Flower breeding for the global market – Ulrich Sander

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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

**The global flower market**
- 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 vast 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 professionality
  - 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

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 market share 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: 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
  - Discontinuation of 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
  - Gene pool 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 Colombia
- Breeders need strong management skills and have to be prepared to travel
Genetic engineering in ornamentals

Examples 1987 to 2005

- Anthurium
- Antirrhinum
- Begonia
- Calendula
- Dendrobium
- Dianthus
- Eustoma
- Gentiana
- Gerbera
- Gladiolus
- Osteospermum
- Pelargonium
- Petunia
- Rhododendron
- Rose
- Torenia

Flower colour
Fragrance
Vase life
Production characteristics
Stress tolerance
Pathogene resistance

Commercial examples

Biotechnology in ornamentals: Genetic engineering

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

Biotechnology in ornamentals: Genetic engineering

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 production.
- One reason is that the research applied before marker assisted selection is long term and costly.
  - Genotyping
  - 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

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.

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