International Journal of Agriculture and Environmental Research

ISSN: 2455-6939

Volume: 10, Issue: 06 "November-December 2024"

FROM FRAGRANCE TO FORTUNE: UNVEILING THE BOTANICAL, SOCIOECONOMIC, AND GLOBAL SIGNIFICANCE OF *ROSA DAMASCENA*

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DOI: https://doi.org/10.51193/IJAER.2024.10608

Received: 08 Nov. 2024 / Accepted: 26 Nov. 2024 / Published: 12 Dec. 2024

ABSTRACT

Rosa damascena, celebrated for its aromatic essence and enchanting beauty, holds a prominent position in global botanical and socio-economic landscapes. This extensive review aims to delve into the multifaceted characteristics of *Rosa damascena*, covering its taxonomy, unique botanical features, genetic intricacies, and the socio-economic dynamics associated with its cultivation across key regions such as Turkey, Bulgaria, Iran, India, and Saudi Arabia. Exploring its taxonomy reveals insights into its evolutionary lineage and botanical relationships, alongside an examination of its distinctive attributes, including thorny stems, fragrant flowers, and vibrant petals. Additionally, the review uncovers genetic mysteries surrounding *Rosa damascena*, investigating the complex genetic interplay governing traits like fragrance production, flower color variation, and disease resistance. Furthermore, it sheds light on the socio-economic aspects of *Rosa damascena* cultivation, emphasizing its cultural significance and economic contributions in regions of extensive growth. Through case studies, it highlights the intricate balance between tradition, innovation, and economic development in rose cultivation. Moreover, the review delves into agronomic practices crucial for optimizing *Rosa damascena* yields, encompassing soil and

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climate requirements, propagation techniques, and water management strategies. By offering detailed guidance, it aims to empower growers to enhance both the quality and quantity of their *Rosa damascena* harvests, ensuring the sustained prosperity of this fragrant economic treasure. Ultimately, *Rosa damascena* emerges not only as a botanical marvel but also as a symbol of cultural heritage, economic prosperity, and human ingenuity. This review explores the botanical, genetic, and socio-economic dimensions of *Rosa damascena*, focusing on its taxonomy, cultivation practices, and cultural impact in regions like Turkey, Bulgaria, Iran, India, Saudi Arabia, and Morocco.

Keywords: Botanical characteristics**,** *Rosa damascena***,** socioeconomic impact, and sustainable cultivation.

1. INTRODUCTION

Rosa damascena, commonly known as the Damask rose, has long been revered for its exquisite fragrance, captivating beauty, and versatile applications in perfumery, cosmetics, and traditional medicine. As one of the most economically significant rose species, *Rosa damascena* is cultivated extensively in regions such as Turkey, Bulgaria, Iran, India, and Saudi Arabia, where it plays a central role in local economies and cultural practices. The plant's distinctive botanical features, such as its thorny stems, aromatic flowers, and vibrant petals, have made it an object of fascination for botanists and horticulturists alike. Beyond its aesthetic value, *Rosa damascena* also holds immense scientific interest due to its complex genetic makeup, which influences key traits such as fragrance production, flower color variation, and resistance to pests and diseases.

While *Rosa damascena* has been the subject of numerous studies focusing on its taxonomy, cultivation, and commercial uses, several gaps in the literature remain. For instance, although fragrance production is one of the most critical traits for the commercial value of *Rosa damascena*, the genetic and biochemical pathways underlying this process remain poorly understood. Additionally, the impact of climate change on the cultivation of this delicate crop, including challenges related to water management, soil health, and temperature fluctuations, is an area that requires further investigation. Moreover, while past reviews have touched upon the economic importance of *Rosa damascena*, there is still a need for a comprehensive analysis that connects the plant’s genetic, agronomic, and socio-economic dimensions across its primary cultivation regions.

This review aims to fill these gaps by offering new insights into the botanical characteristics, genetic intricacies, and socio-economic implications of *Rosa damascena* cultivation. We provide an in-depth examination of the plant's taxonomy, genetic factors influencing fragrance production, and the evolving challenges faced by growers in different climatic regions. Furthermore, this review explores innovative agricultural practices, the role of *Rosa damascena* in local economies, and the potential for sustainable cultivation practices that could support the plant's continued

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prosperity in the face of climate change. Through this comprehensive analysis, we aim to advance our understanding of *Rosa damascena* and guide future research and cultivation strategies to ensure its economic and ecological sustainability.

By addressing these research gaps, this paper contributes to a more holistic understanding of *Rosa damascena* and sets the stage for future studies that can further unravel its genetic mysteries and socio-economic potential.

2. BOTANICAL INSIGHTS INTO *ROSA DAMASCENA*

2.1 Taxonomy and classification

Rosa damascena, falls under the *Plantae* kingdom and *Tracheobionta* subkingdom. It is classified under the *Magnoliopsida* class and *Rosidae* subclass. *Rosa damascena* belongs to the *Rosales* order and *Rosaceae* family (Anonymus, 2023). At the genus level, *Rosa* is characterized by thorny stems and fragrant flowers, while the subgenus *Eurosa* narrows down the classification to a specific lineage within the genus (Zlesak, 2007). Finally, at the species level, *Rosa damascena* stands out as a distinct entity with unique characteristics and cultural significance (Nybom, 2009). The hierarchical classification helps to understand the botanical relationships of *Rosa damascena* and its importance in plant diversity.

2.2 Unique botanical features and genetic mysteries

Rosa damascena is a perennial bushy plant that possesses unique agronomic characteristics (El Malahi et al., 2024; Nasri et al., 2016). It has a long lifespan of up to 50 years and thrives as a medium-sized bush (Marko et al., 2018), with a height that can vary between 1.5 to 3.0 meters and reaching up to 3 meters under optimal conditions (Baydar et al., 2016; Rusanov et al., 2020). The plant's stem is cylindrical, dark, and slightly arching, densely branched, and adorned with medium-strength sickle-shaped thorns of varying sizes (Ningning et al., 2021). These thorns, along with small uneven prickles and glandular hairs, help in the plant's defense and structure (Darwin, 1875; Fahn, 1988; Haberlandt, 1914; Zhang et al., 2024). The leaves of *Rosa damascena* are stipulated, compound, and imparipinnate (Sweet, 1830; Elhawary et al., 2021). They typically consist of five to seven distinct leaflets, with moderate dimensions, oval to oblong, ranging from 2.5 to 7.5 cm in length and 1.5 to 4.0 cm in width (Bailey, 1919; Miller, 1768). The leaves feature finely serrated margins and a smooth texture on the upper surface, with slight pubescence on the lower end (Linné, 1753; Panda, 2005).

The flowers of *Rosa damascena* are among its most remarkable and defining features, both botanically and economically (Alizadeh & Fattahi, 2021; Haberlandt, 1914; Zeynali et al., 2009). These flowers are typically solitary but can occasionally appear in corymbs, and are hermaphroditic, meaning they possess both male and female reproductive organs (Nagar et al.,

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2007). Each flower consists of five sepals and around 30 semi-double, oval petals that are known for their delicate scent and vibrant hues (Dickerson, 2001). The color of the petals ranges from soft pink to pale pink, often speckled with white near the base, adding to their aesthetic appeal (Baser & Arslan, 2014). Pollination of *Rosa damascena* flowers is facilitated primarily by bees and wind, aided by numerous stamens and styles arranged in a bowl-shaped receptacle, a unique floral structure that ensures effective reproduction (MacPhail, 2007; Gracie, 2021). Over time, the receptacle of the flowers develops into rose hips, small, fleshy red berries that contain hairy nuts, which can be used in the production of rose products (Bernhardt, 1999). Beyond their botanical beauty, the floral characteristics of *Rosa damascena* play a pivotal role in its global economic significance, particularly within the perfume industry. The fragrance of the flower is its most valuable trait, with the petals containing essential oils that are highly sought after for their rich, complex aroma. The production of rose oil, derived from the petals of *Rosa damascena*, is a cornerstone of the global fragrance market. The scent, often described as sweet, floral, and slightly spicy, is integral to high-end perfumes and cosmetics, making *Rosa damascena* one of the most economically valuable plants worldwide. In addition to fragrance, the unique color variation of the flowers contributes to the aesthetic qualities that make *Rosa damascena* a popular choice in ornamental horticulture and cultural traditions.

The combination of these floral characteristics—the intoxicating fragrance and appealing color—has solidified *Rosa damascena*'s status as a cultural and economic treasure, particularly in regions where it is cultivated for essential oil production. These attributes are not only critical to the plant's reproduction but also to the thriving industries that rely on it, ensuring its place in both the botanical world and the global market.

Rosa damascena not only boasts unique agronomic characteristics but also harbors genetic mysteries that continue to intrigue researchers and enthusiasts alike. Despite being extensively cultivated for its aromatic properties and ornamental value (Bendahmane et al., 2013; El Malahi, et al., 2024b; El Malahi et al., 2024a; Raymond et al., 2018), the genetic makeup of *Rosa damascena* remains largely uncharted territory, presenting an intriguing puzzle waiting to be unraveled (Sun et al., 2023). The intricate interplay of genes governing its distinct traits, such as fragrance production, flower color, and disease resistance, holds immense potential for unlocking valuable insights into both the molecular basis of these traits and their evolutionary significance (Balilashaki et al., 2019). One of the genetic mysteries surrounding *Rosa damascena* lies in the biosynthesis of its signature fragrance compounds, which include a diverse array of volatile organic compounds responsible for its characteristic scent (Noh et al., 2024; Peng et al., 2023). Unraveling the genetic pathways underlying fragrance production in *Rosa damascena* could not only shed light on the biochemical processes involved but also offer opportunities for enhancing fragrance quality through targeted breeding or genetic engineering approaches (Venkatesha et al.,

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2022). Additionally, understanding the genetic basis of flower color variation in *Rosa damascena* presents another intriguing avenue of inquiry, as the range of hues observed in its blooms—from delicate pinks to vibrant reds—suggests the presence of complex genetic mechanisms governing pigment biosynthesis and expression (Liu et al., 2023). Furthermore, the genetic diversity within populations of *Rosa damascena* holds clues to its evolutionary history and adaptive potential in response to environmental challenges and changing cultivation practices (Smulders et al., 2019). High-throughput genomic technologies offer promising avenues for exploring this genetic diversity at unprecedented scales, facilitating the identification of genetic markers associated with desirable traits and informing strategies for conserving and harnessing the genetic resources of this iconic plant species (Jeong, 2020).

3. SOCIO-ECONOMIC DYNAMICS OF *ROSA DAMASCENA* CULTIVATION WORLDWIDE

The value of *Rosa damascena* in the global perfume and cosmetics industry cannot be overstated. Its petals are highly prized for their rare essence, which is an essential component of many fragrances and beauty products. Beyond its economic significance, *Rosa damascena* holds cultural and religious importance (Ghazanfar, 2011). Across different regions, it is integral to various cultural practices: in Syria, it is essential for the production of attar of roses, a traditional perfume exported internationally (Dugan, 2011); in Iran, it is used to make gulab, a traditional beverage (Osama et al., 2021); and in India, it is a key ingredient in gulab jamun, a beloved dessert (Kanse et al., 2020). These examples highlight how *Rosa damascena* transcends cultural boundaries, emphasizing its universal cultural significance.

Turkey is the leading country in producing rose flowers. As per the 2014 Rose Flower Report, Turkey has a rose flower plantation area of 2,200 hectares, producing 6,750 tons with a yield of 4,250 kg ha-1 (Yuca et al., 2023). The report also indicates that Turkey exported 3,443 kg of rose oil, earning a total return of $13,961,163 in 2014 (Dilmen & Baydar, 2016). The Turkish rose flower industry, continues to thrive, as evidenced by recent data and reports. The country is known for producing 2,500 tonnes of rose essence annually, primarily from the Cappadocia and Isparta regions (Dario & Veiga De Vincenzo, 2024). These regions have an ideal climate for rose cultivation and promote tourism through their picturesque landscapes (Tosun et al., 2023). This industry supports approximately 200,000 livelihoods, mainly among farmers and agricultural workers, and bolsters the economy (Turgut et al., 2023).

Bulgaria follows as the second-largest producer of *Rosa damascena* mainly from the Rhodope Mountains, celebrated for their ideal climatic conditions (Savvides et al., 2023). Bulgarian rose cultivation preserves cultural heritage while stimulating economic growth, providing income to

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about 100,000 individuals and fostering exports to various regions globally (Pise et al., 2023; Sarwar et al., 2023).

Iran, despite producing less volume, annually contributes nearly 50 tons of rose essence, primarily from mountainous regions such as the Zagros (Aghaloo & Sharifi, 2023; Nadaf et al., 2023). Iranian rose cultivation not only has economic significance but also celebrates tradition and craftsmanship, enriching the country's cultural heritage and providing vital economic opportunities for local communities (Pourmahdi et al., 2023).

India, with a production predominantly from the Himalayan region, supports around 25,000 livelihoods and contributes to the country's economic and trade dynamics (Anuradha et al., 2023). Indian rose cultivation is not only economically impactful but also socially significant, preserving cultural traditions and offering economic opportunities to rural communities (Muthukumaran et al., 2024; Saha et al., 2014; Borah et al., 2019).

Saudi Arabia is a newer player in the global market for rose cultivation, primarily from the Hijaz region, as per a study by (Alqethami et al., 2020). Even though it operates on a modest scale, rose cultivation in Saudi Arabia plays a significant role in the economy, providing a source of income for around 10,000 people and safeguarding cultural traditions embedded in Saudi society (Majrashi & Khandaker, 2020).

Overall, *Rosa damascena* cultivation worldwide intertwines economic prosperity with cultural heritage, playing a vital role in both local economies and global industries.

3.1 The Case of Rosa damascena in Morocco

Nestled within the picturesque landscapes of Morocco's mountainous regions, particularly in Kelaa M'Gouna, the cultivation of *Rosa damascena* stands as a testament to the country's rich agricultural heritage and economic prowess (Koehler, 2012). This fragrant flower, renowned for its aromatic properties, has emerged as a cornerstone of Moroccan agriculture, fostering community networks and bolstering the nation's economy (Radi et al., 2022; Zrira, 2017).

Spanning approximately 1,000 hectares across the Moroccan terrain, the cultivation of *Rosa damascena* represents more than just a traditional agricultural practice—it embodies a thriving industry that generates an annual turnover of around 100 million dirhams. Beyond its economic significance, this sector serves as a vital source of employment, providing livelihoods for nearly 200,000 individuals, particularly in rural communities where opportunities for sustainable employment are limited (Chaabi, 2023).

Recognizing the immense potential of this sector, the Moroccan government has embarked on ambitious agricultural development initiatives, notably through the Generation Green Project

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(Hamdaoui & Bsibis, 2021). This comprehensive endeavor is dedicated to enhancing the cultivation and production techniques of *Rosa damascena*, fostering innovation in rose varieties, and amplifying the global presence of Moroccan rose products. By investing in research and development, the aim is to fortify Morocco's position as a preeminent leader in the global perfume rose market.

Moreover, the cultural significance of *Rosa damascena* transcends its economic contributions, as it remains deeply ingrained in the fabric of Moroccan society. From local festivities to traditional medicinal practices, the perfume rose holds a revered status, symbolizing resilience, beauty, and healing. Its integration into traditional medicine underscores its therapeutic properties, further cementing its role as a cherished cultural heritage and emblem of national identity.

3.2 Unique position in Moroccan agriculture and economy

The cultivation of *Rosa damascena* occupies a unique position within Morocco's agricultural landscape, particularly in regions such as Kelaa M'Gouna and the broader Drâa-Tafilalet region (El Malahi et al., 2024b; Zahidi et al., 2022). As a Protected Designation of Origin product, Moroccan perfume rose commands global recognition for its exceptional quality and distinct terroir characteristics (Bertini et al., 2023). This recognition not only elevates Morocco's status in the global marketplace but also fosters pride and appreciation among local communities.

From an economic perspective, the perfume rose industry contributes significantly to the nation's GDP, with exports bolstering foreign exchange reserves and stimulating economic growth (Adeola et al., 2018; Hlaibi & Mechnou, 2025; Ubaldi, 2024). The sector's exponential growth in recent years, evidenced by its rise to become the world's third-largest producer, underscores its importance as a driver of economic prosperity and rural development (Iiyama et al., 2024; Narwal et al., 2024).

3.3 Socio-economic challenges and opportunities

Despite its considerable contributions, the perfume rose sector is not without its challenges. Climate change poses a significant threat to rose cultivation, with shifting weather patterns and unpredictable rainfall impacting yields and quality (Al-Rawahi et al., 2014; Kurniawan et al., 2024). Additionally, fluctuations in global demand and market prices necessitate adaptive strategies to ensure the long-term sustainability of the sector (Ersan & Başayiğit, 2022). However, amidst these challenges lie opportunities for innovation and diversification. Through sustainable agricultural practices, technological advancements, and value-added product development, Morocco can further enhance its competitive edge in the global perfume rose market. Moreover, targeted initiatives aimed at empowering women and marginalized communities within the sector can foster inclusive growth and social development (Mondal & Palit, 2022).

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In conclusion, the cultivation of *Rosa damascena* in Morocco symbolizes a harmonious blend of tradition, innovation, and cultural heritage. As a vital component of the nation's agricultural economy, perfume rose production not only generates economic prosperity but also fosters social cohesion and preserves Morocco's rich cultural legacy. By addressing challenges and embracing opportunities, Morocco can continue to flourish as a global leader in the perfume rose industry, enriching the lives of its people and sustaining its natural beauty for generations to come.

4. AGRONOMIC PRACTICES FOR *ROSA DAMASCENA* CULTIVATION

4.1 Crop cycle and cultivation techniques

The crop cycle of *Rosa damascena*, the revered rose renowned for its aromatic essence, is a meticulously choreographed symphony of biological, physiological, and molecular processes. Beginning with the meticulous preparation of the land in autumn, the cultivation cycle sets the stage for optimal growth conditions (Turgut et al., 2023). Through ancestral practices and modern agricultural insights, the planting phase in November to December ensures the strategic positioning of young plants to facilitate robust development (Rusanov et al., 2020). Throughout the year, dedicated maintenance, including watering, weeding, and pruning, sustains the roses' health and vitality. The pinnacle of the cycle arrives in June, when the Damascus roses bloom in all their splendor, emitting their captivating fragrance and showcasing their captivating beauty (Dugan, 2011). The culmination of this year-long endeavor is the delicate and precise harvesting conducted at dawn, capturing the essence of the petals' scent and honoring the tradition of *Rosa damascena*. From a scientific perspective, the cultivation ecology and agronomic factors intricately influence the growth and composition of *Rosa damascena* (Demir et al., 2024). The content and relative composition of essential components in rose oil, such as citronellol and geraniol, are profoundly influenced by environmental factors like temperature, light, soil quality, pruning techniques, nutrient levels, and harvest timing. For instance, the duration and intensity of the flowering period are directly affected by climatic conditions, with cooler, cloudier, and wetter environments prolonging the bloom, while hot and dry climates shorten it (Byczynski, 2008; Randhawa & Mukhopadhyay, 1986; Rusanov et al., 2020). Moreover, the yield of rose oil is intricately tied to these ecological factors, with optimal conditions resulting in higher yields (Ailli et al., 2023; Antoniadou et al., 2023). Consequently, a comprehensive understanding of these ecological and agronomic variables is imperative for maximizing both the quantity and quality of *Rosa damascena* production, highlighting the fusion of traditional wisdom and scientific knowledge in the cultivation of this exceptional rose.

Figure 1 below represents the crop cycle of *Rosa damascena* under Kelâat M'Gouna conditions, Morocco.

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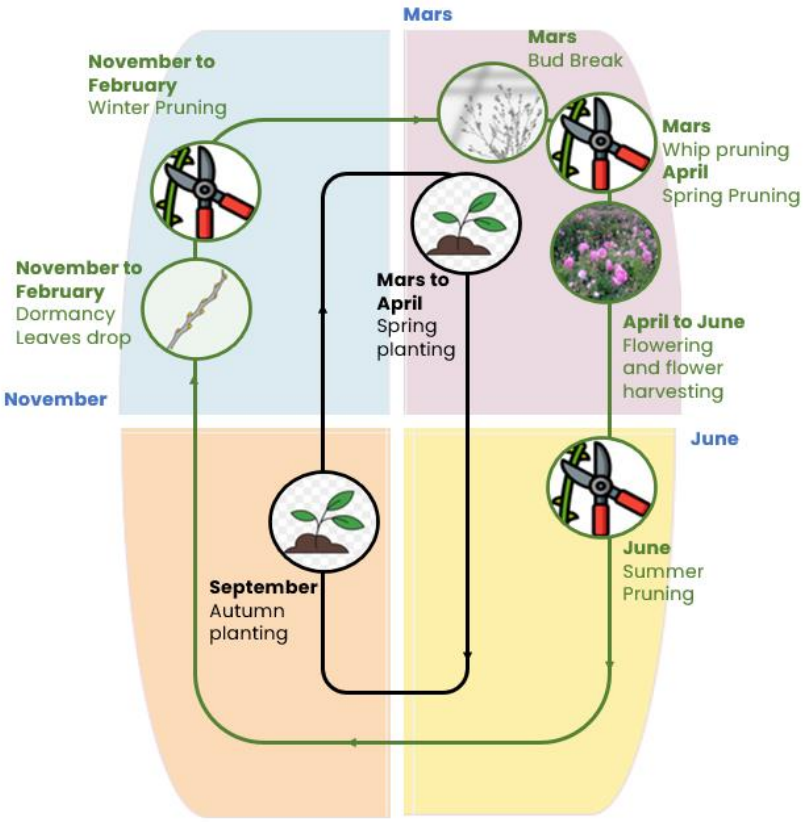

Figure 1: Cultivation Cycle of *Rosa damascena* under Kelâat M'Gouna Conditions in Morocco

4.2 Soil and climate requirements for optimal growth

The optimal growth of *Rosa damascena* hinges upon precise soil and climatic conditions meticulously tailored to meet its stringent requirements. In terms of soil, the selection of appropriate characteristics is paramount to nurturing this cherished rose. The soil should possess a minimum depth of 60 cm to accommodate robust root systems, facilitating nutrient absorption and stability (Pal & Singh, 2013; Popa, 2022). A loamy-clay texture strikes a delicate balance between drainage and water retention, essential for maintaining adequate soil moisture levels (Kakabouki et al., 2021). Moreover, maintaining a slightly acidic pH between 6.5 and 7 enhances nutrient uptake (Batool et al., 2023), while an organic matter content of 2 to 3% fosters soil structure and encourages the proliferation of beneficial microorganisms (El Malahi et al., 2024b; Mineva & Stoyanova, 2020). With a water retention capacity between 60 and 70%, the soil ensures consistent hydration crucial for *Rosa damascena*'s growth and blooming (Hessini et al., 2022).

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In parallel, climatic conditions play a pivotal role in shaping the development and flowering of *Rosa damascena*. Optimal temperatures ranging from 15 to 25°C foster favorable growth conditions, while extremes below -10°C or above 35°C pose risks of damage and heat stress, respectively (Jiao & Grodzinski, 1998; Khayat et al., 1988). Balancing humidity levels at 60-70% in both soil and ambient air ensures continuous hydration, mitigating the threat of water stress (Hajizadeh et al., 2023). Gentle wind speeds not exceeding 60 km h^{-1} preserve the integrity of delicate stems and petals (Yaghoobi et al., 2022). A photoperiod of 12 to 14 hours of light per day (Khaleghi et al., 2023; Picone et al., 2004), coupled with optimal brightness between 15,000 and 20,000 lux, stimulates metabolic activity and promotes lush, fragrant blossoms (Ravinath, 2007). By adhering to these meticulous soil and climatic specifications, *Rosa damascena* flourishes, exuding its full splendor and enchanting fragrance, embodying the epitome of botanical perfection.

Achieving the full potential of *Rosa damascena* requires a nuanced understanding of its specific hydric and mineral demands. While renowned for its adaptability, precise water and nutrient management are crucial for optimal growth and exceptional flower production. *Rosa damascena* thrives under a well-defined irrigation regime. Studies suggest an average of 10-12 irrigations per year, aiming to deplete approximately 50% of readily available soil moisture before each watering (Pal & Singh, 2013). Maintaining soil moisture around 85% of its maximum capacity during the growing season can significantly enhance flower yield (Kiymaz et al., 2022). Notably, irrigation timing plays a key role - it's vital after pruning and during dry periods, but should be avoided during flowering to facilitate harvesting (Thakur et al., 2019).

Beyond water, mineral nutrition is equally critical. Research indicates that *Rosa damascena* absorbs substantial amounts of nitrogen (64 kg ha^{-1} $year^{-1}$), phosphorus (8.7 kg ha^{-1} $year^{-1}$), and potassium (36 kg ha^{-1} $year^{-1}$) (Erdal & Munduz, 2017; Karlik et al., 2003; Pal & Singh, 2013). Supplementing the soil with recommended doses of these elements (100-150 kg ha^{-1} N, 50-75 kg ha^{-1} P, 150-200 kg ha^{-1} K) is crucial. Micronutrients like boron, iron, zinc, copper, and molybdenum, although required in lesser quantities, are indispensable for various metabolic processes (Janakiram et al., 2013). For instance, a specific combination of 100 kg ha^{-1} N and 26 kg ha^{-1} P has been shown to promote high floral yield (Ali et al., 2021; Pal & Singh, 2013). Additionally, incorporating manure at planting and utilizing superphosphate can further enrich the soil with essential nutrients (Hamedi et al., 2022).

By carefully balancing water and mineral management based on biological, physiological, and molecular research findings, growers can unlock the full potential of *Rosa damascena*. This meticulous approach will not only ensure healthy growth and abundant flowering but also yield the exceptionally high-quality essence that makes this rose so celebrated. Table 1. below summarizes the different requirements of *Rosa damascena* shrubs.

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Table 1: Summary table of the edapho-climatic, hydric, and mineral requirements of *Rosa damascena*.

	Rosa damascena requirements	Specifications
Soil	Minimum soil depth	≥ 60 cm
	Soil texture	Loamy-clay
	pH	6.5 - 7
	Organic matter	2 - 3%
	Water retention capacity	60 - 70%
Climatic conditions	Temperature	15 - 25°C
	Extreme temperature range	< -10°C ou > 35°C
	Soil humidity and Air humidity	60 - 70%
	Wind speed	< 60 km/h
	Photoperiod	12 - 14 hours/day
	Light intensity	15,000 - 20,000 lux
Irrigation	Frequency	10-12 irrigations $year^{-1}$
	Soil depletion level	About 50% before each watering
	Maintenance of soil moisture	About 85% of the maximum capacity during the growing season
Mineral nutritient	Nitrogen (N)	100-150 kg ha^{-1} $year^{-1}$
	Phosphorus (P)	50-75 kg ha^{-1} $year^{-1}$
	Potassium (K)	150-200 kg ha^{-1} $year^{-1}$
	Micronutrients	Boron, iron, zinc, copper, molybdenum

Recent trends in the cultivation and trade of *Rosa damascena* reflect a dynamic interplay between consumer preferences, agricultural practices, and global market dynamics. The enduring allure of this iconic flower, prized for its fragrance and versatility in various industries, persists across cultures and continents. One significant trend is the shift towards sustainable practices, with producers embracing eco-friendly farming methods to meet the demand for ethically sourced products. This includes organic cultivation techniques and water conservation measures to preserve both the delicate ecosystem and the quality of the rose harvest. Additionally, there is a resurgence of small-scale artisanal cultivation, emphasizing traditional farming practices and catering to niche markets with high-quality products. Technology integration is also reshaping *Rosa damascena* cultivation, with advancements in precision farming and digital platforms enhancing efficiency and transparency throughout the supply chain.

While traditional hubs like Morocco, Bulgaria, and Turkey remain dominant, emerging players from regions such as India and Iran are gaining prominence, diversifying the market and introducing unique flavor profiles. However, challenges such as climate change impacts and labor

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shortages persist, highlighting the need for adaptive strategies and fair labor practices to ensure the sustainability of the industry.

5. CONCLUSION

Rosa damascena, celebrated for its captivating fragrance and aesthetic beauty, stands as a prominent figure in both botanical and socio-economic spheres. As evidenced by numerous case studies across regions such as Turkey, Bulgaria, Iran, India, and Saudi Arabia, *Rosa damascena* is not only an integral part of local cultural heritage but also a significant contributor to economic prosperity. Its cultivation serves as a vital source of income for rural communities, stimulates trade, supports local industries such as perfume and cosmetics, and contributes to tourism, enhancing both landscapes and livelihoods. In this way, *Rosa damascena* exemplifies the symbiotic relationship between nature and society, where the plant's botanical grace is intertwined with its socio-economic value.

Looking ahead, the future of *Rosa damascena* cultivation presents both challenges and opportunities. As climate change, water scarcity, and soil degradation pose increasing threats to traditional farming practices, the need for sustainable cultivation strategies becomes more urgent. The integration of modern technologies, such as precision agriculture, genetic research, and advanced irrigation systems, holds great promise for addressing these challenges. Precision agriculture, for instance, could optimize resource use, minimize environmental impact, and improve the efficiency of rose production. Furthermore, advancements in genetic research could enhance disease resistance, fragrance production, and overall yield, ensuring that *Rosa damascena* remains competitive in the global market.

By embracing sustainable farming practices and cutting-edge technologies, the *Rosa damascena* industry can navigate these challenges while ensuring its long-term sustainability. Investments in research and development will be crucial for improving cultivation practices, enhancing genetic diversity, and boosting resilience to environmental changes. Ultimately, the continued success of *Rosa damascena* will depend on the ability to innovate while preserving the rich cultural and economic value it brings to communities around the world. Through these efforts, *Rosa damascena* can continue to thrive, enhancing both the natural world and the socio-economic landscapes in which it flourishes.

Funding: This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

Conflict of Interest: The authors declare that there are no conflicts of interest associated with this publication.

Acknowledgment: The authors gratefully acknowledge the support provided by their respective institutions.

REFERENCES

[1]. Adeola, O., Meru, A.K., Kinoti, M.W., 2018. Kenya's blooming flower industry: Enhancing global competitiveness. In: Africa's Competitiveness in the Global Economy, 331–349.

[2]. Aghaloo, K., Sharifi, A., 2023. A GIS-based agroecological model for sustainable agricultural production in arid and semi-arid areas: The case of Kerman Province, Iran. Current Research in Environmental Sustainability 6, 100230. https://doi.org/10.1016/j.crsust.2023.100230

[3]. Ailli, A., Handaq, N., Touijer, H., Gourich, A.A., Drioiche, A., Zibouh, K., Eddamsyry, B., El Makhoukhi, F., Mouradi, A., Bin Jardan, Y.A., Bourhia, M., Elomri, A., Zair. T., 2023. Phytochemistry and Biological Activities of Essential Oils from Six Aromatic Medicinal Plants with Cosmetic Properties. Antibiotics 12(4), 721.

[4]. Aithida, A., Tahiri, A., Oubassine, Y., Cherifi, K., Mokhtari, M., Hassani, L.A.I., 2019. The Agromorphological characterization of the perfume rose (Rosa damascena Mill.) Of Kelâa M'gouna-Dades (Morocco). Atlas Journal of Plant Biology 86–95. https://doi.org/10.5147/ajpb.v0i0.200

[5]. Ali, E.F., Alyasi, H.M., Hassan, F.A., Alamer, K.H., Hessini, K., Attia, H., Elshazly, S., 2021. Effect of the Pruning System and P-Fertilizer on Growth and Productivity of *Rosa damascena mill. Var.* Egyptian Journal of Botany 61(2), 565–578.

[6]. Alizadeh, Z., Fattahi, M., 2021. Essential oil, total phenolic, flavonoids, anthocyanins, carotenoids and antioxidant activity of cultivated Damask Rose (*Rosa damascena*) from Iran: With chemotyping approach concerning morphology and composition. Scientia Horticulturae 288, 110341. https://doi.org/10.1016/j.scienta.2021.110341

[7]. Alqethami, A., Aldhebiani, A.Y., Teixidor-Toneu, I., 2020. Medicinal plants used in Jeddah, Saudi Arabia: A gender perspective. Journal of Ethnopharmacology 257, 112899.

[8]. Al-Rawahi, M. N., Brinkmann, K., Schlecht, E., Buerkert, A., 2014. Effects of changing water availability on land use in irrigated mountain oases of Al Jabal Al Akhdar, northern Oman. DIE ERDE – Journal of the Geographical Society of Berlin, 145(4), 197–211. https://doi.org/10.12854/erde-145-18

[9]. Antoniadou, M., Rozos, G., Vaiou, N., Zaralis, K., Ersanli, C., Alexopoulos, A., Tzora, A., Varzakas, T., Voidarou, C., 2023. The *In Vitro* Assessment of Antibacterial and Antioxidant Efficacy in Rosa damascena and Hypericum perforatum Extracts against Pathogenic Strains in the Interplay of Dental Caries, Oral Health, and Food Microbiota. Microorganisms 12(1), 60.

[10]. Anuradha, M., Poorna Bindu, J., Prabhakara Rao, K., Chandrasekhara Rao, C., Sheshu Madhav, M., 2023. Souvenir of International Conference on "Frontiers on Tobacco and Commercial Agriculture Towards Preparedness for Future Farming." Indian Society of Tobacco Science, ICAR-CTRI, Rajahmundry, India. https://ctri.icar.gov.in/digital%20library/pdf/2023/ISTS%20Souvenir%20Dec%202023%20Final.pdf

[11]. Bailey, L.H., 1919. The standard cyclopedia of horticulture (Vol. 3). Macmillan.

[12]. Balilashaki, K., Vahedi, M., Wani, S., Zaid, A., 2019. Unraveling Omics Based Technologies in Enhancing Abiotic Stress in Genus Rosa: Progress and Prospects. The Journal of Plant Science Research; Vol. 35, N° 1, (2019): 25-38. DOI:10.32381/JPSR.2019.35.01.3

[13]. Baser, K. H. C., Arslan, N., 2014. Oil Rose (Rosa damascena). In: Yaniv, Z., Dudai, N., (Eds.), Medicinal and Aromatic Plants of the Middle-East. Springer Netherlands (pp. 281–304). https://doi.org/10.1007/978-94-017-9276-9_16

[14]. Batool, F., Mohyuddin, A., Amjad, A., ul Hassan, A., Nadeem, S., Javed, M., Othman, M.H.D., Wayne, C.K., Rauf, A., Kurniawan, T.A., 2023. Removal of Cd (II) and Pb (II) from synthetic wastewater using Rosa damascena waste as a biosorbent: An insight into adsorption mechanisms, kinetics, and thermodynamic studies. Chemical Engineering Science 280(2), 119072.

[15]. Baydar, H., Erbaş, S., Kazaz, S., 2016. Variations in floral characteristics and scent composition and the breeding potential in seed-derived oil-bearing roses (Rosa damascena Mill.). Turkish Journal of Agriculture and Forestry 40(4), 560–569.

[16]. Bendahmane, M., Dubois, A., Raymond, O., Bris, M.L., 2013. Genetics and genomics of flower initiation and development in roses. Journal of Experimental Botany 64(4), 847–857.

[17]. Bernhardt, P., 1999. The rose's kiss: A natural history of flowers. Island Press.

[18]. Bertini, A., Caruso, I., Vitolo, T., 2023. Methods and Scenario Analysis into Regional Area Participatory Planning of Sustainable Development: The "Roses Valley" in Southern Morocco, A Case Study. Engineering Proceedings 39(1), 8. https://doi.org/10.3390/engproc2023039008

[19]. Borah, M., Rajkhowa, M., & Ali, S., 2019. Occurrence of Diseases in Floricultural Crops in and around Jorhat, Assam. International Journal of Economic Plants, 054–063. Retrieved from https://ojs.pphouse.org/index.php/IJEP/article/view/4586

[20]. Byczynski, L., 2008. The flower farmer: An organic grower's guide to raising and selling cut flowers. Chelsea Green Publishing.

[21]. Chaabi, C., 2023. La croissance de la filière de la rose à parfum freinée par la sécheresse. Médias24. https://medias24.com/2023/04/27/la-croissance-de-la-filiere-de-la-rose-a-parfum-freinee-par-la-secheresse/

[22]. Dario, F.R., Veiga De Vincenzo, M.C., 2024. Tourism as an instrument for valuing, and disseminating natural, and cultural heritage. The Institute of Biopaleogeography Named under Charles R. Darwin 22, 1–86. http://psjd.icm.edu.pl/psjd/element/bwmeta1.element.psjd-d43e615c-d020-4556-ad1d-9aa0a036ce63.

[23]. Darwin, C., 1875. The movements and habits of climbing plants. John Murray.

[24]. Demir, S., Dedeoğlu, M., Başayiğit, L., 2024. Yield prediction models of organic oil rose farming with agricultural unmanned aerial vehicles (UAVs) images and machine learnaing algorithms. Remote Sensing Applications: Society and Environment, 33, 101131.

[25]. Dickerson, B., 2001. The Old Rose Advisor: Updated, Enlarged (Vol. 1). iUniverse.

[26]. Dilmen, R., Baydar, N.G., 2016. Yağ Gülü (*Rosa damascena Mill*.)'nde Doku Kültürü Uygulamaları. Ziraat Fakültesi Dergisi 11(2), 134-141.

[27]. Dugan, H., 2011. The ephemeral history of perfume: Scent and sense in early modern England. JHU Press.

[28]. El Malahi, S., Irahoui, L., Mokhtari, W., Ennami, M., Taimourya, H., Zim, J., Zayani, A., Zakri, B., Dhassi, K., Mokhtari, M., Idrissi Hassani, L.M., 2024b. Exploring the synergistic effect of rose distillation waste and biostimulant beside other organic amendments on Rosa damascena seedlings' growth. International Journal of Recycling Organic Waste in Agriculture 13(2), 132416. https://dx.doi.org/10.57647/j.ijrowa.2024.1302.16

[29]. El Malahi, S., Sbah, N., Zim, J., Ennami, M., Zakri, B., Mokhtari, W., Taimourya, H., Mokhtari, M., Hassani, L.M.I., 2024a. Enhancing rooting efficiency and nutrient uptake in Rosa damascena Mill. cuttings: Insights into auxin and cutting type optimization. Plant Science Today 11(1), 119-131. https://doi.org/10.14719/pst.2585

[30]. Elhawary, E., Mostafa, N., Milad, R., Singab, A.-N., 2021. Botanical and Genetic Profiling of Three Rosa Varieties Cultivated in Egypt. Archives of Pharmaceutical Sciences Ain Shams University 5(1), 111–127.

[31]. Erdal, İ., Munduz, H., 2017. Comparing the nutritional status of organic and conventional oil-bearing rose (*Rosa damascena Mill*.) gardens in lakes region with leaf and flower analyzes. Toprak Su Dergisi 6(2), 26–31. https://doi.org/10.21657/topraksu.339828

[32]. Ersan, R., Başayiğit, L., 2022. Ecological modelling of potential Isparta Rosa areas (*Rosa damascena Mill*.). Industrial Crops and Products 176(1), 114427.

[33]. Fahn, A., 1988. Secretory tissues in vascular plants. New Phytologist 108(3), 229–257.

[34]. Ghazanfar, S.A., 2011. Medicinal and aromatic plants arabia and Iran.

[35]. Gracie, C., 2021. Florapedia: A Brief Compendium of Floral Lore (Vol. 3). Princeton University Press.

[36]. Haberlandt, G., 1914. Physiological plant anatomy. Macmillan and Company, limited.

[37]. Hajizadeh, H.S., Rezaei, S., Yari, F., Okatan, V., 2023. In vitro simulation of drought stress in some Iranian damask rose landraces. Horticultural Science, 50(1), 45-60. doi: 10.17221/107/2021-HORTSCI

[38]. Hamdaoui, A., Bsibis, M., 2021. Green Spaces for Residential Projects as a Commitment to Environmental Concerns and a Sustainable Development Initiative: Design of a Peri-Urban Park in Casablanca, Morocco. In: Abu-hashim, M., Khebour Allouche, F., Negm, A., (Eds.), Agro-Environmental Sustainability in MENA Regions. Springer International Publishing. (pp. 179–208). https://doi.org/10.1007/978-3-030-78574-1_8

[39]. Hamedi, B., Ghasemi Pirbalouti, A., Rajabzadeh, F., 2022. Responses to morpho-physiological, phytochemical, and nutritional characteristics of damask rose (Rosa damescena Mill.) to the applied of organic and chemical fertilizers. Communications in Soil Science and Plant Analysis 53(17), 2156–2169. https://doi.org/10.1080/00103624.2022.2070634

[40]. Hessini, K., Wasli, H., Al-Yasi, H.M., Ali, E.F., Issa, A.A., Hassan, F.A., Siddique, K.H., 2022. Graded moisture deficit effect on secondary metabolites, antioxidant, and inhibitory enzyme activities in leaf extracts of Rosa damascena Mill. Var. Trigentipetala. Horticulturae 8(2), 177.

[41]. Hlaibi, M., Mechnou, I., 2025. Food industry effluents, a renewable source for the production of porous materials with high added value. In: Nutraceutics from Agri-Food By-Products, 391–421.

[42]. Iiyama, C.M., Vilcherrez-Atoche, J.A., Germanà, M.A., Vendrame, W.A., Cardoso, J.C., 2024. Breeding of ornamental orchids with focus on Phalaenopsis: Current approaches, tools, and challenges for this century. Heredity, 132(6) 1–16.

[43]. Janakiram, T., Banyal, N., Jain, R., Kumar P.P., Narkar, N., 2013. Fertilizer best management practices in floriculture. Indian Journal of Fertilizers 9(4), 160–175.

[44]. Jeong, Y.G.P., Park, Y.H., Manivannan, A., Soundararajan, P., Jeong, B.R., 2020. Exploiting the genetic diversity of ornamentals (1st Edn.). In: Achieving sustainable cultivation of ornamental plants. Burleigh Dodds Science Publishing.

[45]. Jiao, J., Grodzinski, B., 1998. Environmental influences on photosynthesis and carbon export in greenhouse roses during development of the flowering shoot. Journal of the American Society for Horticultural Science 123(6), 1081–1088.

[46]. Kakabouki, I., Tataridas, A., Mavroeidis, A., Kousta, A., Roussis, I., Katsenios, N., Efthimiadou, A., Papastylianou, P., 2021. Introduction of alternative crops in the

ISSN: 2455-6939

Volume: 10, Issue: 06 "November-December 2024"

Mediterranean to satisfy EU Green Deal goals. A review. Agronomy for Sustainable Development 41(71), 1–19.

[47]. Kanse, S., Rani, R., Shingh, S., Chopde, K., 2020. Development of antioxidants and vitamin c enriched gelato ice cream by incorporating gulkand. 10(35), 1168–1172.

[48]. Karlik, J.F., Becker, J.O., Pemberton, H.B., Schuch, U.K., 2003. Production and Marketing. Field Rose Production.

[49]. Khaleghi, A., Khadivi, A., Akramian, M., Bikdeloo, M., 2023. The role of supplemental lighting during late fall and winter on photosynthetic and non-photosynthetic pigments biosynthesis of cut rose flower (Rosa hybrida cv.'Dolce Vita'). The Journal of Horticultural Science and Biotechnology 1–12.

[50]. Khayat, E., Zieslin, N., Mortensen, L., Moe, R., 1988. Effect of alternating temperature on dark respiration and 14C export in rose plants. Journal of Plant Physiology 133(2), 199–202.

[51]. Kiymaz, S., Altun, B., Ertek, A., 2022. Effect of different water regimes and nitrogen applications on the growth, yield, essential oil content, and quality parameters of the oil rose (Rosa damascena Mill.). Journal of Plant Nutrition 45(14), 2108–2122.

[52]. Koehler, J., 2012. Morocco: A Culinary Journey with Recipes from the Spice-Scented Markets of Marrakech to the Date-Filled Oasis of Zagora. Chronicle Books.

[53]. Kurniawan, T.A., Bandala, E.R., Othman, M.H.D., Goh, H.H., Anouzla, A., Chew, K.W., Aziz, F., Al-Hazmi, H., Nisa'ul Khoir, A., 2024. Implications of climate change on water quality and sanitation in climate hotspot locations: A case study in Indonesia. Water Supply 24(2), 517-542.

[54]. Linné, C.V., 1753. Species plantarum. –Stockholm. LinnéSpecies Plantarum1753. https://www.biodiversitylibrary.org/item/84235#page/1/mode/1up

[55]. Liu, X., Han, Y., Luo, L., Pan, H., Cheng, T., Zhang, Q., 2023. Multiomics analysis reveals the mechanisms underlying the different floral colors and fragrances of Rosa hybrida cultivars. Plant Physiology and Biochemistry 195, 101–113. https://doi.org/10.1016/j.plaphy.2022.12.028

[56]. MacPhail, V.J., 2007. Pollination biology of wild roses (Rosa spp.) in eastern Canada. University of Guelph. https://atrium.lib.uoguelph.ca/server/api/core/bitstreams/9cf4ad21-d691-4957-b343-ddaf0e4ee7c4/content

[57]. Majrashi, A., Khandaker, M.M., 2020. Survey of Chenopodiaceae family from Taif, Saudi Arabia Peninsula. Plant Archives 20(2), 5958–5964.

[58]. Marko, N.V., Khlypenko, L.A., Plugatar, Y.V., 2018. Aromatic rose cultivars in the collection of the Nikitsky Botanical Gardens. Acta Hortic. 1287, 41-48 https://doi.org/10.17660/ActaHortic.2020.1287.6

[59]. Miller, P., 1768. The gardener's dictionary, London: Printed for the author.

[60]. Mineva, R., Stoyanova, A., 2020. Research of the effect of organic fertilizer Siapton on productivity of oil rose (Rosa damascena Mill). Scientific Papers. Series A. Agronomy, Vol. LXIII, No. 2, (pp.153–157).

[61]. Mondal, S., Palit, D., 2022. Challenges in natural resource management for ecological sustainability. In: Natural Resources Conservation and Advances for Sustainability (pp. 29–59). Elsevier.

[62]. Muthukumaran, M., Parveen, M., Velavan, S.V., 2024. Survey of the beneficial flowers available in Coimbatore District, Tamil Nadu, India. Plant Science Today 11(1), 366–376.

[63]. Nadaf, M., Amiri, M.S., Joharchi, M.R., Omidipour, R., Moazezi, M., Mohaddesi, B., Taghavizadeh Yazdi, M.E., Mottaghipisheh, J., 2023. Ethnobotanical Diversity of Trees and Shrubs of Iran: A Comprehensive Review. International Journal of Plant Biology 14(1), 120-146. https://doi.org/10.3390/ijpb14010011

[64]. Nagar, P.K., Sharma, M., Pati, P.K., Ahuja, P.S., 2007. Rose: Some Important Findings with Special Reference to Physiology of Flowering. Biology, Environmental Science, 1(2), 102-114.

[65]. Narwal, S., Kaur, M., Yadav, D.S., Bast, F., 2024. Sustainable blue economy: Opportunities and challenges. Journal of Biosciences 49(1), 18.

[66]. Nasri, F., Fadakar, A., Yousefi, B., Zahedi, B., 2016. Evaluation of genetic diversity of some Damask rose (Rosa damascena Mill.) genotypes of Kurdistan province using morphological traits. Journal of Ornamental Plants 6(4), 237–243.

[67]. Zhou, N., Simonneau, F., Thouroude, T., Oyant, L.H., Foucher, F., 2021. Morphological studies of rose prickles provide new insights. Horticulture Research 8(1), 221.

[68]. Noh, Y.-M., Ait Hida, A., Raymond, O., Comte, G., Bendahmane, M., 2024. The scent of roses, a bouquet of fragrance diversity. Oxford University Press UK. doi: 10.1093/jxb/erad470. PMID: 38015983.

[69]. Nybom, H., 2009. Introduction to rosa. Genetics and Genomics of Rosaceae, 339–351. https://doi.org/10.1007/978-0-387-77491-6_16

[70]. Osama, M., Ikram, R., Wei, C.R., Saleem, R., Bhurgri, G.R., Siyal, F.J., Nadeem, 2021. Evaluation of biochemical effects of famous unani herbal product "Arq-e-Gulab" on cardiac enzymes. NVEO- Natural Volatiles & Essential Oils Journal | NVEO, 8(5) 13600–13606. https://doi.org/10.53555/nveo.v8i5.5578

[71]. Pal, P.K., Singh, R.D., 2013. Understanding crop-ecology and agronomy of Rosa damascena Mill. for higher productivity. Australian Journal of Crop Science 7(2), 196–205.

[72]. Panda, H., 2005. Cultivation and utilization of aromatic plants. Asia Pacific Business Press INC.

[73]. Peng, Q., Zhang, Y., Fan, J., Shrestha, A., Zhang, W., Wang, G., 2023. The development of floral scent research: a comprehensive bibliometric analysis (1987–2022). Plants 12(23), 23. https://doi.org/10.3390/plants12233947

[74]. Picone, J.M., Clery, R.A., Watanabe, N., MacTavish, H.S., Turnbull, C.G., 2004. Rhythmic emission of floral volatiles from Rosa damascena semperflorens cv.'Quatre Saisons.' Planta, 219(3), 468–478.

[75]. Pise, V.H., Harlalka, R., Thorat, B.N., 2023. Drying of aromatic plant material for natural perfumes. CRC Press. https://doi.org/10.1201/9781003315384

[76]. Popa, R.G., 2022. Study on establishment efficiency a rose culture. Annals of Constantin Brancusi'University of Targu-Jiu. Engineering Series, 3. https://www.utgjiu.ro/rev_ing/pdf/2022-3/18_ROXANA-GABRIELA%20POPA_STUDY%20ON%20ESTABLISHMENT%20EFFICIENCY%20A%20ROSE%20CULTURE.pdf

[77]. Pourmahdi, O., Moradi Gardeshi, T., Amirkhani, A., GholamiAhangaran, M., 2023. The Effect of Rosa damascena Extract on Diazinon Toxicity in Mice. Journal of Chemical Health Risks, 4 (13),721-728. https://doi.org/10.22034/jchr.2021.1941985.1422

[78]. Radi, F.Z., Khamar, H., Remok, F., Amine, S., Drioiche, A., Aoudry, S., Zekri, N., Bouzoubaa, A., Zair, T., 2022. Aromatic and medicinal plants in the Ifrane region (Morocco): Floristic diversity, with special emphasis on ethnobotanical and socioeconomic studies of six spontaneous plants. Journal of Pharmacy & Pharmacognosy Research 10(3), 517–550. https://doi.org/10.56499/jppres21.1331_10.3.517

[79]. Randhawa, G.S., Mukhopadhyay, A., 1986. Floriculture in India. Allied Publishers.

[80]. Ravinath, D., 2007. Floriculture: A viable business. Excel Books India.

[81]. Raymond, O., Gouzy, J., Just, J., Badouin, H., Verdenaud, M., Lemainque, A., Vergne, P., Moja, S., Choisne, N., Pont, C., Carrère, S., Caissard, J.-C., Couloux, A., Cottret, L., Aury, J.-M., Szécsi, J., Latrasse, D., Madoui, M.-A., François, L., Fu, X., Yang, S.-H., Dubois, A., Piola, F., Larrieu, A., Perez, M., Labadie, K., Perrier, L., Govetto, B., Labrousse, Y., Villand, P., Bardoux, C., Boltz, V., Lopez-Roques, C., Heitzler, P., Vernoux, T., Vandenbussche, M., Quesneville, H., Boualem, A., Bendahmane, A., Liu, C., Le Bris, M., Salse, J., Baudino, S., Benhamed, M., Wincker, P., Bendahmane, M., 2018. The Rosa genome provides new insights into the domestication of modern roses. Nature Genetics 50, 772–777. https://doi.org/10.1038/s41588-018-0110-3

[82]. Rusanov, K., Kovacheva, N., Dobreva, A., Atanassov, I., 2020. Rosa x damascena Mill. (Rose). Medicinal, Aromatic and Stimulant Plants 467–500. https://doi.org/10.1007/978-3-030-38792-1_14

[83]. Saha, T. N., J. Majumder, Kadam, G. B., Kumar, G., Tiwari, A. K., Girish, K. S., & Kumar, R., 2014. Role of All India Coordinated Research Project in Development of Floriculture

in India. International Journal of Bio-Resource and Stress Management, 5, 159–165. Retrieved from https://ojs.pphouse.org/index.php/IJBSM/article/view/500

[84]. Sarwar, M., Saleem, M. F., Ullah, N., Maqsood, H., Ahmad, H., 2023. Physiological Ecology of Medicinal Plants: Implications for Phytochemical Constituents. In: Izah, S.C., Ogwu, M.C., Akram, M., (Eds.), Herbal Medicine Phytochemistry: Applications and Trends (pp. 1–33). Springer International Publishing. https://doi.org/10.1007/978-3-031-21973-3_35-1

[85]. Savvides, A.M., Stavridou, C., Ioannidou, S., Zoumides, C., Stylianou, A., 2023. An Ethnobotanical Investigation into the Traditional Uses of Mediterranean Medicinal and Aromatic Plants: The Case of Troodos Mountains in Cyprus. Plants 12(5), 1119. https://doi.org/10.3390/plants12051119

[86]. Smulders, M.J.M., Arens, P., Bourke, P.M., Debener, T., Linde, M., De Riek, J., Leus, L., Ruttink, T., Baudino, S., Hibrant Saint-Oyant, L., Clotault, J., Foucher, F., 2019. In the name of rose: A roadmap for rose research in the genome era. Horticulture Research 6, 65. https://doi.org/10.1038/s41438-019-0156-0

[87]. Sun, M., Ren, X., Liu, Y., Yang, J., Hui, J., Zhang, Y., Cui, Y., Zhang, J., Lin, G., Li, Y., 2023. Genetic Structure and Selection Signature in Flora Scent of Roses by Whole Genome Re-Sequencing. Diversity 15(6), 701. https://doi.org/10.3390/d15060701

[88]. Sweet, R., 1830. Sweet's Hortus Britannicus: Or, a catalogue of all the plants indigenous or cultivated in the gardens of Great Britain. J. Ridgway. https://biotanz.landcareresearch.co.nz/references/e29c02a5-abb2-4179-a4b3-c643dbab71c4

[89]. Thakur, M., Sharma, S., Sharma, U., Kumar, R., 2019. Study on effect of pruning time on growth, yield and quality of scented rose (*Rosa damascena Mill.)* varieties under acidic conditions of western Himalayas. Journal of Applied Research on Medicinal and Aromatic Plants 13, 100202.

[90]. Tosun, C., Soylu, Y., Atay, L., Timothy, D.J., 2023. Environmentally friendly behaviors of recreationists and natural area tourists: a comparative perspective. Sustainability, 15(13) 10651. https://doi.org/10.3390/su151310651

[91]. Turgut, K., Baydar, H., Telci, İ., 2023. Cultivation and Breeding of Medicinal and Aromatic Plants in Turkey. In: Medicinal and Aromatic Plants of Turkey (pp. 131–167). Springer.

[92]. Ubaldi, P., 2024. Species identification and geolocalization tools for seafoods products. Enhancement of Italian fish and analysis of food safety through a system of characterization, guarantee of quality and origin of origin based on the use of innovative bio-technological tools.

[93]. Anonymous, USDA Plants Database. (2023). Available at: https://plants.usda.gov/. Accessed on: XXXX.

[94]. Venkatesha, K.T., Gupta, A., Rai, A.N., Jambhulkar, S.J., Bisht, R., Padalia, R.C., 2022. Recent developments, challenges, and opportunities in genetic improvement of essential oil-bearing rose (Rosa damascena): A review. Industrial Crops and Products 184(2), 114984.

[95]. Yaghoobi, M., Farimani, M.M., Sadeghi, Z., Asghari, S., Rezadoost, H., 2022. Chemical analysis of Iranian Rosa damascena essential oil, concrete, and absolute oil under different bio-climatic conditions. Industrial Crops and Products 187(3), 115266.

[96]. Yuca, H., Tekman, E., CiVaş, A., Karakaya, S., Öztürk, G., DemiRci, B., Karaca, A., Güvenalp, Z., 2023. Comparison of essential oils and secretion structures of Rosa damascena Mill. Grown in Iğdır and Isparta (Turkey). Sakarya University Journal of Science 27(3), 523–529. https://doi.org/10.16984/saufenbilder.1197825

[97]. Zahidi, M., Ayegou, J., Ait Hou, M., 2022. Proximities and Logics of Sustainable Development of the Territorial Resource: The Case of the Localised Agro-Food System of Kalâat M'gouna in Morocco. Sustainability 14(23), 15842.

[98]. Zeynali, H., Tabaei, A.S., Arzani, A., 2009. A study of morphological variations and their relationship with flower yield and yield components in Rosa damascena. Journal of Agricultural science and technology, 11: 439-448. https://web.archive.org/web/20180510044732/http://jfst.modares.ac.ir/article-23-2169-en.pdf

[99]. Zhang, Y., Zuo, M., Li, R., Huang, J., Cheng, W., Shi, C., Bao, M., Zhang, W., 2024. Morphology, structure and development of glandular prickles in the genus Rosa. Scientia Horticulturae, 326, 112763.

[100]. Zlesak, D.C., 2007. Rose: Rosa x hybrida. In: Flower breeding and genetics: Issues, challenges and opportunities for the 21st century. Springer (pp. 695–740).

[101]. Zrira, S., 2017. Some important aromatic and medicinal plants of Morocco. Medicinal and Aromatic Plants of the World-Africa 3, 91–125.

