Advancement in Propagation, Breeding, Cultivation, and Marketing of Ornamentals

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Ornamental horticulture is an important branch of horticulture addressed to grow and market plants or cut flowers used for decorative purposes and landscape design. Accordingly, the ornamental industry appears to be segmented and diversified. Moreover, the industry should meet the fast-changing needs of consumers, and, in consideration of the aesthetic value of its final product, the achievement of high-quality standards is mandatory.

In 2021, the flower and ornamental plants market was globally estimated at about 27 billion USD, and the sector is forecast to increase its value more than one and a half times by 2029 (source: Global Flowers and Ornamental Plants Market—Industry Trends and Forecast to 2029 Report; https://www.databridgemarketresearch.com/reports/global-flowers-and-ornamental-plants-market, accessed on 7 June 2024). The European market has a great impact on the ornamental industry and represents about 47% of the global market. The ornamental industry is fast changing; new producer and consumer countries are entering the global market [1], and consequently, in the coming years, the ornamental market and the dynamics of trade at an international level could be modified.

Several factors are driving this industry, linked to the increasing demand for cut flowers and ornamental plants used for floral arrangement gardening and landscaping. On one side, the expected increase in demand can be related to the increases in urban consumers, a greater spending capacity, and the growing population of retiring and elderly people. On the other side, technological advancements and innovative approaches enhanced the number of high-standard products and efficient crop management.

Therefore, the question is whether the ornamental industry can satisfy this request and, at the same time, maintain high standards of innovation and quality, an essential prerequisite of this sector. Indeed, several challenges must be overcome to satisfy the market trend for innovative, sustainable, and eco-friendly products and to enhance product quality and efficiency. In this light, the major issues the ornamental sector must meet are related to the following:

- Limited resources availability in term of natural resources, as well as labor and capital to maintain the operations required for crop management.
- Climate change, which can greatly affect the plant growth and health.
- Necessity to implement sustainable and effective methods for pest and disease management, minimizing the use of chemicals and enhancing an environmentally friendly approach.
- Diversification of supply through products meeting the criteria of innovation and sustainability in a broad sense (environmental, economic, and social).
- Marketing and distribution optimization.

Breeding is a key step in the obtention of new and performant cultivars, and through the classical methods (selection, hybridization, and mutation breeding), new flower colors
and shapes and new cultivars resistant to biotic and abiotic stresses have been introduced into the ornamental industry [2]. However, conventional breeding of ornamentals can be a long and costly process; modern methods, including in vitro techniques and/or genomic tools, can represent a valuable aid to speed up and make the breeding process more efficient [3]. In recent years, the novel tools of genomics, nanotechnology, and gene editing have been shown to be useful in developing new traits of flowers to meet the current requirements of the global market [4,5]. However, although advancements in breeding strategies plays a pivotal role, a new product can reach the market only if efficient systems for propagation, cultivation, and marketing are put into action. The ornamental industry has been constantly improved thanks to the availability of new propagation and cultivation systems, which enable the production of uniform and high-quality plant material. Innovative technologies are needed to reduce production costs and satisfy the need for more efficient and sustainable cultivation [6]. In addition, to face the global production, the ornamental sector could benefit from new networking and new logistics, which can bring innovation from the individual farm level to the system level [7].

This Special Issue (SI) was addressed to present the advancement in the ornamental sector, considering the entire productive flow from breeding to marketing. In more detail, this SI wanted to focus on the innovative approaches that can meet the above-mentioned challenges in the present ornamental industry. In total, 20 papers, of which 3 are review papers and 17 are scientific papers, were gathered in this SI.

Contributions (1, 2) addressed molecular aspects, (9, 11, 14) breeding, (5, 8, 16) propagation, (4, 13, 17) growth regulators, (6, 12) physiology, (3, 7, 10, 15) production, and (18, 19, 20) literature review.

Contribution 1 looked to determine the role of the PEBP gene family in Cymbidium species. Researchers mapped multiple PEBP genes to the chromosomes of C. ensifolium, C. sinense, and C. goeringii. In addition, the physiochemical characteristics of the protein encoded by 40 PEBP genes were analyzed in Cymbidium, Phalaenopsis, and Arabidopsis using a phylogenetic tree. The results indicated that PEBP genes play a role in growth and development, flowering, vegetative and reproductive growth, and root development.

Contribution 2 aimed to add to the understanding of molecular mechanisms regulating lily (Lilium sp.) stem bulblet formation as a result of hormonal regulation. Researchers used RNA sequencing in lily ‘Aladdin’ to characterize the transcriptional response of 6-BA. The results indicated that sucrose and genes associated with auxin and cytokinin transport signaling aid in triggering bulblet formation, emergence, and growth.

Contribution 3 investigated a way to cultivate potted chrysanthemums suitable for outdoor production in Northern China. Researchers investigated different substrates, water, and fertilizer ratios to reduce cost and improve efficiency. The results indicated that a combination of coir, peat moss, perlite, and pine needle mulch for the substrate, along with 336 mg/L nitrogen, 93 mg/L$^{-1}$ phosphorus, and 273 mg/L$^{-1}$ potassium for nutrient fertility and 40% water capacity, reduced production by 16%.

Contribution 4 examined the effects of growth regulators on cyclamen ‘Halios F1 Salmon Rose’ to correct stem elongation due to low light conditions from February to March in Eastern Europe. Researchers applied daminozide, paclobutrazol, gibberellic acid, and benzyladenine. The results indicated that daminozide and paclobutrazol did control plant elongation, while GA$_3$ and GA$_4+7$ + BAP increased the number of flower buds, number of flowers, and inflorescence diameter.

Contribution 5 focused on developing an efficient micropropagation protocol using a new bioreactor system (SETIS™) and biostimulant, IQ Forte, on Monstera deliciosa Liebm ‘Thai Constellation’. Researchers studied three different immersion durations and aeration frequencies using the bioreactor plus semi-solid medium as a control and IQ Forte at three different rates plus a control. The results indicated that bioreactor treatments improved multiplication rates, while the biostimulant did not improve growth during acclimation.

Contribution 6 identified peony (Paeonia lactiflora Pall.) cultivars with strong photosynthetic productivity using a portable photosynthesis machine. Researchers evalu-
ated 20 different cultivars for photosynthetic rate, stomatal conductance, intracellular carbon dioxide concentration, and transpiration rate. The results indicated that ‘Xueyuanhonghua’, ‘Qingwen’, ‘Taihuafeixue’, ‘Chifen’, and ‘Qihualushuang’ all had high photosynthetic productivity.

Contribution 7 evaluated extending the economic productivity of Amaryllis belladonna L. as a specialty cut flower and potted plant. Researchers put bulbs into six different warm (23 °C) storage regimes over different weekly intervals. The results indicated that warm temperature storage affected flower production, flowering time, and quality attributes, with 8–12 weeks of warm bulb storage being recommended.

Contribution 8 wanted to introduce efficient propagation methods for Dactylorhiza umberosa and Epipactis veratifolia, which are endangered orchid species. Researchers explored the effects of different light spectrums, explant types, wounding, and plant growth regulators on direct somatic embryogenesis. The results indicated that wounding the protocorm, adding 3 mg/L$^{-1}$ of TDZ, and white light for D. umberosa and red light for E. veratifolia increased production by 94% and 99%, respectively.

Contribution 9 aimed to improve the success of interspecific hybridization in hardy geranium (Geranium sp.). Researchers made crosses among 42 different genotypes and studied pollen tube growth, seed development, seed set, and parental differences. The results showed that interspecific hybridization can be predicted by parental distance and logistic regression models, which can predict the number of crosses needed to achieve 10 successful products.

Contribution 10 assessed if biostimulants could help mitigate drought stress under continuous or periodic irrigation deficits on container-grown Hydrangea paniculata. Researchers used seaweed extracts (Ascophyllum nodosum, Soliera chordalis, Ecklonia maxima, and Saccharina latissimi) and a microbial biostimulant. The results found that biostimulants had limited effects, but A. nodosum accelerated flowering and E. maxima reduced branching under repeated drying and wet cycles.

Contribution 11 looked at the genetic diversity of Ilex germplasm for breeding purposes. Researchers determined the genome size, chromosome number, and genetic fingerprints of mostly I. crenata accessions. The results indicated wide intra- and interspecific genetic diversity among accessions that will be useful to ornamental breeding programs looking to develop newly improved hybrids.

Contribution 12 determined the morphological, physiological, anatomical, and biochemical responses of zinnia (Zinnia sp.) to salinity stress. Researchers used Z. elegans Jacq. ‘Zinnita Scarlet’ (sensitive) and Z. marylandica D.m. Spooner et al. ‘Double Zhara Fire Improved’ under salt concentrations ranging from 1–200 mM NaCl at intervals of 50 mM NaCl. The results showed that ‘Zinnita Scarlet’ had high Na content, high ion leakage, slow stomatal closure, reduced photosynthetic pigments, and decreased stomatal number under salt stress, while ‘Double Zhara Fire Improved’ showed quicker stomatal closure, early proline synthesis, maintained photosynthetic pigments, and had low ion leakage.

Contribution 13 analyzed the effects of thidiazuron (TDZ) on the flowering and physiological metabolism of potted Dendrobium nobile. Researchers applied 0, 200, 500, and 1000 mg/L$^{-1}$ concentrations to the plant roots. The results found that TDZ greatly influenced flowering and increased relative membrane permeability with 500 mg/L$^{-1}$, leading to the greatest amount of flowering and highest quality morphological flower features.

Contribution 14 clarified how parental pigment composition and content influence flower color separation in Asiatic hybrid lilies (Lilium sp.). Researchers made crosses among ‘Easy Waltz’, ‘Red Life’, ‘Tresor’, and ‘Pearl Loraine’, which have different pigment compositions and contents. The results revealed that carotenoid content was highly heritable, generally leading to orange offspring, while parents with varying levels of carotenoids and anthocyanins produced more extensive color segregation progeny.

Contribution 15 established case studies using RGB visual imagery from a UAV to assist in the breeding and selection of nursery plants. Researchers used sweet box (Sarcococca Lindl.) and garden rose (Rosa L.) to compare UAV-based measurements to on-
ground measurements. The results showed that plant architecture, flowering, and disease resistance can be assessed faster and more objectively using UAV imaging.

Contribution 16 found that air-layering could be a new technique for tree peony (Paonia suffruticosa Andr.) propagation. Researchers used tree peony cultivars ‘Baoping Hong’, Quehao’, and ‘Xishi’ and looked at propagation during mid-May, June, and July, along with different rates of NAA and IBA plant growth regulators. The results indicated that the rooting rate was greatest when air-layering was performed in mid-June, while the type and concentration of growth regulators used were cultivar-dependent.

Contribution 17 studied the plant defense-related hormone responses of jasmonic acid and salicylic acid to broad mite presence on azalea (Rhododendron simsii Planch.). Researchers looked at both short-term and long-term responses to artificial and natural infestations. The results indicated that the primary plant response to broad mite feeding is through the jasmonic pathway but later switches to the salicylic acid pathway, and variation in broad mite susceptibility occurs within azalea germplasm.

Contribution 18 reviewed the literature on tissue culture methods for propagating bulb-type geophytes. Researchers pooled the literature to explain the history, economy, techniques, and stages of micropropagation, challenges, and opportunities for geophyte tissue culture production. Findings indicate that tissue culture techniques are an important propagation method for geophytes and that future advances in protocols may require insight from multiple disciplines or artificial intelligence.

Contribution 19 reviewed the literature on how plant genetic considerations can contribute to urban planning. Researchers discussed recent genomic sources, defining urban areas, the role of genetics in plant sustainability and adaptability, and the services different genetic traits provide for urban environments and the human population. Findings indicate that identification of genetic resources for urban spaces is fundamental for future breeding programs to develop plants with resilient traits.

Contribution 20 reviewed the literature on emerging and evolving consumption trends, marketing strategies, and governance settings of the ornamental plant market. Researchers reviewed integrated data sources and the structured grey literature. Finding outlined the European ornamental market and the need for public and private stakeholder collaboration to advance research for greater social and environmental goals.

As a general comment, we would like to highlight that the contributions of this SI came from a wide geographical area (China, Romania, the United States, South Africa, Nigeria, Iran, Belgium, Turkey, and Italy) and covered a diverse range of research in the field of the ornamental industry. This highlights the relevance of this SI by presenting different methodologies and case studies that testify to the richness of the research in the ornamental field. In addition, this SI wanted to consider the research related to the entire productive flow, allowing the reader to find a wide overview of the challenges and opportunities in the ornamental sector. We hope that the reader finds inspiration for further research in the worldwide ornamental industry.

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References


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