANTE™



HIGANTENG ANI MAKAKAMTAN KAHIT SA TAG-ULAN !

Matibay sa Bacterial Leaf Blight
(BLB - pamumula ng palay)

- **BLB tolerance of Arize Bigante is acknowledged by Filipino farmers**
- **Arize Bigante is No1 hybrid in WS in the Philippines**

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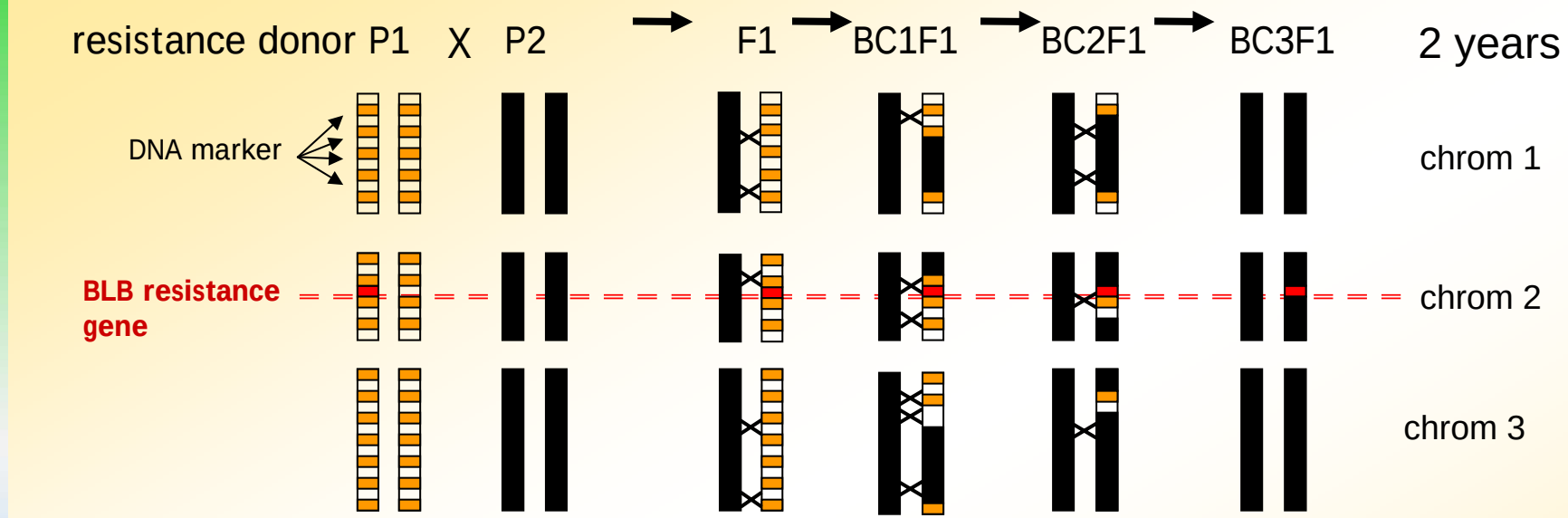
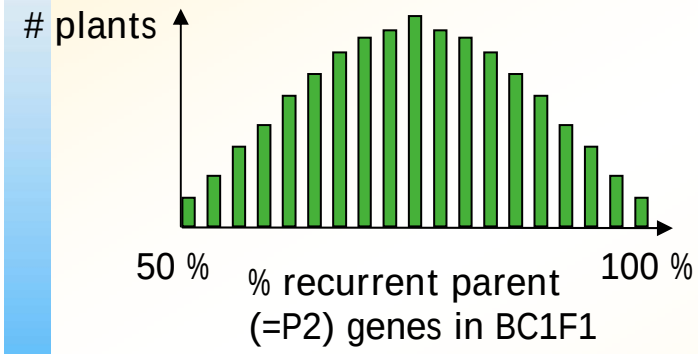
Breeding of a “fully” BLB-tolerant hybrid

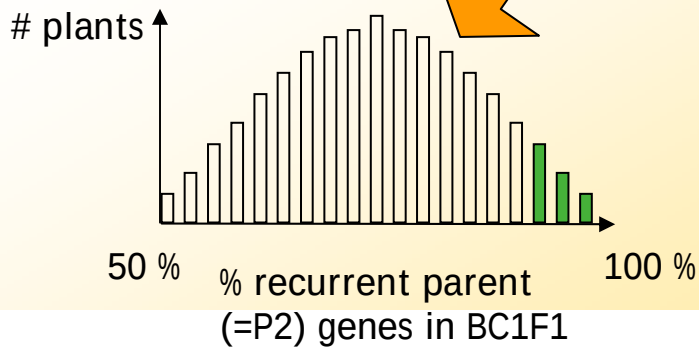
- Breeding process started in 2002
- Breeding goal was to develop a hybrid highly tolerant to BLB for cultivation in the coastal lowlands of India during the rainy season
- Both the male and female parental lines of this hybrid were bred in-house using molecular marker technology
- The hybrid was field tested in bacterial leaf blight hot spots since 2006
- Besides high yield, hybrid characteristics are
  - duration 140-145 days
  - non aromatic medium slender grains
  - high field resistance to bacterial leaf blight
- This first “fully” BLB-tolerant hybrid will be available for sale in India in 2008

Molecular Assisted Breeding – shorter timelines and reduced workload





number plants to consider
without and with marker data



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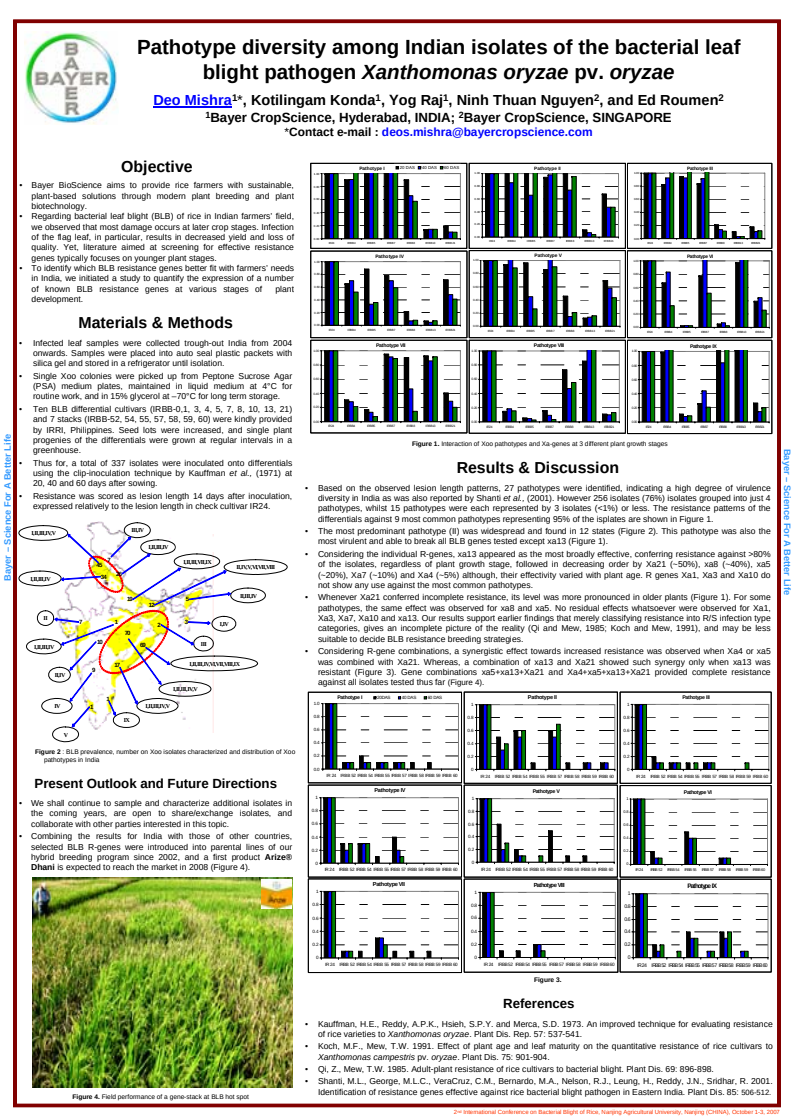
For further details – see poster at Bayer stand



Pathotype diversity among Indian isolates of the bacterial leaf blight pathogen *Xanthomonas oryzae* pv. *oryzae*

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Objective

- Bayer BioScience aims to provide rice farmers with sustainable, plant-based solutions through modern plant breeding and plant biotechnology.
- Regarding bacterial leaf blight (BLB) of rice in Indian farmers' field, we observed that most damage occurs at later crop stages. Infection of the flag leaf, in particular, results in decreased yield and loss of quality. Yet, literature aimed at screening for effective resistance genes typically focuses on younger plant stages.
- To identify which BLB resistance genes better fit with farmers' needs in India, we initiated a study to quantify the expression of a number of known BLB resistance genes at various stages of plant development.

Materials & Methods

- Infected leaf samples were collected trough-out India from 2004 onwards. Samples were placed into auto seal plastic packets with silica gel and stored in a refrigerator until isolation.
- Single Xoo colonies were picked up from Peptone Sucrose Agar (PSA) medium plates, maintained in liquid medium at 4°C for routine work, and in 15% glycerol at –70°C for long term storage.
- Ten BLB differential cultivars (IRBB-0,1, 3, 4, 5, 7, 8, 10, 13, 21) and 7 stacks (IRBB-52, 54, 55, 57, 58, 59, 60) were kindly provided by IRRI, Philippines. Seed lots were increased, and single plant progenies of the differentials were grown at regular intervals in a greenhouse.
- Thus for, a total of 337 isolates were inoculated onto differentials using the clip-inoculation technique by Kauffman *et al.*, (1971) at 20, 40 and 60 days after sowing.
- Resistance was scored as lesion length 14 days after inoculation, expressed relatively to the lesion length in check cultivar IR24.

Figure 2 : BLB prevalence, number on Xoo isolates characterized and distribution of Xoo pathotypes in India

Present Outlook and Future Directions

- We shall continue to sample and characterize additional isolates in the coming years, are open to share/exchange isolates, and collaborate with other parties interested in this topic.
- Combining the results for India with those of other countries, selected BLB R-genes were introduced into parental lines of our hybrid breeding program since 2002, and a first product **Arize® Dhani** is expected to reach the market in 2008 (Figure 4).

Figure 4. Field performance of a gene-stack at BLB hot spot

Figure 1. Interaction of Xoo pathotypes and Xa-genes at 3 different plant growth stages

Results & Discussion

- Based on the observed lesion length patterns, 27 pathotypes were identified, indicating a high degree of virulence diversity in India as was also reported by Shanti *et al.*, (2001). However 256 isolates (76%) isolates grouped into just 4 pathotypes, whilst 15 pathotypes were each represented by 3 isolates (<1%) or less. The resistance patterns of the differentials against 9 most common pathotypes representing 95% of the isplates are shown in Figure 1.
- The most predominant pathotype (II) was widespread and found in 12 states (Figure 2). This pathotype was also the most virulent and able to break all BLB genes tested except xa13 (Figure 1).
- Considering the individual R-genes, xa13 appeared as the most broadly effective, conferring resistance against >80% of the isolates, regardless of plant growth stage, followed in decreasing order by Xa21 (~50%), xa8 (~40%), xa5 (~20%), Xa7 (~10%) and Xa4 (~5%) although, their effectivity varied with plant age. R genes Xa1, Xa3 and Xa10 do not show any use against the most common pathotypes.
- Whenever Xa21 conferred incomplete resistance, its level was more pronounced in older plants (Figure 1). For some pathotypes, the same effect was observed for xa8 and xa5. No residual effects whatsoever were observed for Xa1, Xa3, Xa7, Xa10 and xa13. Our results support earlier findings that merely classifying resistance into R/S infection type categories, gives an incomplete picture of the reality (Qi and Mew, 1985; Koch and Mew, 1991), and may be less suitable to decide BLB resistance breeding strategies.
- Considering R-gene combinations, a synergistic effect towards increased resistance was observed when Xa4 or xa5 was combined with Xa21. Whereas, a combination of xa13 and Xa21 showed such synergy only when xa13 was resistant (Figure 3). Gene combinations xa5+xa13+Xa21 and Xa4+xa5+xa13+Xa21 provided complete resistance against all isolates tested thus far (Figure 4).

Figure 3.

References

- Kauffman, H.E., Reddy, A.P.K., Hsieh, S.P.Y. and Merca, S.D. 1973. An improved technique for evaluating resistance of rice varieties to *Xanthomonas oryzae*. Plant Dis. Rep. 57: 537-541.
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- Qi, Z., Mew, T.W. 1985. Adult-plant resistance of rice cultivars to bacterial blight. Plant Dis. 69: 896-898.
- Shanti, M.L., George, M.L.C., VeraCruz, C.M., Bernardo, M.A., Nelson, R.J., Leung, H., Reddy, J.N., Sridhar, R. 2001. Identification of resistance genes effective against rice bacterial blight pathogen in Eastern India. Plant Dis. 85: 506-512.

2nd International Conference on Bacterial Blight of Rice, Nanjing Agricultural University, Nanjing (CHINA), October 1-3, 2007

Bayer – Science For A Better Life

In short:

- selection of the "best" resistance genes
- gene stack approach on both parents

➔ a "fully" BLB-tolerant hybrid, with good resistance breakdown management

Ari

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Validation of the resistance to BLB in hot spot; small plots in India in 2006

Validation of the resistance to BLB in hot spot; larger plots in India in 2007

BLB-TOLERANT HYBRID RICE IS NOW A REALITY !

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Tomorrow's Rice

Thank you for your kind attention