Potential Use of Transgenic Technology in Ornamental Crops for Commercial Use©

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Ornamental plants are produced mainly for their aesthetic value, thus the propagation and improvement of quality attributes such as flower colour, longevity, flower and leaf form, plant shape and the creation of novel variation are important economic goals for horticulturists. Also, the plant's resistance to environmental stress and pests and diseases are becoming an increasing concern for the propagation specialist and consumer. Therefore, the development of new quality products through genetic transformation breeding programs has become necessary to propose better suited taxa.

INTRODUCTION

Plants, especially food and fodder crops have been engineered with novel traits using genetic modification for many years now. Millions of hectares of plants carrying transgene for the insect resistant *Bacillus thuringiensis* endotoxin (Bt toxin) and herbicide resistant genes are being cultivated worldwide. However, the use of these technologies for development of novel ornamental flowers is still limited. In an industry driven by the evolving consumer interests in novel products, the possibilities offered by introduction of novel genes into plants are enormous.

As per latest reports, close to 150 million hectares of land in the world is occupied by genetically modified (GM) crops and this accounts for up to 7% of the total cultivated area. This figure is increasing every year as more and more countries start accepting the benefits of the technology and as farmers are convinced about their potential benefits. The major GM crops that are being cultivated today include food crops- maize and soybean; canola for oil and cotton as a non-food crop. U.S.A., Brazil, Argentina, India, and China account for the largest area of cultivated GM crops. The first commercial crops were planted in 1996 and by 2010 accumulated acreage has reached 1 billion hectares worldwide strongly indicating that biotech crops are the order for the future. A record 15.4 million farmers, in 29 countries, planted 148 million hectares (365 million acres) of GM crops in 2010 (James, 2010).

Ornamental horticulture is a global industry and covers cut flowers, potted ornamentals, turf, shrubs and ornamental trees. The ornamental horticulture industry has stayed away from the influences of commercial transgenic crop plants. This short review will look at the possibilities offered by the technology to the industry.

MAJOR ADVANTAGES OF GENETICALLY MODIFIED TECHNOLOGY IN NON-FOOD CROPS

Genetically modified technology can be used to precisely transfer gene(s) for the production of plants with specific traits. These traits can be for a variety of characters leading from novel visual traits like flower colour and longevity to non-visual but important characteristics like better tolerance against disease and stress. The application of GM technology will enable faster development of novel varieties as the time required will be considerably shortened compared to conventional breeding methods. Another major advantage is that unlike food and fodder crops where the end product is consumed, which demands for extensive regulatory steps, horticultural crops may be easier to commercialize. This also means a reduction in the costs involved in developing a variety as large amount of resources are needed for the extensive field trials and subsequent safety studies required of food crops.

SOME DISADVANTAGES OF THE TECHNOLOGY

The major disadvantages include the lack of acceptance of the technology in many spheres of society and the possible public backlash. However, as GM crops get more and more acceptable with the advent of favourable aspects like marker free GM technology. It may still be required to restrict growing areas to greenhouses and restricted fields to stop cross pollination to wild relatives. The costs of setting up such an infrastructure may restrict producers from venturing into the use of technology. However, it may be only required to add on to existing labs and greenhouses rather than constructing an overall new infrastructure.

REQUIREMENTS FOR DEVELOPMENT OF A SUCCESSFUL PRODUCT

The major requirements for developing and marketing a successful transgenic horticultural plant are many. A biotechnology laboratory established as per the required regulations are the primary requirement and this has to be complemented by a well established quick and reliable tissue culture method for the plant. Gene transfer enables the introduction of foreign genes, or specifically designed hybrid genes, into host plant genomes, thus creating novel varieties with specifically designed characters. For successful generation of good varieties, very efficient transformation methodology for each plant species is essential. The method should be able to produce large number of plants in the shortest possible time and depend on many factors such as the type of genome, regeneration rate and shoot regeneration capacity. An effective transformation methodology adapted to the established tissue culture technique will ensure that the technology can be applied with relative ease.

Selection of the right trait for transformation is of utmost importance. The trait in question should be very novel for e.g., a blue rose and not a white chrysanthemum. A blue rose is of high commercial value whereas a white chrysanthemum already exists in the market. Therefore sensible application of technology is called for the development trait. The genes which will be transferred will have to be well characterized and very effective for the desired trait. It is therefore always advisable to use a trait which will enable the novel plant to stand out from the rest of

myriad plants of the same species currently in market. Proper and quick evaluation method for the desired trait followed by time bound field evaluation in compliance with regulatory requirements will ensure that the plants reach the market sooner.

CURRENT RESEARCH IN THE AREA

There was little interest by companies in this regard due to the previously mentioned reasons until Suntory in Japan and Florigene, Australia, collaborated to produce the first blue hued rose variety developed by transgenic technology. This has led to researchers pondering over the possible traits that can be introduced into horticultural crops. Table 1 summarizes some of the research that has been published. The list includes many potential traits like flower colour, fluorescence, reduced flowering time, longer lasting flowers, fungal resistance, viral resistance and herbicide resistance.

Table 1. List of some ornamental and other horticultural plants which have been employed in genetic modification studies

Plant	Gene/pathway transferred	Trait acquired	Reference
rose	Delphinidin pathway	Blue coloured flowers	Katsumoto et al., 2007
Eustoma (syn. *Lisianthus*), *Osteospermum*	Green fluorescent protein	Flourescent flowers	Mercuri et al., 2002
Eustoma	*LEAFY*	Reduced flowering time	Zaccai et al., 2001
Petunia	Ethylene biosynthesis blockage	Longevity of flowers	Huang and Lai, 2007
Eustoma	BEAT and LIS	Improved fragrance	Zaccai et al., 2001
Petunia	Endochitinase and osmotin	Botrytis resistance	Esposito et al., 1998
calla lilly	Ferredoxin	Erwinia resistance like protein	Yip et al., 2007
Phaelenopsis	Cymv coat protein	Cymbidium mosaic virus resistance	Liao et al., 2004
Petunia	Ace-AMP1 resistance	Botrytis	Bi et al., 1999
snapdragon	Bar	Herbicide resistance	Hoshino & Mii, 1998
zoysia grass	Gus	-	Ge et al., 2006
creeping bentgrass	Bar	Herbicide resistance	Luo et al., 2004

FUTURE PROSPECTS

There are numerous opportunities for the application of GM technology in non-food horticulture especially in the ornamental plants. This has to be explored by the producers to come out with novel and interesting products which the customers will find appealing. The selection of the right plants and traits can lead to a successful novel plant giving excellent returns to the producer. Although the product development may require some extra investment, this is always justified by the high priced end product.

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