Cotton Research and production in China

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Outline

- Survey of cotton production in China
- Progress in genetic improvement and cultivation
- Problem
- Collaboration
Cotton production in China

- Plant Area for cotton: 5.6 million hectares
- Total lint yield: 6.5 million Ton
- Lint Yield: 1200 kg/ha.
3 cotton superiority regions in China

- Northwest inland: 1.4 mil ha, 25% Yield 33.0%
- Yellow River: 2.8 mil ha, 50% Yield 45%
- Changjiang River: 1.4 mil ha, 25% Yield 22%
Improvement of Lint yield per ha.

- 1949: 160.5 kg/ha.
- 1985: 904.5 kg/ha.
- 2000: 1107 kg/ha.
我国棉花品种改良的4个阶段
Four stages for cotton variety improvement in China

(1) Improving the G.hirsutum and G.arboreum(1920～1950)
   - G.arboreum(1920s)    G.hirsutum(1940s)
(2) Improving the yield (1950s-1970s)

- 1950’s Varieties Introduction
  - America — Stonville, Deltpine, King, Coker
  - Soviet Union: kk 1543, 108f, C4744, Tashkent 3

- 1960’s Selection Breeding: Guannong 1, Xuzhou 1818

- 1970’s Crossing Breeding: Lumian 1, Ersha 28, Erjin 92
(3) Improving the yield, fiber quality and resistance to disease (1980s-1990)

CCRI 12, Simian 3

(4) Improving fiber strength, transgenic cotton resistant to bollworm and hybridization (1990s-)

High fiber strength: Yumian 1

Transgenic hybrid variety resistant to bollworm: CCRI 29
Cotton breeding goals

- High yield
- Good fiber quality
- Early maturing
- Resistance to disease (verticillium and fusarium)
- Resistance to Insects (boll warms, aphis)
- Draught and Salt tolerance
- Low gossypol
- Color cotton
Techniques for breeding

• Inter and intraspective cross
• Backcrossing
• Mutation Breeding (Radiation, chemical, universe ray)
• Ploidy Breeding
• Population Improvement and Recurrent Selection
• Biochemical and molecular assistant
• Transgenic cotton
• Utilization of hybrid vigor
转基因技术/Transgenic technology
初步构成了农杆菌介导、花粉管通道、基因枪轰击三种转基因技术体系
3 transgenic technology systems

Pollen tube  Gene Gun bombardment  Agri-bacterial
花粉管通道  基因枪  农杆菌介导
大规模高效转基因棉花转化体系，达到了年产转基因植株8000株以上的能力/Annual transgenic plants: 8000
Almost all transgenic cotton: resistance to Bollworm

<table>
<thead>
<tr>
<th>YEAR</th>
<th>AREA (ten thousand ha.)</th>
<th>PERCENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>1996</td>
<td>0.3</td>
<td></td>
</tr>
<tr>
<td>1999</td>
<td>55</td>
<td></td>
</tr>
<tr>
<td>2001</td>
<td>160</td>
<td>35%</td>
</tr>
<tr>
<td>2002</td>
<td>194</td>
<td>48.4%</td>
</tr>
<tr>
<td>2007</td>
<td></td>
<td>70-80%</td>
</tr>
</tbody>
</table>
DNA Transfer lines from G. barbadense into Yumian 17

- donor: G. barbadense
- receiver: Yumian 17
- 4 Lines : HB1、HB2、HB3 and HB4
- Variation of agro. Traits: Small bolls, short fiber, low lint output and late matrurity.
- SSR markers: inosculate
2 棉花杂种优势利用
Cotton hybrid

20—30年代，曾开展了亚洲棉品种间杂种优势利用研究；

- 1920-1930: G.arboreum × G.arboreum

50年代末和60年代初，主要集中于陆地棉与海岛棉种间杂种优势利用，

- 1958-1965: G.hirsutum × G.barbadense

70年代品种间杂种优势利用，重点集中于利用核雄性不育及人工去雄陆地棉品种间杂种优势利用研究。

- 1970-: G.hirsutum × G.hirsutum
  
  hybrid seeds in nuclear male infertile lines and by hand emasculation
杂种优势利用的规模扩大

- 90年代前，每年面积100万亩，以营养生长优势强为主。

- Until 1990: 66.7 thousand hectares per yr

- 90年代后，转Bt基因抗虫杂交棉生殖生长优势增强，优势明显。利用面积达600万亩/年，占总面积的10%。

- After 1990: 400 thousand hectares per yr, 10%

- 预计现在面积达3000万亩/年, 占37%

- Now, 2 million hectares per yr, 37%
In China, more than 30 natural color fiber cotton cultivars and lines were bred in 1987-2007, and their fiber quality is almost near to that of commercial white cotton variety. The total growing area was 70,000 hectares in 1998-2007.
Collections and conservation of cotton genetic resources in China

<table>
<thead>
<tr>
<th>Species (物种)</th>
<th>No.of Accession (份数)</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Gossypium hirsutum</em> (陆地棉)</td>
<td>6522</td>
</tr>
<tr>
<td><em>Gossypium hirsutum race</em> (陆地棉种系)</td>
<td>350</td>
</tr>
<tr>
<td><em>Gossypium barbadense</em> (海岛棉)</td>
<td>565</td>
</tr>
<tr>
<td><em>Gossypium arboreum</em> (亚洲棉)</td>
<td>378</td>
</tr>
<tr>
<td><em>Gossypium herbaceum</em> (非洲棉)</td>
<td>17</td>
</tr>
<tr>
<td><em>Gossypium species</em> (野生种)</td>
<td>46</td>
</tr>
<tr>
<td>Total</td>
<td>7878</td>
</tr>
</tbody>
</table>

Total 7878 accessions of cotton germplasm were collected and preserved in China.
Germplasm Identification and Evaluation
种质鉴定和评价

- Criteria of assessment: Based on IPGRI standard descript for cotton (1980)
- 66 Traits have been evaluated (评价66项性状) among more than 6372 cotton germplasm including:
  - 41 morphological and agronomic characters (农艺性状)
  - 13 fiber quality (纤维品质)
  - 4 seed quality (种子品质)
  - 8 traits with disease, insect, adverse resistance (抗病虫)
### Germplasm high frequency released

<table>
<thead>
<tr>
<th>Release times</th>
<th>Variety No.</th>
<th>Released germplasms</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-5</td>
<td>1528</td>
<td>Acala 4-42, Arcot 436, B431-6, Des 926, Heishanmian 1, Sicala V1, Simian 2, Lumian 1</td>
</tr>
<tr>
<td>6-10</td>
<td>117</td>
<td>Acala sj-4, L142-9, DPL 15, CCRI 17, CCRI 19, Xuzhou Half-half, Lumian 6, G. barbadense</td>
</tr>
<tr>
<td>11-15</td>
<td>54</td>
<td>Lambright Gl-5, Earlistaple 7, Uganda 3, Belsnow, 86-1, Liaomian 5, CCRI 10, Simian 3</td>
</tr>
<tr>
<td>16-20</td>
<td>36</td>
<td>AC 239, AC 241, PDo111, PD 0259, PD 4461, PD 695, CCRI 16, Jinta herbacium</td>
</tr>
<tr>
<td>21-25</td>
<td>20</td>
<td>PD 875, PD 9223, PD 9232, PD 9263, PD 9264, FTA, CCRI 12, Shixiya 1</td>
</tr>
<tr>
<td>26-30</td>
<td>15</td>
<td>PD 0109, PD 0113, PD 3246, PD 4381, PD 6520, PD 8619, Purple-brown upland, green cotton</td>
</tr>
<tr>
<td>31-35</td>
<td>8</td>
<td>PD 2164, PD 2165, PD 3249, PD 4548, FJA, Line F, SC-1, purple-spot cotton</td>
</tr>
<tr>
<td>Total</td>
<td>1756</td>
<td></td>
</tr>
</tbody>
</table>
Key Culture Technology in China
Rape/wheat-cotton doubling cropping  Multi-maturity
Cropping system in cotton field/棉花不同的套种方式
Plant density

![Graph showing cotton harvested density from 2001 to 2006 in China]

**图 1 2001–2006 年全国棉花收获密度**

**Fig. 1 Cotton harvested density in 2001–2006 in China**
Culture Technology

seedling raising and transplanting
Seedling production industrially
Planting by machine
Film-mulching:

• During seedling raising
• Before seeding
• After transplanting
chemical control and agronomic regulation

• DPC applying
• Manual cut invalid branch
Basic Research Progress for Cotton Molecular Breeding
陆海种间DNA分子标记遗传连锁图谱构建

Genome mapping of G. hirsutum × G. barbadense
3. 棉花主要经济性状的 QTL 研究进展

QTLs Identification of main economic traits

1) 纤维品质性状
   Fiber properties
2) 产量及其构成因子
   Yield and its components
3) 株高、叶片形态和茎叶茸毛征等
   Plant height, Leaf morphological characters etc.
4) 抗病性(角斑病、黄萎病等)
   Disease resistance
功能基因组学研究
Functional Genomics

● 基因文库Genes Libraries
  • 基因组(gDNA)文库构建/gDNA Libraries
  1 YAC Library (Xie Yongbiao, 2001)
  2 BAC Libraries (Ma Shiying, 2004)

● 转录组(cDNA)文库/cDNA Libraries

Fiber cDNA 不同纤维发育时期的cDNA文库构建

cDNA for disease resistance 抗病等生物逆境(枯、黄萎病

cDNA文库构建

cDNA for stress resistance 抗旱等非生物逆境(干旱、盐碱、
低温等)的cDNA文库构建

● Clone and isolate 30 genes related fiber developed. 已克隆
出相关候选功能基因30多个。
172 fiber specific cDNA were gained by DNA chips.

通过基因芯片筛选，得到172个纤维特异表达的cDNA克隆。
控制种皮特异启动子GhDET2改良纤维品质
3 genes of PR-10 family for verticillium wilt resistant were isolated, two from G.barbadense, one from G.hirsutum.

Amino acid sequence analysis of cotton PR-10 family
More than 1300 protein spots for fiber development have gotten by 2-D gel electrophoresis.
Problem

- Less varieties with high fiber quality
- Lack of varieties with high Verticillium wilt resistance
- Limited land used for cotton growing, So the salination and arid land were need to exploit
Collaboration

- Research on Germplasm:
  - Germplasm with high fiber quality;
  - Resistance to Verticillium wilt;
  - Short season (early mature);
  - Stress resistance including salinity, drought resistance, high temperature tolerance, low temperature tolerance
  - Exotic G. hirsutum (Interspecific cross)

- Visiting Scientists
  - To conduct graduate study and training in the area of cotton genomics and molecular biology
  - To cooperate for exploiting specific cotton products
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60个现代化实验室
合肥试验基地综合楼
中棉所北疆生态育种试验站
海南繁育中心
中棉所新试验农场
THANK YOU!