Flower breeding for the global market

UPOV Symposium on the plant breeding of the future

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Introduction: Complexity of the flower market

- Different segments
  - Cut flowers
  - Indoor plants
  - Bedding plants
  - Perennials
  - Grasses
  - Shrubs
  - Trees

- Propagation technology
  - Seeds
  - Cuttings
  - Bulbs
  - In vitro material
  - Grafting

- Wide range of species with a commercial value

- In Europe
  - 400 species
  - 250 genera
  - 100 families
Introduction: Company profile Selecta

- Family owned company group with 10 companies focused on breeding, young plant production and distribution of vegetative propagated ornamentals

- Breeding: approx. 45 species
  - bedding plants, pot plants, perennials and cut flowers
  - 7 breeders located in Germany and Italy
  - Breeding facilities in Germany, Italy, Tenerife, Kenya
  - Laboratory for in vitro culture, biotechnology and phytopathology in Germany

- Production of unrooted cuttings in Kenya, Uganda and Tenerife (30 ha)

- Rooting facilities in Germany and Italy (15 ha) plus contract rooting in 8 European locations

- Distribution worldwide through sales reps, agents, root and sells, wholesalers and licensees
The global flower market

- Total retail value approximately $100 billion
- Cut flower segment $40 to 60 billion
- North America, Europe and Japan are 80% of the market
- Cut flower markets are declining
- The outdoor segment is moderately growing
- The cut flower market is dominated by vegetative propagated species
- The fast majority of protected varieties are vegetatively propagated
Floriculture is in a heavy consolidation process driven by price pressure in retail which effects also the breeding companies

- In the last years we saw a number of mergers and acquisitions
- Breeders and young plant producers relocated their mother stock, seed production and tissue culture to low cost countries
- The fast majority of the breeding activities is still located in North America, Europe and Japan
- Despite consolidation, there is an impressive number of small breeding companies and private breeders who achieve very frequently important breeding results
  - Huge diversity of ornamentals
  - Enthusiasm achieves sometimes more than professionalism
  - The technical level of breeding is in many species still low
The global flower market: Trends in gardening

- The classical plant classes like bedding plants, perennials, shrubs and even vegetables are blurring

- Having a nice garden or patio is in, working in a garden is out
  - „Do it myself“ is becoming „Do it for me“
  - Decorating is taking over gardening

- Breeders have to provide solutions
  - Recipes for plant mixes
  - Mixed pots
  - Not the single variety but the combination of varieties has to perform
The global flower market: Impact of marketing

The introduction of Surfinia changed the bedding plant market in Europe:

- Innovated breeding was combined with a strong marketing approach
- Surfinia became a synonym for all trailing Petunia
- Surfinia is today one of very few brands in our industry which achieved a certain level of consumer recognition

Today innovative marketing is nearly always combined with a strong marketing approach and the success of breeding is highly depending on the marketing behind it

The retail demands today from the breeder a package of new varieties and marketing tools
Conventional breeding approaches: Bedding plants

- The bedding plant market is driven by the introduction of new commercial products which can be a new hybrid, a new species or even a new genera.

- The novelties take marketshare of the existing commodities and can develop into a major product within a few years.

- A good example is the genus Calibrachoa:
  - First varieties were introduced by Suntory 1996, before that Calibrachoa was not known as an ornamental.
  - Today Calibrachoa is already the second biggest vegetative propagated bedding plant in North America and also in Europe and in Japan the product is already a major genus with a strong growth year by year.
  - At least 8 companies have established breeding programs and release improved varieties yearly.
Conventional breeding approaches: Bedding plants

- The breeding of bedding plants was driven by innovations during the last years and created the development of new interspecific or even intergeneric hybrids
  - Examples we can find in Osteospernum, Lobelia, Impatiens, Nemesia, Calibrachoa …
- In ornamentals very often the new hybrid is the variety or the starting point of a completely new genepool
- Backcrossings to commercial varieties to transfer a single characteristic trait (like a disease resistance) have very little relevance in vegetative propagated bedding plants
- Due to this breeding method we find many varieties with a very limited fertility and complex genepools with a range of different ploidy levels
Conventional breeding approaches: Cut flowers

- Cut flower production has been moved over the last decades from Europe and North America to East Africa and South America due to lower production costs and better climate conditions
  - Shipping ability has become an important selection criteria
  - Suitability for sea freight may become a new challenge for the breeders
  - Productivity is also in the low costs countries a major breeding target
- Cut flower breeders have moved their activities to East Africa and South America
  - Trial Stations
  - Purchase of cut flower farms by breeding companies
  - Dislocation of complete breeding programs
- Major cut flower producers in Central America and East Africa have started themselves to invest into breeding
Conventional breeding approaches: Cut flowers

- The carnation breeding program of Selecta benefits from the assets of the different locations of the company and is adapted to the needs of the key markets
  - Genepool and candidate stock is kept in Germany
  - Crossing work is done in Tenerife
  - Seedling selection takes place in Kenya
  - Trials of the selected clones are in Germany, Kenya, Italy, Japan and Columbia

- Breeders need strong management skills and have to be prepared to travel
## Genetic engineering in ornamentals

### Examples 1987 to 2005

- Anthurium
- Antirrhinum
- Begonia
- Calendula
- Dendrathema
- Dedrobium
- Dianthus
- Eustoma
- Gentiana
- Gerbera
- Gladiolus
- Osteospernum
- Pelargonium
- Petunia
- Rhododendron
- Rosa
- Torenia

### Flower colour

- Anthurium
- Antirrhinum
- Begonia
- Calendula
- Dendrathema
- Dedrobium
- Dianthus
- Eustoma
- Gentiana
- Gerbera
- Gladiolus
- Osteospernum
- Pelargonium
- Petunia
- Rhododendron
- Rosa
- Torenia

### Fragrance

- Anthurium
- Antirrhinum
- Begonia
- Calendula
- Dendrathema
- Dedrobium
- Dianthus
- Eustoma
- Gentiana
- Gerbera
- Gladiolus
- Osteospernum
- Pelargonium
- Petunia
- Rhododendron
- Rosa
- Torenia

### Vase life

- Anthurium
- Antirrhinum
- Begonia
- Calendula
- Dendrathema
- Dedrobium
- Dianthus
- Eustoma
- Gentiana
- Gerbera
- Gladiolus
- Osteospernum
- Pelargonium
- Petunia
- Rhododendron
- Rosa
- Torenia

### Production characteristics

- Anthurium
- Antirrhinum
- Begonia
- Calendula
- Dendrathema
- Dedrobium
- Dianthus
- Eustoma
- Gentiana
- Gerbera
- Gladiolus
- Osteospernum
- Pelargonium
- Petunia
- Rhododendron
- Rosa
- Torenia

### Stress tolerance

- Anthurium
- Antirrhinum
- Begonia
- Calendula
- Dendrathema
- Dedrobium
- Dianthus
- Eustoma
- Gentiana
- Gerbera
- Gladiolus
- Osteospernum
- Pelargonium
- Petunia
- Rhododendron
- Rosa
- Torenia

### Pathogene resistance

- Anthurium
- Antirrhinum
- Begonia
- Calendula
- Dendrathema
- Dedrobium
- Dianthus
- Eustoma
- Gentiana
- Gerbera
- Gladiolus
- Osteospernum
- Pelargonium
- Petunia
- Rhododendron
- Rosa
- Torenia

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**Table 3: Transgenic Floriculture Crop with Modified Traits**

<table>
<thead>
<tr>
<th>Species</th>
<th>Trait</th>
<th>Reference</th>
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<tr>
<td>Anthurium andreanum</td>
<td>Delayed flowering</td>
<td>Galbraith et al., 1993</td>
</tr>
<tr>
<td>Antirrhinum</td>
<td>Increased flower longevity</td>
<td>Galbraith et al., 1993</td>
</tr>
<tr>
<td>Begonia</td>
<td>Increased flower longevity</td>
<td>Galbraith et al., 1993</td>
</tr>
<tr>
<td>Calendula</td>
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<td>Galbraith et al., 1993</td>
</tr>
<tr>
<td>Dendrathema</td>
<td>Increased flower longevity</td>
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<tr>
<td>Dedrobium</td>
<td>Increased flower longevity</td>
<td>Galbraith et al., 1993</td>
</tr>
<tr>
<td>Dianthus</td>
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<td>Galbraith et al., 1993</td>
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<tr>
<td>Eustoma</td>
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<td>Gladiolus</td>
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<td>Osteospernum</td>
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<td>Rosa</td>
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<tr>
<td>Torenia</td>
<td>Increased flower longevity</td>
<td>Galbraith et al., 1993</td>
</tr>
</tbody>
</table>

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*From the field test release permit database for the US (http://www.ars.usda.gov/obc/fieldTestInfo/).*

Genetic engineering in ornamentals

» Commercial examples
Breeding companies today have very limited activities in the field of genetic engineering

- Small markets even of the most important ornamentals
- High deregulation costs
- Lack of access to intellectual property rights of enabling technology and interesting trait genes
- High costs for research and development
- Fundamental opposition against GMO‘s in Europe
Ornamental Bioscience was founded in 2007 as a joint venture of Mendel Biotechnology and Selecta Klemm

- Mendel Biotechnology has characterized transcription factors from Arabidopsis
- Transcription factors which give increased abiotic stress tolerance and disease resistance are tested in ornamentals
- Ornamental bioscience has access to the enabling technology of Monsanto

The vision is to create a new generation of convenience plants which are easy to handle, stay healthy and are tolerant to reduced water supplies
Genetic engineering of ornamentals

First results of Ornamental Bioscience

- Improvements in Petunia:
  - Reduction of the water demand of 30 %
  - Tolerance against long drought periods
  - Normal plant development also after several periods of drought stress
Biotechnology in ornamentals: Marker technology

- Molecular markets have been applied in a huge amount of species (160 before 2006)

- Fast majority of applications in ornamentals is in the field of fingerprinting research for identification, diversity and taxonomy studies

- The history of the gene pool of ornamentals is very often unknown in ornamentals. Fingerprints are a powerful technology to get an understanding of the relationship between different genotypes and to make the start of a new breeding program more effective.
Biotechnology in ornamentals: Marker technology

- Marker assisted selection is still - with a very few exceptions - not used in ornamental

- One reason is that the research applied before marker assisted selection is long term and costly
  - Exact phenotyping
  - Clarification of the inheritance of important traits
  - Genetic linkage maps

- Ornamentals have very often a complex cytology which increases the complexity

- Roses are the best studied groups in ornamentals. A linkage map is available and disease resistance genes have been characterized. Nevertheless to my knowledge the markers are not used in the commercial breeding programs

- Before marker technology will be applied in breeding programs much more research has to be done. A development as we have seen it in the breeding of vegetables is very unlikely.
Double flowering Calibrachoa: A case study

- The breeding program was established in 1996 with the focus on colour, production characteristics and early flowering.
- In the 2006/2007 the first variety with double flowers was introduced by Selecta and recognized as a major step in the Calibrachoa breeding.
- In the US a Utility patent was filed and granted with the title “Double Flowering Calibrachoa Breeding Methods and Plants Produced Therefrom.”
- In the breeding process of the Double Flowering Calibrachoa new technologies had to be developed or adapted for this species and contributed to the development of the new trait:
  - Protoplast culture
  - Induction of mutations
  - Anther culture
Double flowering Calibrachoa: A case study

- Beside the implementation of the technology a new species was integrated into the breeding program.

- Already in 2008 a competitor presented on the US Pack trials a Calibrachoa variety with double flowers.

- AFLP and cytology analysis proved that the variety was a hybrid of the first commercial variety.

- It took years and a highly sophisticated breeding approach to develop this new character in Calibrachoa.

- Unfortunately due to the relatively simple inheritance of the double flowering it can be transferred very easily to new varieties.
Intellectual property rights and breeding progress

- Effective Plant Breeder Rights are a precondition for the commercial breeding of vegetatively propagated ornamentals.

- The UPOV convention from 1991 has improved the position of the breeders:
  - Vast majority of the growers accept that mutations belong to the breeder of the original variety.

- Illegal propagation is still a severe problem and breeders have to defend their position constantly.

- We have today more conflicts between the breeders in the field of EDV’s and patents.

- Patents can be an important addition to plant breeders rights for the breeders of ornamentals.
Thank you for your attention!

Ulrich Sander