Super Hybrid Rice in China

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1. Super rice breeding program in China
2. Technical approaches for HR breeding
3. Progress of Phase I
4. Progress of Phase II
5. Progress of Phase III
6. Result from planting super varieties
1. Super rice breeding program in China

1.1 Basic information

- China’s population: 1.3 billion.
  - popu. as staple food: 0.8 billion (60%)
- rice area: 28. mil ha (4.3 yi mu 2008)
- rice yield: 6.3 t/ha (420kg/mu)
- HR yield: 7.35t/ha (490kg/mu)
1.2 Super rice breeding program

time: in 1996
enacted by: China Ministry of Agriculture
applied regions:
all over the planted rice except Yunnan province.
standard:
at 2 locations with 6.7 ha each in 2 running years.
## 1.3 Yield standard of super rice in China

<table>
<thead>
<tr>
<th>Phase</th>
<th>Hybrid Rice</th>
<th>Yield increase</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Early season indica</td>
<td>Single season rice</td>
</tr>
<tr>
<td>Present level</td>
<td>7.50</td>
<td>8.25</td>
</tr>
<tr>
<td>Phase I</td>
<td>9.75</td>
<td>10.50</td>
</tr>
<tr>
<td>96-- 2000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Phase II</td>
<td>11.25</td>
<td>12.00</td>
</tr>
<tr>
<td>01--2005</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Phase III</td>
<td></td>
<td></td>
</tr>
<tr>
<td>11-2015</td>
<td></td>
<td>13.5</td>
</tr>
</tbody>
</table>
2. Technical approaches for HR breeding

Based on Prof. Yuan Longping

2.1 morphological improvement
2.2 raising heterosis level
2.3 by means of biotechnology
2.1 Morphological Improvement

Plant type of super hybrid rice

- tall erect-leaf canopy
- lower panicle position
- bigger panicle size
IRRI’s new plant type  
Yuan’s super HR plant type
Tall erect-leaf canopy

- height of canopy: 1.2 m above
- upper 3 leaves:
  - long, erect, narrow, V-shape, thick
long------- to increase leaf area
erect------- to intercept solar radiation from both sides
narrow---- to occupy less space, with higher LAI
v-shape-- making leaf blade stiffer, so not prone to droopy
thick------- with higher photosynthetic function and not easy to senescent
Lower panicle position

The tip of panicle is 60-70cm above the ground during ripening stage.
Bigger panicle size

Grain weight/panicle: around 6 g
Number of panicles: around 250/m²
2.2 Raising heterosis level
桂花黄

南京11号

japonica

indica

F₁
F₁

japonica

indica
Heterosis in different rice hybrids

Dry matter weight per plant (g)

- I/Jp
- I/jv
- Jp/Jv
- I/I
- Jp/Jp
Heterosis in different rice hybrids

Spikelets / plant

- I/Jp
- I/Jv
- Jp/Jv
- I/I
- Jp/Jp
Heterosis in different rice hybrids

Seed-setting rate

<table>
<thead>
<tr>
<th>Genotype</th>
<th>Seed-setting Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>I/Jp</td>
<td>20</td>
</tr>
<tr>
<td>I/Jv</td>
<td>40</td>
</tr>
<tr>
<td>Jp/Jv</td>
<td>60</td>
</tr>
<tr>
<td>I/I</td>
<td>80</td>
</tr>
<tr>
<td>Jp/Jp</td>
<td>100</td>
</tr>
</tbody>
</table>
Filled seed

Empty seed

Indica/Japonica F1
Yield potential of an indica/japonica hybrid

<table>
<thead>
<tr>
<th>Combination</th>
<th>Plant height (cm)</th>
<th>Number of spikelets /panicle</th>
<th>Number of spikelets /plant</th>
<th>Seed setting rate %</th>
<th>Actual yield (kg/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chengte232(japonica) × 26Zhaizao(indica)</td>
<td>120</td>
<td>269.4</td>
<td>1779.4</td>
<td>54.0</td>
<td>8250</td>
</tr>
<tr>
<td>Weiyou35 (indica/indica)</td>
<td>89</td>
<td>102.6</td>
<td>800.3</td>
<td>92.9</td>
<td>8625</td>
</tr>
<tr>
<td>Increase %</td>
<td>34.8</td>
<td>162.8</td>
<td>122.4</td>
<td>-41.9</td>
<td>-4.3</td>
</tr>
</tbody>
</table>
2.3. By means of biotechnology

2.3.1 Utilization of favorable genes from wild rice
Two yield enhancing QTLs were identified.
CK: 430 g/100 panicles

J23A/Q-611: 580 g/100 panicles
J23A/Q611

10 t/ha in farmer's field as second cropping (2004)
2.3.2 Using genomic DNA from barnyard grass to create new source of rice
Total DNA of barnyard grass introduced into R207 by Spike-stalk injection

Fragments of DNA from barnyard grass confirmed to be introduced into R207 by molecular analysis

New elite R-lines have been developed

Barnyard grass

_Echinochloa crusgalli_
<table>
<thead>
<tr>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Panicles/m²</td>
<td>225</td>
</tr>
<tr>
<td>Spikelets/Pan.</td>
<td>256</td>
</tr>
<tr>
<td>1000-grain weight</td>
<td>32g</td>
</tr>
<tr>
<td>Seed-setting rate</td>
<td>85%</td>
</tr>
<tr>
<td>Yield estimated</td>
<td>15.7t/ha</td>
</tr>
</tbody>
</table>
2.3.3 Transferring $C_4$ gene from maize into super hybrid rice

$C_4$ genes from maize have been cloned and are being transferred into super hybrid rice. The yield potential of $C_4$ super hybrid rice can be further increased by a big margin theoretically.
3. Progress of Phase I

Time: 1996-2000

Target: 10.5t/ha

Hybrids: P64S/9311, P64S/E 32
4. Progress of Phase II

Time: 2001-2005
Target: 12 t/ha
Hybrids: Liang you 293
Y liangyou 1
Y liangyou 7
T you 640
Liang you 0389
II you hang 1
两优293
Y两优1号
5. Progress of Phase III

Time: 2011-2015

Target: 13.5 t/ha

Hybrid: Y liang you 2
        Guang zhan 63S/R1128
Progress of the project

2008: 12.72 t/ha  (848 kg/mu)
2009: 12.84 t/ha  (856 kg/mu)
2010: 13.17 t/ha  (878 kg/mu)
2011: 13.899 t/ha was obtained
2011: 13.899 t/ha was obtained

Location: Longhui county, Hunan
Altitude: 375 m
Area: 7.20 ha (108 mu)
Hybrid: Y liang you 2
Yield components

Yield : 13.899 t/ha (926.6kg/mu)

Effective panicles: 3.023 m/ha
(=20.15 w/m)

Spikelets/panicle : 230.1

Filled grains/panicle: 210.3

Seed setting rate: 91.39%

1000-grain weight: 25.66 g
Growth stages

Sowing date: April 14, 17
Transplanting date: May 12-17
Initiating heading date: July 28
Full heading date: Aug. 8
Ripening date: Sept. 18

Growth duration: 156-158 days
6. Result from planting super varieties

6.1 Yield standard of super rice variety
(1) + 8% over the Check in provincial varieties’ trail with 1 year high-yielding demonstration.
(2) yield: 11.7t/ha for single rice (780 kg/mu) with 6.67 ha at same area at 2 years.
6.2 Number of super rice varieties

2005-2011: 83 （92个-9个退出）

hybrids: 54 （58个-4个退出）
inbreds: 29 （34个-5个退出）
6.3 Area of super rice varieties

2005: 2.558 mil. ha (3837 wan mu)
2007: 5.333 mil. ha (8000 wan mu)
2008: 5.561 mil. ha (8342 wan mu, 19.2%)
2009: 6.070 mil. ha (9100 wan mu)
2010: 6.733 mil. ha (1.01 yi mu)