RESEARCH AND DEVELOPMENT ON NEW CROPS IN THE UNITED STATES DEPARTMENT OF AGRICULTURE

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Abstract

A research program was initiated in 1982 to increase the diversity of florist crop germplasm in the United States. New plants are identified from specialty growers, breeders, and research institutes all over the world. The initial evaluation includes studies on propagation, growth, and flowering. Once the initial evaluation is completed, several cooperators across the United States are identified and a production system under the same cultural protocol is tested. Results of the regional cooperators are then published in scientific and grower journals. During the past four years, E u s t o m a g r a n d i f l o r u m has been extensively investigated in the laboratory and by five cooperators in the United States during the last two years. Cooperative research on heat stress in association with flower bud initiation and development in addition to the investigation of environmental factors controlling growth and flowering by sexual and asexual propagation in the nationwide program will be discussed.

1. Introduction

Expansion of the florist crop trade in the United States depends on the development and introduction of new crops as well as the introduction of new varieties of crops currently marketed. New crops research programs in The Netherlands and Denmark have expanded rapidly and it is evident that a greater range of plant material should be developed for the United States market. Introduction of new crops requires an identification and collection of a plant, an extensive scientific evaluation with horticultural and economic judgement, and analysis of market acceptability. A national germplasm evaluation program, in coordination with a regional evaluation system of new crops with commercial potential, is urgently needed to systematically introduce new crops to the United States market.

To meet the increasing needs of the market recognized by growers and consumers, in 1982 the Florist and Nursery Crops Laboratory initiated a program of germplasm development in cooperation with industry organizations to identify, collect, evaluate, and introduce new crops.

Among the large quantity of new plant material collected, the Laboratory has worked extensively with E u s t o m a, commonly known as lisianthus. Various phases of the new crops research program

from plant selection to the introduction of new germplasm are described in this article using E u s t o m a mainly as an example.

2. New crops

2.1. Definition of new crops

The definition of new crops can be: a newly discovered genera or species; newly introduced cultivars based on the improvement in color, growth characteristics, and longevity of flowers or foliage; plants grown in earlier years, but forgotten; or plants that are cultivated in foreign countries but have not been introduced in the United States. In the program conducted by the Florist and Nursery Crops Laboratory, a new crop is defined as "a plant introduced into commercial culture with a knowledge of production technology and market potential".

3. Overall scheme of the new crops program

The overall scheme is diagramed in Figure 1.

3.1. Collection

New crops are collected from: botanical gardens that include native plants idigenous to the country where the gardens are located or other plants from abroad; growers specializing in certain plant families; research institutes currently evaluating new crops; or commercial seed companies or growers where new plants and cultivars are available. The Laboratory collection includes: many genera or species of native Australian plants including C o r r e a and A n i z o z a n t h o s (kangaroo paw); Gesneriaceae such as A c h i m e n e s and C o l u m n e a from specialty growers; C e n t r a d e n i a and C o p r o s m a from Denmark; and new cultivars of E u s t o m a, or plant material like C l e m a t i s for pot plant use, from growers and commercial seed companies.

When plants of certain species or cultivars are identified as a potential new crop for possible introduction, it is very important to secure as many species or cultivars as possible in order to determine the variability in growth and flowering response. For example, several C o l u m n e a cultivars have been collected here in the United States and from Austria. Cultivars collected in the United States show upright growing characteristics and flower freely when temperatures in the greenhouse are maintained at 15°C or above. Cultivars that were bred in Austria require low temperature treatment for more than seven to nine weeks for flower bud initiation and do not grow upright. If only Austrian cultivars were collected and evaluated, cultural information could not be applied to the cultivars collected here in the United States.

3.2. Propagation

Generally less than 10 propagules are collected and it takes approximately a year to build enough stock plants by division or rooting of cuttings to obtain uniform cuttings for experiments.

The required time to establish a stock plant population can be reduced by utilizing tissue culture. For example, A n i g o z a n t h o s is only multiplied 10-fold through conventional division of the lateral fans. Tissue culture produces enough plants in five months for large-scale experiments. During propagation and early growth and development, initial observations are made on the rate and the ease of propagation as well as plant statue, mainly focusing on the compact and dwarf appearance of plant, time of flowering, and susceptibility to disease organisms. Some species or cultivars can be eliminated from further consideration based on these observations. Care must be taken not to eliminate potentially important germplasm. Flowering may be erratic under natural greenhouse growing conditions. For example, A e s c h y n a n t h u s generally grows well in the greenhouse, but does not flower uniformly. Therefore, A e s c h y n a n t h u s has required extensive research to determine factors necessary for uniform and controlled flowering in year-round production.

3.3. Production

Following propagation and an initial period of observation, a cultural production protocol is developed. Controlled growth and flowering as influenced by growth media/nutrition, light, temperature, and growth regulator treatments are investigated. When manipulation of flowering can be easily accomplished as with chrysanthemum, the production phase may be terminated within a year. If flowering responses are dependent on the forcing season or controlled flowering is not understood, the experiment may require more than a year.

A major factor to consider while assessing production capability is the forcing period. The forcing period may or may not involve the time when plants occupy greenhouse bench space. For example, if plug seedlings are used, the period when the seedlings were grown before shipping to the growers should be excluded. From the time the grower places the rooted plant in the greenhouse bench, a maximum production time of 18 weeks will allow a turnover of three to four crops a year. Should the plant be excluded if more than 18 weeks are required? The decision should be made during propagation and the initial observation period.

The total production time of E u s t o m a from seed sowing to flowering requires about seven months. On the basis of cropping time, E u s t o m a might be excluded from the program, although post-production longevity is excellent. A production decision requires an extensive and vigorous research program to attempt to shorten the total production time.

After the initial production trials with as many species or cultivars as possible, the number should be narrowed down by using three criteria for selection. They include: 1) easy, intermediate, or difficult to program flowering; 2) short, intermediate, or tall plant height; or, 3) sensitive, intermediate or insensitive to temperature or light requirements for controlled flowering response. The initial production phase should focus on

these three criteria since each criterion may have to be considered independently. Results with C o l u m n e a and G e r b e r a explain this very clearly.

After an initial production trial in the laboratory, cultural information is released. Evaluation of the same production protocol is then tested at various locations under diverse environmental conditions. Similar experiments at various locations must be closely coordinated. Cooperators can further evaluate a production protocol developed in one location to obtain a 'blue print' for quality crop production and industries can enhance, modify, or adjust the production techniques suitable to their production systems.

3.4. Production - nationwide evaluation

A crop that meets growth and flowering criteria must be further consumer tested to evaluate product acceptance. A new crop should not be judged by an individual's taste or by a limited and localized group of growers. Before marketing a crop as new, proper nationwide evaluation with scientists at universities, research institutes, and with growers in commercial firms should be carried out. Development of a systematic and well coordinated national program on the new crop project is vital for the success of the total introduction program. The nationwide system described by the Florist and Nursery Crops Laboratory for new crop introduction requires support from all sectors of industry and from research scientists as well as an effective market analysis.

3.5. Schedule for production trial

The time required for a regional and national production trial may vary depending on the nature of the new crop. If the plant material is collected from the wild or acquired with very limited improvement over the native species, development of techniques to obtain a horticulturally desirable forms may require several years of breeding and evaluation. Plants that are commercialized in other parts of the world may require less time in production evaluation than those mentioned above. The time required also depends on the extent of the information to be developed. We are projecting a maximum of four to five years if a plant, like E u s t o m a, is relatively new or has not been investigated extensively. A maximum of two to three years may be sufficient when plants have been commercialized on a limited scale or previously introduced in other the countries.

3.6. Pre- or post-production physiology

Post-production physiology can be an important factor in determining which plants should or should not be included in the program. However, the post-production characteristics can not be used to screen the plant material at the beginning of the program.

Acclimatization of several foliage plants before shipping or the use of silver compound based floral preservatives are commonly

used to increase the longevity of foliage or flowers. When new crops are evaluated as pot plants, cultural practices used during the production phase will affect post-production longevity. Water quality during routine irrigation, nutritional levels in the media and the tissue, light intensity level, and temperatures must be closely monitored for high quality crop production. This is important in pot plant evaluation as compared to cut flowers, since growth media with varying amounts of moisture and nutrition levels may significantly influence the keeping quality.

Some post-harvest problems have been solved in our research, but others must be further investigated. For example, C o p r o s m a 'Coppershine' showed the undesirable characteristic of yellowing and shedding of leaves, but by maintaining a tissue nitrogen content higher than three percent, plants may be moved from a greenhouse to a home environment without acclimatization. The tiny flower buds of G e r b e r a will not develop to flower under low-light home environment. This is also true with E u s t o m a, since tiny buds will not open on stems harvested before buds are at the puffy stage nor will a full purple or pink color develop when cut stems or potted plants are placed in a low-light intensity.

3.6. Distribution of plant material and release of cultural information

Following the research phase, a potential new crop is distributed to selected growers in the United States so that the plants can be tested and evaluated under commercial conditions. Plant material is sent either as seeds, rooted cuttings, or stock plants for propagation, depending on the nature of the test. Plant material is distributed to the cooperators with complete instructions on how to handle the crop for proper evaluation. Data collected by the cooperators are combined with previously accumulated research information and published.

Cultural information and technical information are made available to growers or consumers in several ways. For example, technical publications describing cultural and handling information on G e r b e r a, E u s t o m a, and 'Toyland' P h a l a e n o p s i s were printed in trade magazines and published by garden writers. Research results were also presented at growers meetings in various states and at national conventions and trade shows along with displays of plant material and posters describing the production and handling information for each crop.

3.7. Consumer education

At the time of the introduction of plant material and cultural information, consumers and the general public must be informed of the planned new crop introduction. Growers, wholesalers, and retailers should all receive advance information prior to introduction.

Consumer education is of concern to innovative growers who are constantly searching for new plant material to satisfy their

customers. Growers may have their own marketing channel. If consumers are not properly informed by the retailer at the end of the marketing channel or by other media sources, the demand at the time of an initial introduction may be so low that the new plant may be a disappointment to the grower and the economic potential of the crop may not be realized.

The need for new plants may also originate from consumers. If consumers are informed when innovative growers are ready to produce new crops, new plants will be successfully introduced and accepted. Consumer education can not be done effectively solely by organizations such as the Society of American Florists or FTD. Along with the initial efforts of the national organization or association, growers who are producing new crops may participate in various flower shows held locally to present their new crops directly to the consumer.

4. Financial support of the research program

The introduction of a regional and nationwide evaluation system involving many research locations adds to the total cost. The need for national new crops research is recognized by the United States Department of Agriculture and by industry. Financial support is provided by both the government and industry.

New crops research in the Florist and Nursery Crops Laboratory was initiated with support from the USDA Small Farms Program and by a grant from the Fred C. Gloeckner Foundation in 1982. In 1984, the program was expanded with a contribution from industry members of the SAF and the SAF Growers Division through the American Florists Endowment. The annual contribution from industry is matched by the Administrator of the USDA, Agricultural Research Service for each of five years pledged by the Endowment.

The funds for this project are used to support a scientist, technical staff, and a visiting investigator. In addition, funds were allocated to support regional university cooperators in five locations in 1984. The regional evaluation was expanded to include a total of 21 cooperators working with E u s t o m a, G e r b e r a, A n i g o z a n t h o s, C u p r e s s u s, C r a s s u l a, and L i a t r i s in 1986.

Program sponsors from industry have formed an advisory committee that assists in locating and securing new plants, suggests research directions, and aids in market analysis for the new plant material to be released. The advisory committee meets twice a year, once at Beltsville to observe new plant material and advise in the selection of plant candidates for further experiments. The advisory committee members are given up-to-date information on new plant material collected and results of past research.

5. E u s t o m a as a new crop

The first crop investigated extensively in the Florist and Nursery Crops Laboratory was E u s t o m a. The initial research

began in 1982 and a nationwide evaluation was started in 1984 and is still ongoing.

Lisianthus, E u s t o m a was included in the USDA program for the following reasons: Lisianthus is a native to the United States but was not recognized or extensively commercialized; Lisianthus was not know to United States growers and consumers until 1982; and Lisianthus is an excellent cut flower because of monopodial growth characteristics. Dwarf, self-branching forms would be useful for pot plant production if they could be developed.

5.1. Growth and tissue culture

All cultivars tested showed a monopodial growth characteristics which was only suitable for cut flower production.

E u s t o m a seedlings should be grown at temperatures lower than 15.5°C during the first two to three month-long seedling period (Table 1). If seedlings are exposed to temperatures higher than 21°C, high temperature related heat-stress symptoms are observed. Heat stress was judged by the earliness of flowering and reduced plant height and fewer flowers (Figure 2). Temperature can not be a sole factor for heat stress, since long-day conditions prevailing during summer may elevate the temperature effects.

There are no basal branching cultivars available at the present. From more than 700 plants regenerated from stem, leaf, and meristem explants, a strong basal branched characteristic was observed in 10 plants and the progeny produced by selfing the genetic variants showed similar basal branching characteristics as the parent clone (Table 2). This characteristic is very important for pot plant production. Basal branched seedlings produce weak shoots that spread instead of growing upright. Basal branched plants were crossed with 'Blue Poppy', and branching characteristics were observed in 50 percent of the seedlings (Table 3). One important characteristic of the branching selection crossed with 'Blue Poppy' is that hybrid vigor was observed, thus eliminating the weak stem problem.

When the research on winter flower production is completed and genetically dwarf and basal branching cultivars are investigated for pot plant production, the E u s t o m a project will be completed.

6. Conclusion

New crops research is dynamic and the interest in new crops is rapidly expanding among scientists, growers, and the general public. From the identification of potential new plant material with commercial value, to its release with cultural information, each of the steps described in this article is important for the successful introduction of a new plant.

The program at the United States Department of Agriculture is a joint venture between the floral industry and the government. Also systematic evaluation procedures with university and industry

sponsors will produce complete cultural information that can be utilized immediately across the United States. This research program is an example of how government and industry can work together and how production technology can be developed with close communication and cooperation among individuals representing various geographical areas.

7. Acknowledgements

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Table 1 - Effect of temperatures on growth and flowering of 'Kiri no Mine' (KM) and 'Saga no Momo' (SM) E u s t o m a, 1985. Temperature given for 120 days after germination.

Temperature (°C)	Days to flower		Height (cm)		No. of flower	
	KM	SM	KM	SM	KM	SM
15.5	153	162	69	67	26	42
21.0	143	145	58	53	15	28
26.5	143	144	52	46	16	28

Plants grown in 10 cm pot.

Table 2 - Number and types of plants regenerated from stem, shoot tip, and leaf explants of E u s t o m a. A total of 250 regenerated plants from each organ was examined.

Explant	No. of variant plant	No. of true genetic variants
Stem	3	3
Shoot tip	8	4
Leaf	6	3

The selfed progeny produced between 2.2 and 5.8 basal branches.

Table 3 - Distribution of basal branching characteristics of E u s t o m a, a hybrid between tissue cultured selection and 'Blue Poppy' from the 15 October 1985 sowing.

No. of basal branches		No. of plants (20 plants)
flowered	non flowered	
0	2	2
0	3	1
1	0 - 5	8
2	0 - 2	4
3	0 - 1	3
4	0	2

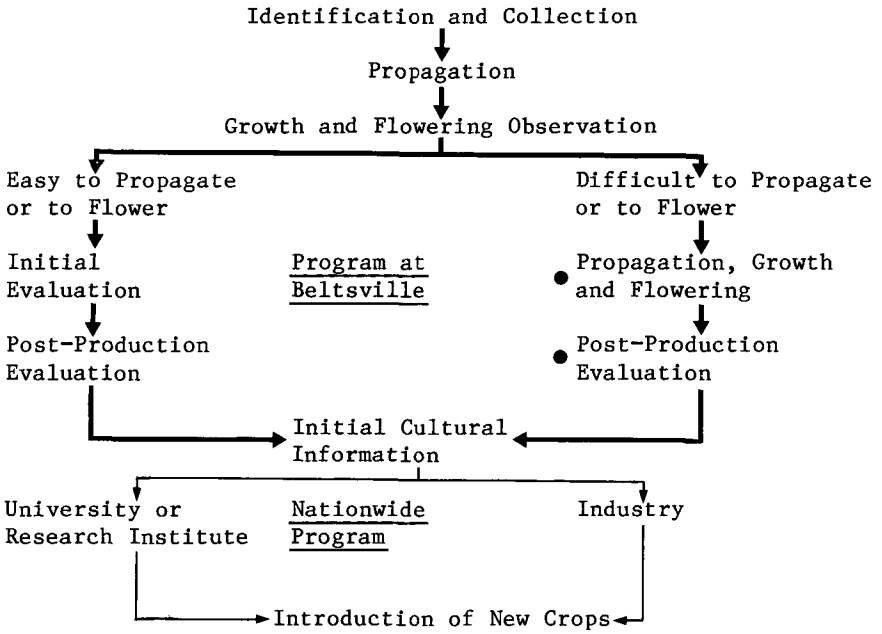

Figure. 1. Overall scheme of the new crops evaluation system.

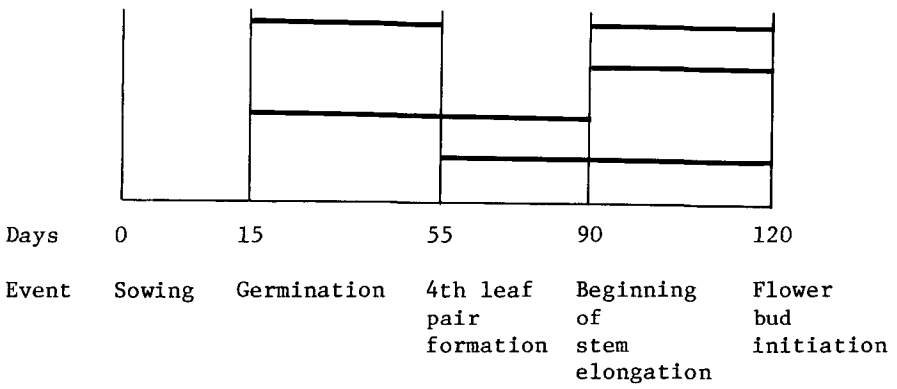

Figure. 2. Critical stage (———) when high temperature (21° or higher should be avoided. Experiment performed sowing seeds on 10 January 1985.