Make Breeding More Efficient©

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INTRODUCTION

With background in our breeding of *Aster novi-belgii* relations of importance for the efficiency in breeding are described. The procedure in *Aster* can be used in other vegetatively propagated plants. Crossings are made in the autumn and the first selection among seedlings is performed the coming spring. Selected seedlings are cloned and two groups of each clone are grown according to a standard programme for potted *A. novi-belgii*. The clones flower approximately 1 year after the crossings are made. The best clones are then selected and evaluated the following season in a number of nurseries prior to a final selection of clones worth introducing to the market. This time schedule gives a period of 2.5 years from crossing until plants are available on the market (Kristiansen, 1996; Kristiansen and Brandt, 1994).

Breeding of *Aster* is carried out in cooperation with the Danish Pot Aster Association (25 to 30 nurseries producing approximately 7 million pots). The breeding was initiated in 1991 and the first cultivar, 'Purple Viking', was on the market in 1993. The first series has the name Viking to illustrate strong plants from Denmark. Since 1993, 13 cultivars in this series have been introduced. During summer 2000 a new series without yellow disc florets was introduced by the Danish Pot Aster Association (Kristiansen, 2000). The name of the series is Victoria as the flowers could remind about the rococo period of Queen Victoria of England. Until now three cultivars in this series have been introduced, but additional cultivars will come.

Initially in the breeding of *Aster* the degree of self fertility, flower induction in seedlings, and characteristics suitable for selection among seedlings were investigated.

POLLINATIONS

If plants are self fertile methods to secure cross pollinations are important in a breeding programme. Individual (ray and disc florets) flowers in the capitulum of *A. novi-belgii* are rather small, making emasculation impossible. In some selfings very few seeds were produced compared to crossings between cultivars. If *Aster* had been self fertile the procedure could have been only to use pollen sterile cultivars as pollen recipients or only to harvest seeds produced by the ray florets, as they are unisexual (only female) and the stigma is ripe for pollination before pollen is released from the disc florets. Thus, self pollinations within the same capitulum will not take place. Both these alternatives are less efficient by reducing the number of cultivars to be used in the breeding and by reducing the number of seeds harvested per capitulum.

The growth conditions of the parental plants also influence seed setting. Plants should be in good vigour and growth regulators and pesticides should be avoided. As a first attempt pollinations should be made between 10 AM and 12 AM and not during the darkest winter. If seed setting is not satisfactory experiments with daylength, temperature, and growing season could be made.

FLOWERING OF SEEDLINGS

After seeds have been obtained, seedlings should flower as soon as possible in order

to make the first selection. *Aster novi-belgii* is a short-day plant, however, how seedlings react on photoperiodic treatments was not known at the start of our breeding. To determine at which time short-day treatments of our seedlings should be started we moved seedlings with various length of the main stem to short day condition and thereafter measured time to flowering. If seedlings were more than 5 cm at the beginning of short-day treatment they flowered approximately 5 weeks later (Kristiansen et al., 1997).

SELECTION AMONG SEEDLINGS

Among the produced seedlings the most interesting plants are selected for further testing and selection. Plants have both a juvenile and adult growth period. When plants have reached the adult phase they are able to flower if the proper conditions are given. However, many other characteristics differ between juvenile and adult plants. The length of the juvenile phase differs among plant species. In some it is nearly not present and in trees it can be several years. After vegetative propagation the growth phase of the plants are normally retained. Further, seedlings of a pot plant species differ from the pot plant due to pinching and use of growth regulators. Thus, it might be difficult to know which characteristics should be of highest priority during selection among seedlings.

In our breeding of *Aster* we initially measured a number of characteristics on the seedlings and again on pot plants produced from each seedling (Kristiansen et al., 1997). The highest correlations between measurements made on the two types of plants were obtained for flower colour, flower size, and number of ray florets. The correlation for plant height was low, but still significant. For time to flowering no correlations were present. Such experiments are not necessary each time a group of seedlings is in flower, however, when starting breeding of a new crop it might be beneficial to investigate the parameters described above.

SELECTION

The most expensive part of a breeding programme is to test selected seedlings in clonal experiments. Depending on the breeding efforts made earlier in the plant species the number of new cultivars among a seedling lot varies. The potentials of most pot plants are not at all exhausted, so large improvements can be expected in the first generations of a new breeding programme. In our breeding of *Aster* 5% to 10% of seedlings are selected, and during the first selection among the vegetatively produced offspring 10% are selected for testing in the nurseries in the Pot Aster Association. Normally two new cultivars are applied for plant breeders rights each year. In the Danish rose-breeding company Poulsen Roser Aps., 97% of the seedlings are discarded at the first selection (Rindom, 2000).

SELECTION OF SPECIFIC CHARACTERISTICS

In most breeding programmes of pot plants, the general performance of the plant is used as selection criterion, i.e., an overall impression of flower colour, growth habit, health, etc., and the selection is normally made under the standard production scheme used for that crop.

If specific characteristics such as resistance against pests and diseases, low content of allergens, long shelf life, etc., are the main breeding goals different selection methods have to be applied. It is necessary to test the breeding material under

conditions where the specific characteristics can be expressed – maybe on cost of other important characteristics. After selection of plants with the specific characteristic new selections have to be made in order to select for other characteristics.

We want to make *Aster* cultivars with a longer keepability, so if it is possible already among seedlings to select efficiently for a long keepability the number of clones to be tested could be reduced. We found a significant correlation between keepability of the first developed flower on the main stem of the seedling and the keepability of the clones in a standard interior room used for testing keepability.

In a breeding programme to select *Campanula carpatica* with resistance against the root pathogen, *Phytophthora*, Thinggaard (1995) developed a method, where petioles are dipped in a solution of zoospores of the fungus. The resistance of the plant can then be determined by how far the fungus grow in the leaf.

Primula obconica, among many plants, can give allergic reaction to people coming in contact with the plant. New cultivars have been released without this negative characteristics. Christensen and Larsen (2000a,b) have developed a very sensitive method to measure the content of the compound giving the allergic reaction. Also *Alstroemeria* is known to give eczema, and chemical methods to measure the allergens have been developed and used in a breeding programme (Christensen and Kristiansen, 1995; Kristiansen and Christensen, 1998). The alternative to measure the content of allergens would be to test new cultivars on people already sensitized to the allergens and that is of course not possible.

DOMINANCE

The phenotype of a plant is controlled both by the genes and the environment. Plants have at least two copies (alleles) of each gene, and the alleles can interact in different ways. Often one allele dominates the other, i.e., only one of the alleles is expressed. The two alleles come from the pollen donor (male) and pollen recipient (female). In most plants alleles giving nonwhite flowers dominate over alleles giving white flowers. Thus, crossing a white and a nonwhite plant will only give nonwhite offspring, however, all seedlings will have the allele for white flowers. New crossings between the offspring will give white-flowered plants.

To make a white-flowered Viking *Aster*, we crossed the old cultivar 'White Swan' with 'Purple Viking' and among the seedlings with the best flowers we made new crossings, and from these the white-flowered cultivar 'Margrethe Viking' was selected. The knowledge of dominance with respect to flower colour in *Aster* reduced the time needed to breed a white-flowered Viking cultivar by almost 1 year.

LITERATURE CITED

Christensen, L.P. and **K. Kristiansen.** 1995. A simple HPLC method for isolation and detection of the allergens, tuliposide A and tulipalin A in *Alstroemeria*. Contact Dermatitis 32:199-203.

Christensen, L.P. and **E. Larsen.** 2000a. *Primula obconica* – undersøgelser af ikke allergifremkaldende sorter. pp. 1-6. Grøn Viden 130 (Havebrug).

Christensen, L.P. and **E. Larsen.** 2000b. Priminfrie *Primula obconica* nu på markedet. Gartner Tidende 116 (16): 4-5.

Kristiansen, K. 1996. Viking Asters. pp. 1-4. Grøn Viden 98 (Havebrug).

Kristiansen, K. 2000. En ny Asterserie på vej. Gartner Tidende 116 (4):27-28.

Kristiansen, K. and **K. Brandt.** 1994. Forædling af *Aster novi-belgii* med nye blomsterfarver. Gartner Tidende 110:622-623.

Kristiansen, K. and **L.P. Christensen.** 1998. Allergen content in *Alstroemeria* can be reduced by breeding. Euphytica 101:367-375.

Kristiansen, K., C.W. Hansen, and **K. Brandt.** 1997. Flower induction in seedlings of *Aster novi-belgii* and selection before and after vegetative propagation. Euphytica 93:361-367.

Rindom, P. 2000. I rosenforædlernes værksted. Gartner Tidende 116 (20):12-13

Thinggaard, K. 1995. *Phytophthora* rodråd i *Campanula*. Gartner Tidende III(52):5.

Flower Breeding in Practice©

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INTRODUCTION

F_1-breeding of seed-propagated species is an important method for breeding new cultivars. At Dæhnfeldt we have a number of breeding programmes in progress, but we frequently decide whether we are going to start new programmes. We get inspiration and ideas for new cultivars from many places: exhibitions, journeys, botanical gardens, catalogues, magazines, customers, and trend researchers. There is seldom lack of ideas but they have to be discussed thoroughly before decisions are made because breeding must be profitable. A number of questions are important:

- Do the species fit into our assortment?
- How big is the market? It can be very difficult to estimate for small or new crops, while the market for larger, well-known crops can be estimated from various statistics.
- How is the competition?
- Will we be alone with the new cultivars of the particular species or are we the seventeenth seed company with series of the species?
- What is the cost of producing seeds? It can be very difficult to estimate without practical experience and typically large seed productions will give cheaper seed than small productions. Further, seed production in foreign countries may give cheaper seed than production in Denmark.
- What will the price of the seed be?

F_1–BREEDING

When it has been decided to work with a new species, plant material must be collected. All accessible varieties and botanical species are procured. Information about the species, method of cultivation, etc., must also be procured. This information can be found, e.g., in books, plant clubs, on the Internet, and at specialists. Trial tests are made to see how the species behaves. The flower is examined and test pollinations are made. Some species will then be discarded, because they are too difficult to work with.

Then the hard work in the F_1-hybrid breeding comes. Crossings are made followed by selection of plants with the desired characteristics and inbreeding until the offspring has become sufficiently homogeneous to be called pure lines.