Introduction

1. Proprietary seed market accounts for almost 67% (Watch, 2009)
2. Horticultural seed companies are minor in world seed trade.
3. Only Sakata and Takii are Asian seed companies ranked in world top 10 seed company. Both occupy only 2% of world seed market. → Seed companies based in Asia are still weak
4. Sakata and Takii are both strong in world flower seed market.
5. Zespri and Suntory, originated in Asia, are very strong worldwide in specific fields, eg) Kiwii and flower breeding
6. Crop oriented private company or governmental institutes are focusing on breeding and development of specific crops.

Horticultural seed market in Asia

Table 4. Horticultural Seed market in Asian countries.

<table>
<thead>
<tr>
<th>Countries</th>
<th>Market size (million US$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>China</td>
<td>4,000</td>
</tr>
<tr>
<td>India</td>
<td>1,500</td>
</tr>
<tr>
<td>Japan</td>
<td>1,500</td>
</tr>
<tr>
<td>Russia</td>
<td>500</td>
</tr>
<tr>
<td>Australia</td>
<td>400</td>
</tr>
<tr>
<td>Korea</td>
<td>400</td>
</tr>
<tr>
<td>Other</td>
<td>300</td>
</tr>
<tr>
<td>Total</td>
<td>8,600</td>
</tr>
</tbody>
</table>

Recent breeding activities for horticultural crops in Asia

- Vegetables : Hot Pepper, Chinese cabbage, Radish, Watermelon, Strawberry, Tomato, Onion
- Fruit trees : Kiwii fruit, Apple, Pears, Grape,
- Ornamental flowers : Lisianthus, Gentiana, Statice, Pansy, Petunia, seed Lilium
- Seed companies :
  - Vegetables : Sakata, Takii, Nongyu, Nongwoo etc.
  - Fruit trees : Zespri int'l, Governmental institute etc.
  - Flowers : Sakata, Takii, Myoshi, Suntory, Kirin etc.
Gene / Chromosome manipulation

- + : Crossing
- - : Mutation
- + : GMO
- X : Polyploidisation (2x → 4x → 8x)
- ° : Haploidisation (2x → x)

Plant breeding is the purposeful manipulation of plant species in order to create desired genotypes and phenotypes for specific purposes.

Tools for improving crop quality

1. Hybrid Breeding : SI, MS, haploid breeding, intra- or interspecific hybridisation : all crops
2. Mutation Breeding : ornamental flowers, Fruit, cereals
3. GMO Breeding : ornamental flowers
4. Marker Assisted Breeding : vegetables, fruit trees

Plant breeding

Breeding tools?

Pepper breeding in Asia

80 million $ market
China, India, Indonesia, Korea etc

Interspecific hybridization

Interspecific hybridization in Brassica revealed by U(1935)
Brassicoraphanus

2n=4x=37
A genome =19 (instead of 20)

A new type of Brassica napus for leafy vegetables

B. rapa(A, 2n=20) x B. oleracea(C, 2n=18) → several times BC to B. rapa → 2n=2x=26, 26 → Seeding → F3-F4 (2n=4x=38+2), infertile
Korean “Ssamchu”

Interspecific hybridization in lily

• Pre-fertilization barrier; inability of pollen grains to germinate on the stigma
  • Mentor pollination
  • Bud pollination
  • Cut-style
  • Grafted-style
• Post-fertilization barrier; abortion of embryo and endosperm
  • Ovary culture
  • Ovule culture
  • Embryo culture
Interspecific hybridization in lily

Embryo culture

How to overcome F₁ sterility?
- By mitotic polyploidization
  - Somatic chromosome doubling
  - Colchicine or Oryzalin
  - No homoeologous recombination
- By meiotic polyploidization
  - 2n-gametes by FDR, SDR and IMR
  - Homoeologous recombinations

Interspecific hybridization 1: Mitotic polyploidization

A x B → 2x-2x crossing

2x-2x crossing → Chromosome doubling

AA x AABB → BBBBB

2x-4x crossing

AAB → ABBB

Color variation from 2x-gametes of F₁ hybrid

Interspecific hybridization 2: Meiotic polyploidization

A x B → 2x-2x crossing

2x-2x crossing → 2n pollen

AA x 2x AB → BBBBB

2x-4x crossing

AAB → ABBB

Color variation from 2n-gametes of F₁ hybrid
Mitotic metaphase chromosome of LA hybrid (F1)

Meiotic metaphase I stage of LA hybrid (F1)

BC₁ hybrid: 2n = 3x = 36 = 12 A x (12 L + 12 A)

Variety development by radiation breeding methods by countries in 2009

Mutation breeding

Plant Breeding using ion-beam irradiation

Source: Abe T.
Fig. 7. Examples of mutation breeding in Japan. Flower color modification in chrysanthemum often showed by irradiation of gamma ray and ion beam. Ion beam irradiation showed higher frequency in flower color changes.

Cymbidium, Aerides etc.
- Breeding by crossing
- Radiation breeding

Orchid breeding by radiation

Variegated leaves of Dendrobium
Orchids from seeds carried on the China spaceship ‘Shenzhou #8(2009.9)
Genetic engineering

"Applause" a blue rose cultivar bred first time through plant biotechnology in Japan.

Florigene - The World's First Molecular Breeder
Florigene, part of the Suntory Group, has used genetic modification technology to create valuable improvements to important flower species.

Blue rose, a breakthrough in flower breeding by genetic engineering

Future prospects for horticulture breeding in Asia

For every...
6,000 pints of beer
1,150 loaves of bread
600 kg of sugar
...£1 in royalty is reinvested in plant breeding.

For every...
150 stems of rose
200 stems of chrysanthemum
40 kg of strawberry
...$1 in royalty is reinvested in plant breeding.

Will it be possible?

Rainbow roses......
Will it be possible? It is already made!

Thank you for your attention!