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Editorial

Seed Germination and Micropropagation of Ornamental Plants

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1. Introduction

Ornamental species can improve the environmental conditions in cities, serving the European Union's biodiversity strategy to bring nature back into our lives [1,2]. They are used both in interior and exterior landscaping, as trees, shrubs, and annual and perennial species. Furthermore, they can be cultivated as pot and foliage plants, while the cut flower industry is an important agriculture sector [3]. Alongside widespread ornamental species, native species can also be introduced for use as ornamentals in the floriculture industry and landscape architecture [4,5]. In recent decades, the reproduction and use of native plants have been increased; these species have reduced water and cultivation requirements, being adapted to drought conditions caused by climate change, greatly supporting biodiversity and local pollinators [6]. Moreover, several native species populations are under anthropogenic pressure; therefore, it is crucial to develop conservation strategies using biotechnological tools. There is a high demand for ornamental plants; the global ornamental plants market is expected to reach USD 45.07 billion by the end of 2029 [7]. New ornamental plants can be produced by conventional methods or by improved micropropagation techniques. Micropropagation is an efficient tool used widely for in vitro conservation and research, concerning the production of plant clones with desirable characteristics for crosses to improve wild species for potential use as ornamental species [8]. Moreover, micropropagation is a tool that enhances the availability of necessary propagating material through the year. It requires a small laboratory working space, and facilitates the transfer of disease-free propagating material worldwide. The employment of proper nutrient media, plant growth hormones, and other physical or chemical derivatives is necessary for the establishment of efficient micropropagation protocols. The present Special Issue focuses on seed-plant material and plant tissue culture techniques. The aim was to provide a comprehensive overview of the latest achievements in new ornamental plants that could be introduced in landscaping and floriculture.

2. Overview of Published Articles

Ahmad et al. (contribution 1) performed research on *Lagerstroemia speciosa*, a valuable ornamental tree blooming in beautiful purple flowers, native to China and cultivated across other tropical regions, e.g., in Bangladesh, India, Malaysia, Thailand, the Philippines, Indonesia, and Japan. The species is widely used due to its ethnomedicinal properties, although it is unexploited. Moreover, *L. speciosa* could be extinct at national and international levels without the implementation of suitable conservation strategies. The study aimed to establish an efficient in vitro propagation method starting from the nodal explants of sprouting shoots. The study revealed that a reproducible two-stage in vitro protocol could include both the use of thidiazuron and a secondary Murashige and Skoog medium (MS) supplemented with different cytokinins. An ex vitro rooting method of in vitro

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micro shoots was employed. Furthermore, the study examined possible somaclonal variation using molecular methods, and the genetic uniformity of the micropropagated plants was recorded.

Light quality is significant for many physiological and biochemical processes of plants; light-emitting diodes (LEDs) are widely used, with the aim of improving the regeneration process. Aslami et al. (contribution 2) examined, for the first time, the possibility of establishing an improved African violet regeneration method using leaf cuttings. The use of red and blue LEDs was effective on shoot growth, root growth, and physiological traits. Optimized LED treatments could enhance the regeneration rate of African violets.

Dyckia brevifolia (contribution 3) is an endangered Bromeliad of high ornamental value. It has a remarkable efficiency in both its tolerance to full sunlight and to large quantities of water floods. The plant is under high human pressure; the authors suggested suitable in vitro regeneration methods using solid and liquid MS media, starting from seedlings grown in vitro. The study defined the cardinal temperatures for in vitro germination in the range from 15 °C to 30 °C. Two different types of explants, lateral shoot explants and leaf explants, were used, with shoot explants achieving high multiplication rates in liquid media supplemented with cytokinins. The plantlets regenerated in vitro were successfully acclimatized.

In the next study (contribution 4), the authors investigated a suitable exploitation protocol of the endangered species *Sideritis raeseri* subsp. *Attica*. The species can be introduced as an ornamental plant into the floriculture industry, demonstrating suitability for rocky places. Furthermore, the genus *Sideritis* is well known for its medicinal properties. Hence, an effective micropropagation method could serve both conservation and exploitation strategies of *S. raeseri* subsp. *Attica.* The authors investigated the in vitro seed germination of the species and used seedlings grown in vitro as the starting plant material. The germination rate did not exceed 37% at 25 °C; on the other hand, a producible in vitro protocol was established, using MS medium and low concentrations of cytokinins. Half-strength MS was a suitable medium for in vitro rooting with median efficiency. Hyperhydrated shoots were formed during the multiplication cycles, but the use of hormone-free MS eliminated the phenomenon of hyperhydricity. The acclimatization was successful for all the rooted plantlets, indicating practical aspects for future endeavors.

The subsequent paper (contribution 5) aimed to develop, for the first time, an in vitro regeneration method via the somatic embryogenesis of different *Sanseveria* genotypes, using flower explants. *Sanseveria* presents limited sexual propagation, and the development of new variants is a challenge for modern floriculture. The authors reported that a remarkable regeneration method was obtained on MS media with various plant growth regulator combinations, reaching up to 73.3%. Furthermore, the study highlighted ploidy variations amongst the different *Sansevieria* spp. clones.

Nevertheless, effective rooting systems of stem-cuttings are of high importance for floriculture. Hence, Darras et al. (contribution 6) determined the effect of UV-C irradiation on the growth and development of plant propagation material of *Pelargonium* × *hortorum*, a widespread ornamental species. Both physiological and morphological changes were recorded during the experimentation in a greenhouse. The use of UV irradiation could promote root biomass accumulation depending on the species. In this contribution, UV-C irradiation enhanced the rooting percentage of *Pelargonium* × *hortorum*, inducing endogenous ethylene production. Furthermore, the flower size and the total flower number were increased.

Another species used in interior landscapes is *Philodendron bipinnatifidum*; the plant faces acclimatization difficulties in commercial micropropagation systems, resulting in a 10–40% plant loss. Contribution 7 examined the effect of compatible arbuscular mycorrhiza fungi (AMFs), recording morphological physiological responses. AMFs provide protection against biotic and abiotic stresses, adsorbing nutrients to the plants and improving plant growth and development. It is suggested that the AMF colonization of micropropagated

plants following ex vitro transplantation is efficient for plant development. The study revealed that there was a positive AMF effect during acclimatization.

Ioannidis and Koropouli (contribution 8) employed different nutrient media with varying strengths in their study to examine the in vitro growth and organogenesis of three different individuals of *C. creticus* plants. Additionally, they used simple sequence repeats (SSRs) as molecular markers for the genetic assessment of the micropropagated plantlets. Driver and Kuniyaki Walnut medium (DKW), MS, and woody plant medium (WPM) were proved efficient in different biometric characteristics. SSR markers revealed that there was a narrow genetic base amongst the micropropagated *C. sativa* clones.

The study by Kim et al. (contribution 9), on the dormancy types and germination characteristics of *Berberis koreana* Palibin, concluded that seeds exhibit an intermediate physiological seed dormancy. Seeds germinated both in light and dark conditions; cold stratification treatment at 5 °C for 12 weeks was extremely effective in breaking their dormancy. These data are essential for improving the use of seed plant material, which has the effect of reducing the need for labor.

The next contribution (10) utilized chitosan soaking to improve the seed germination of *Platycodon grandiflorus.* The species serves as ornamental horticulture in Eastern countries (China, North Korea, South Korea, Japan, and Russia). Its seeds have low germination rates, and they show dormancy. Chitosan is a co-polymer which has recently been introduced in agriculture. It can affect plant growth and seed germination, increasing yield. The authors of the present contribution studied the effect of this compound on seed germination and growth. They suggested that 0.15–0.20% chitosan could improve various growth parameters, e.g., leaf growth, stem diameter, and plant height, while several physiological parameters were increased under these concentrations. Chitosan is a low-cost compound that could promote the exploitation of *P. grandiflorus*.

Miler and Kulus (contribution 11) examined the possibility of establishing a new crossing on a widely used ornamental species, i.e., *Chrysanthemum* × *morifolium*/Ramat./Hemsl. They investigated the in vivo seed efficiency increasing the pollination rate of suitable parental genotypes. Seven cultivars with medium-size, semi-full inflorescences were used as the initial plant material. The study outlined eight new phenotypes, varying in shape, size, and color of inflorescence. Six phenotypes received plant breeder's rights, while the two cultivars were evaluated for their distinctness, uniformity, and stability (DUS). The variety "Wda" proved the most suitable as a mother plant, producing the highest seed number.

Contribution 12 was focused on making selections from native Greek sage populations, identifying the most appropriate for ornamental use. The genus *Salvia* (known as the sage genus) is found throughout the Old World and the Americas, and high species of this genus are suitable for use as ornamental or medicinal plants. *Salvia officinalis* is of high medicinal and ornamental value. In this contribution, a collection of native Greek sage populations was evaluated for their ornamental and morphological properties. At the second stage of the study, populations with appropriate morphological characteristics were tested for their asexual propagation ability through shoot cuttings and in vitro techniques. Their vegetative propagation was studied, aiming to reinforce their introduction in the floriculture market as new varieties.

Finally, contribution 13 presents a review article on seed germination within the genus Rosa, one of the most significant plant genera. The study underlines the complexity of germination and the variety of influencing factors (seed dormancy, environmental conditions, and seed treatments). The review identifies the problems that have arisen in the germination of Rosa seeds and proposes the most appropriate methods for stimulating germination. The study outlines the use of different methods to improve the germination of this valuable ornamental species, considering the practical aspect for future endeavors.

3. Conclusions

In vitro culture techniques are effective in terms of multiplication, producing disease-free plants suitable for conservation strategies, plant breeding, and the introduction of new ornamental plants. The present Special Issue reveals that micropropagation can serve as a suitable method for the conservation and exploitation of endangered species, e.g., *Dyckia brevifolia* and *Sideritis raeseri* subsp. *Attica*. Efficient protocols for the seed germination of native species, e.g., *Berberis koreana* Palibin and *Platycodon Grandiflorus*, could promote their exploitation. Modern micropropagation and conventional cross methods have proven suitable for producing new cultivars and varieties of *Sansevieria, Chrysanthemum* and Greek *Salvia officinalis*. Furthermore, studies on *Lagerstroemia speciosa*, *Cistus creticus* L., *Philodendron bipinnatifidum* Schott ex Endl. have revealed suitable micropropagation methods starting from adult mother plants. However, propagation by cuttings or seeds indicated that, combined with proper techniques, this can lead to the production of favorable ornamental plants, as occurred with *Pelargonium* × *hortorum* and *Platycodon Grandiflorus*. Finally, a review manuscript on seed germination within the genus *Rosa* outlined in vitro germination and molecular methods, highlighting the *Rosa* seed germination biology with the aim of establishing new rose production systems and supporting conservation strategies as well.

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