FLORAL INDUSTRY GETS THE GMO BLUES

EXCITEMENT FOR NEW COLOR IS EQUALED BY CONCERN FOR ANOTHER GMO IN THE MARKETPLACE.

By Brenda Silva

As excitement builds among florists and designers for the newly created blue chrysanthemum, genetically modified organism (GMO)-related opposition and developmental costs continue to limit access to the new floral breed, effectively quashing any anticipated increase in sales from the in-demand color. This pseudo-standoff promises to continue until scientists and researchers find a way for the genetically modified flower not to reproduce and spread to the environment or until restrictions that prohibit some GMOs from entering the marketplace are changed. With neither option appearing to happen anytime soon, industry professionals may be forced to wait a bit longer for a solution to these kinds of blues.

Blue Mum – Following the Footsteps of the Blue Rose

Looking at the amount of info online about the new blue chrysanthemum, anyone would think it was the first and only attempt at creating a blue flower through genetic engineering – and they would be wrong. The blue mum actually follows in the original footsteps of a much earlier successful attempt to use genetic manipulation to create a "blue" rose.

The two companies credited with engineering the blue rose as early as 2004 are Japan's **Suntory Flowers Limited** and Australia's **Florigene Flowers**, and even though the final result of their collaboration was labeled as "blue," the engineered rose actually bared a closer resemblance to a color found within the purple color spectrum. Not a problem, however, as according to the gold standard for flowers – the Royal Horticultural Society's color scale – most "blues" are actually violet or purple anyway.

Based on results alone, the difference between the success rates of both attempts lies not in their approach to the science but, rather, in the flowers they chose to work with in the labs. The initial rose attempt inserted a gene for the blue plant pigment delphinidin from a pansy into a purple-red Old Garden rose, with the result being a dark burgundy rose. As a second step toward blue, they used RNA technology to try blocking a protein essential to color production. This did not work as well as conceptualized and resulted in a "red-tinged blue rose" that people referred to as a color found anywhere from mauve to lavender.

Seeming to build upon the rose results, the science behind the blue mum succeeded in engineering a truer blue flower by way of splicing genes from two naturally blue flowers – the butterfly pea (*Clitoria*) and the Canterbury bell (*Campanula*) – instead of just one. In addition, the choice of less-acidic chrysanthemums over higher-acid rose petals is also believed to have increased the chance of success in creating a bluer color by way of a shift in plant acidity through the modifications.

Genetic Modification – Nothing New under the Sun

If you ask a scientist about molecular engineering, he or she is likely to give you a history lesson that dates back many years. One man eager to offer evidence on the idea that there's nothing new under the genetic modification sun is **Henry I. Miller, M.D.**, the Robert Wesson Fellow in Scientific Philosophy and Public Policy at **Stanford University's Hoover Institution**. As a physician, molecular biologist and founding director of the Office of Biotechnology Products at the **U.S. Food & Drug Administration** (**FDA**), Dr. Miller believes the concept of genetic modification is hardly a new one in any type of farming.

"Farmers and plant breeders have been selecting and hybridizing plants to enhance their desirable characteristics for millennia," he says, adding, "A common technique for creating new plant varieties, which originated about a century ago, is subjecting seeds to radiation to scramble their DNA and create mutants, some of which may [and often do] exhibit desirable traits."

Dr. Miller goes on to report that plant breeders have performed "wide cross" hybridizations for many years, which led to "far less precise and predictable results than modern molecular techniques used to alter genes." However, antigenetic-engineering activists have raised little to no concerns about the use of older techniques, which are not subject to mandatory testing and review. By contrast, Dr. Miller notes, "When a single gene is moved by modern molecular techniques, the resulting variety is subject to lengthy and expensive regulation."

Dr. Miller is also quick to point out, "It's not the source of the genetic material or whether DNAs from different organisms are mixed that confers risk. What is important is the function of the genetic alteration – for example, whether it could cause the organism to express a new toxin or allergen or become more weedlike in the field."

Genetically Engineered Ornamentals – Barriers to Bottom Lines

When considering the challenges of genetically engineered (GE) ornamentals, the biggest obstacles are those of dollars and sense – the high dollar amount required to develop a product only to have it denied access to the market makes no sense.

As part of a study of the barriers to GE ornamentals entering the market, **Michael S. Dobres of NovaFlora**, located in West Grove, Pa., reported that the U.S. domestic floriculture and nursery industry was estimated at $8 billion wholesale as of 2007/8. (This figure was updated in a 2012 article by different authors to reflect "more than 300 billion USD for the total

2. Breeder testing plant samples

The ABCs of GMOs in the USA

According to Michael Dobres' report, transgenic plant research is one of the most highly regulated areas of genetic research. In the U.S., oversight and coordination of the agencies involved in ensuring that novel GE plants are developed and produced in a manner safe for the environment and human health falls under a formal policy established in 1986.

For basic R&D, regulatory requirements start in the lab, with all recombinant DNA work needing to be approved by the National Institutes of Health (NIH) Biosafety Committee. If any facility uses a plant pest, the facility needs approval by the U.S. Department of Agriculture (USDA)'s Animal and Plant Health Inspection Service (USDA-APHIS), which has been regulating GE plants for more than 30 years. Once a facility has the green light here, new rules and regulations apply.

For release and commercialization, three agencies are involved in review and approval of GE plants. The USDA-APHIS is responsible for reviewing the plant pest potential of a GE crop; the U.S. Environmental Protection Agency (EPA) is responsible for reviewing and registering their pesticidal properties; and the U.S. Food & Drug Administration (FDA) is involved in consultation on the safety of GE foods, which, for the most part, would not apply to ornamental plants.

Major GMOs in the Marketplace

According to statistics from the International Service for the Acquisition of Agri-biotech Applications (ISAAA), there have been only 23 approved transgenic plant events between 1992 and 2016. Listed by number of approvals, the plants include 19 carnations, two roses, one Petunia and one creeping bentgrass (*Agrostis*). With the popularity of chrysanthemums and excitement over the new blue mum aside, there are currently no GM chrysanthemums commercially available, as molecular breeding research continues to be refined.

Carnations: To date, **Suntory Flowers Limited** and **Florigene Flowers** have the only GM ornamental products commercialized on a large scale with the 'Moon' series of carnations. The 15-flower series contains various colors and has been commercially available in Australia, the EU, Japan and the U.S. since the late 1990s, with Colombia added in the early 2000s. Recently, four additional carnations, ranging in color from lavender to dark purple, were added to the 'Moon' series, with approval of these four in Malaysia in 2012.

Roses: Known as the blue rose, 'Applause' is actually more lavender than blue. Suntory released 'Applause' in Japan in 2009, and later in 2011, released it in North America.

Petunias: Developed by **Beijing University**, the Petunia-CHS features an altered flower color and is the only Petunia event commercially available. However, **Ornamental Biosciences** in Germany is working on creating a Petunia that offers frost tolerance, which would increase environmental options for this plant to be grown in the future.

turnover for all aspects of floriculture." Of that, "cut flowers make up about one-third of the global value of the ornamental plant market.")

His report shows the U.S. cut flower market accounts for more than one billion dollars at wholesale, with approximately two-thirds of this amount imported from countries such as Colombia, Ecuador and Holland, with the remaining one-third produced primarily in the Western U.S. Among domestic and imported cut flowers, the top-selling categories are roses, lilies, *Chrysanthemums*, *Alstroemerias*, carnations, tulips and *Gerberas*.

Dobres says, "At first sight, genetic engineering is a technique well suited to the generation of new commercial varieties of ornamentals. It provides a precise and predictable method to modify color, habit, flower form, shelf life and many other valuable traits. Yet, despite the technical and commercial success of GE in the development of new commodity crops, genetic engineering has not yet been broadly adopted as a tool by ornamental breeders."

Offering his take on the newly created blue mum and how its creation could have a much bigger impact on the GM floral industry, **Rick Coker,** public affairs specialist at **USDA's Animal and Plant Health Inspection Service** (**USDA-APHIS**), located in Riverdale, Md., reports that little progress has been made beyond the creation of the new flower.

"The Animal and Plant Health Inspection Service's **Biotechnology Regulatory Services** (**BRS**) regulates the introduction (importation, interstate movement or environmental

release) of genetically engineered (GE) organisms under the Plant Protection Act (PPA). We have not received a HYPERLINK "https://www.aphis.usda.gov/aphis/ourfocus/biotechnology/permits-notifications-petitions/sa_permits/ct_status" \t "_blank" permit or notification application for field trials in the U.S. nor have we received a petition to deregulate them and do not know if these blue chrysanthemums were engineered using plant pest sequences, thereby falling under our regulatory authority."

When asked if he thought the USDA would change its restrictions on GMOs because of the growing popularity of the new flower and/or if regulatory fees remain the biggest obstacle to GMOs entering the global marketplace, Coker says, "No, the popularity – or lack thereof – of a GE product has no bearing on APHIS' authority to regulate or deregulate it."

Looking at a future industry forecast when considering the inclusion of what are often referred by some to as "Frankenflowers," Coker explains, "APHIS' authority to regulate GE products under the PPA is based on plant pest risk. We would defer to our partners at USDA's Economic Research Service for such forecasting."

Breeding Contempt – Growers Raise Cost Issue

With billion-dollar-plus figures evidencing cut flowers' value, it's ironic that one of the main reasons for the lack of GE florals in the marketplace lies in the prohibitive cost of development. A recent estimate suggests that it takes more than $150 million to bring a GE product from its initial science to final market; however, Coker points out, "There are obviously many variables in R&D, depending on the nature of the product. For some products, costs well exceeded $150 million."

In his examination of factors affecting GE products from entering the market, Dobres lists, "product development costs, intellectual property costs, regulatory costs and public perception, with the last much more difficult to quantify than the others."

Strong supporters of GMOs are quick to stress the benefits they offer – especially in consideration of increasing populations and decreasing available farmland. Some breeders believe they could save money by growing GM products because they require not only less space to grow (with higher product yields) but also less weed/pest control due to growing proximity and potential for inherent pest and disease resistance.

Dr. Andrea Dohm, director of breeding and research at **Selecta Cut Flowers**, in Barcelona, Spain, says, "It would be great if genetic modification would help to develop plants with new traits, which are difficult to achieve through conventional crossbreeding, such as with resistance against thrips or drought tolerance, for example."

Beyond their backyards, breeders understand the economic importance of GM cut flowers just as well as florists and designers – perhaps even more so. As such, the GM issue is one that seems to show more pros than cons, and it is looking to science to act as a liaison between government, field and vase. However, because of unwavering costs and regulations, this issue has turned into a financial waiting game that promises to keep giving the industry many more blues over time in one way or another.

True Blue Demand for Missing Color

Statistics show that less than 10 percent of the world's almost 300,000 flowering plants have blue blossoms, and as with most rare things, this makes them more in demand – a fact not lost on growers. As evidence of a similar situation, rare-colored tulip bulbs were once more valuable than gold during the 1600s, leaving farmers scrambling to find the most sought-after colors (such as black), which were responsible for creating the intense consumer demand.

In today's floral industry, the rarity of naturally occurring blue flowers is the main impetus for scientists to create what Mother Nature forgot. The perceived regality of the color blue serves to drive demand for the color among florists and designers, who can only sigh at what's unavailable and offer complementary colors or dyed or tinted flowers as alternatives. In response to these demands, however, researchers continue growing ideas in the lab as a way to attain the unattainable, with their color spectrum of success likely to be seen on farms, at weddings and in arrangements.