Prospects for Genetically Modified Ornamental Plants

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Nature of Work: The development of new and superior plants helps to stimulate excitement and demand, improve competitiveness and profitability, and ultimately deliver superior and more diverse products to consumers. Numerous sources of novel traits have provided the current diversity in ornamental plants including wild collections of whole plants and seeds, open-pollinated seedling selection, random mutation, mutation breeding and conventional breeding. In the end, the new plant source is significantly less important than its quality, uniqueness and its ultimate marketability. There is little doubt that the long-term prospect for developing novel ornamental plants using the previously mentioned methods is excellent. In addition to the above, genetic engineering is fast becoming a focus among some horticulture breeders following the success of numerous genetically engineered agronomic crops.

Results and Discussion: In a broad sense, tissue culture was the first significant contribution of biotechnology to horticulture and has been critical to the advent of gene transfer technology. Genetic engineering has numerous theoretical advantages over other plant improvement methods. For example, specific traits can be inserted or modified in superior cultivars without altering other desirable traits. Conventional breeding can be used to similarly modify existing traits. However, seven to ten years are typically required to develop a new plant with the novel trait (1). In addition, conventional breeding is limited by the existing gene pool within a given species. Mutation breeding is useful for introducing traits that do not already exist within a gene pool, but the process is completely random necessitating the evaluation of large numbers of progeny. Mutation breeding has, however, been used successfully with many ornamental plants including roses, chrysanthemums, dahlias, begonias and carnations and continues to be a viable method for ornamental plant improvement (2). Genetic engineering, though, is not without limitations and is unlikely to replace more traditional methods. More likely, it will become part and parcel of the overall efforts in ornamental plant improvement programs.

Arguably the most significant limitation to fully using genetic engineering for ornamental plant improvement is the cost associated with the technology. These costs include time, facilities, personnel, and expenses for developing the enabling technology for transforming new plants (e.g., regeneration methods, gene discovery and isolation, etc.), licensing of existing technology, securing regulatory approval, and the eventual development and evaluation of transgenic plants. Numerous technologies necessary for genetic engineering are covered by existing patents. In fact, a typical genetic engineering project resulting in a single new plant could require the use of 17 patented technologies. The β-carotene containing "Golden Rice", an excellent example of the prohibition associated with patented technologies, was created specifically to combat problems of vitamin A deficiency in parts of Asia, Africa and Latin America (3). However, the potential health benefits of Golden Rice continue to be unrealized because patent rights were not originally secured for the numerous technologies involved.

There are, however, a growing number of unpatented alternative technologies that may make it more feasible for researchers to develop genetically engineered minor crops including ornamentals. Among these are alternatives to the widely used polymerase chain reaction (PCR) (4). In spite of these stated challenges to genetically engineering ornamentals, numerous projects are underway within both public and private institutions. Although the majority of these projects are focused on herbaceous ornamental crops, some include woody ornamental species as well (5). Herbaceous crops, especially those grown for cut-flowers, are an obvious starting point for ornamental genetic engineering for several reasons. One reason is a function of sheer volume. Herbaceous ornamental plant species are sold in much greater numbers and are often exported worldwide unlike most woody ornamental plants. This makes the potential short-term return on investments much more likely. Also, systems for regenerating many herbaceous plants from single cells, a process that is currently essential for most transformation systems, are already in place. Numerous ornamental traits have been targeted for modification through genetic engineering including cut-flower vase life, extra flower petals, rose flower fragrance, flower color in forsythia and numerous herbaceous plants, and enhanced plant architecture (5, 6, 7). Efforts to engineer sterility in some woody ornamental plants have been reported. Objectives of these efforts include preventing the spread of invasive woody species, elimination of fruit litter on streets, parking lots and sidewalks and insect and disease resistance (8).

Significance to Industry: Large numbers of new ornamental plants are introduced each year serving to maintain or even bolster enthusiasm among consumers. Sources of new plants are numerous each having its own distinct advantages. Augmenting current plant improvement methods with genetic engineering technologies should facilitate developing traits that would be difficult or impossible to capture using more traditional methods. Insect and disease resistance, increased environmental stress tolerance, adventitious root formation in recalcitrant species, reduced invasiveness, reduced pollen and allergen production, and improved floral and foliage characteristics are a few possible targets in ornamentals (8). As this technology continues to develop and becomes more affordable, it is inevitable that genetic engineering will impact new ornamental plant development. Recent progress in genetically engineered ornamentals, information sources and other possible target traits will be discussed. Also, social, political and financial issues will be addressed.

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