

EVALUATION OF SOME HYACINTH CULTIVARS UNDER OPEN FIELD CONDITIONS

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Abstract

The hyacinth is one of the most important spring-flowering bulbous plants, extremely appreciated for its beautiful and fragrant flowers in attractive colours, which is used in flowerbeds, borders, small groups, mass plantings of single variety or colour for a greater visual impact in parks and gardens, patio containers, and as cut flowers in bouquets and floral arrangements. It is also grown in pots and forced to bloom indoors in late winter. The aim of the study was to evaluate the growth and flowering characteristics of nine hyacinth cultivars grown in open field conditions. The results revealed that the maximum plant height (31.25 cm), length of the leaves (29.38 cm) and inflorescence length (14.33 cm) were recorded in 'Woodstock'. Among the studied cultivars, 'Blue Jacket' produced the highest number of flowers in inflorescence (44.36), 'Purple Pride' recorded the minimum number of days from planting to flowering (146.16 days) and 'Fondant' had the longest flowering duration (15.12 days).

Key words: *Hyacinthus orientalis*, cultivars, growth, flowering

INTRODUCTION

Hyacinthus orientalis L. is a perennial bulbous species in the Liliaceae family with tunicate bulbs that produce an upright, thick and fleshy, succulent flower stem, measuring 20-30 cm in height. The basal leaves are linear, narrow, glossy and deep green. The inflorescence is a more or less dense raceme composed of numerous small, single or double, waxy flowers in various shades of white, pink, red, yellow, orange, blue, and purple, each having a six-lobed, tubular perianth. The bright colour of the flowers is attributed to anthocyanins, the most common plant pigments identified and isolated in the flowers of various hyacinth cultivars, with some differences in composition (Hosokawa et al., 1996; Hosokawa, 1999; Mulholland et al., 2013; Tao et al., 2015). Xie & Wu (2017) reported that the morphology, colour, flowering duration, and quality of flowers can be modulated by inoculation with arbuscular mycorrhizal fungi. The flowers emit an intense and sweet characteristic fragrance that attracts bees. Hyacinths bloom in early to mid-spring (March-April), for two to three weeks, depending on the cultivar and the local climate, at the same time with other spring-flowering plants such as pansies, alpine forget-me-not, common daisies, primroses, daffodils,

and some varieties of tulips, etc. They prefer light, sandy, and sandy-loam soils, with the proper pH, moderately fertile and well-drained. Therefore, heavy, compact soils or those difficult to drain after abundant rains should be avoided. It grows and blooms best in full sun, but can also tolerate partial shade. Temperature has an essential role in controlling plant growth and flowering in geophytes. The optimal temperature for floral induction and early stages of organogenesis in hyacinths is between 17-25°C, followed by a period of low temperatures (4-9°C), crucial for floral stalk development and anthesis in spring (Khodorova & Boitel-Conti, 2013).

Hyacinths are vegetatively propagated through bulbs, which can be globose to ovate and covered with tunics of different colours such as white, cream, silvery-purple, or dark purple, depending on the cultivar grown. These bulbs, which store water and nutrients, are planted in the autumn, typically from late September to November, depending on the location, to bloom the following spring.

The hyacinth bulbs naturally produce very few bulblets. Therefore, various artificial methods have been developed to stimulate bulblets formation at the base of the mature bulb and increase the multiplication rate. Techniques of propagation involving cuts, either in cross or

radial through the basal plate of a dormant bulb (scoring), or scooping out the central portion of the basal plate with a small sterilized knife, while leaving the outer edge intact (scooping), are used to produce multiple new bulblets in a shorter time. Small bulblets will form along the cut surfaces, which are then planted separately from the bulbs and require three to four years to reach the normal size and start blooming. In the scooping method was obtained the highest number of bulblets per bulb, while the diameter, height and weight of the bulblets registered maximum values when the scoring technique was used (Zahraei Basir, 2022). Lexow & Bobadilla (2013) reported that by the scooping method was produced a greater number of bulblets than by cross-cutting in 'Splendid Cornelia', 'Carnegie', and 'Atlantic' hyacinth cultivars. Masoodi et al. (2022) concluded that the scooping technique proved efficient in propagation of the hyacinths, among the studied cultivars, the best results being obtained at 'Yellowstone' cultivar. The hyacinth bulbs do not sprout if planted immediately after harvesting, even under favorable growing conditions. A cold treatment period of several months is necessary to release their dormancy and accelerate the leaf emergence (Gude & Dijkema, 1992; Karjee & Mahapatra, 2019).

Conventional propagation of hyacinths is slow, therefore the micropropagation is an efficient alternative method for rapid production of a superior planting material. *In vitro* propagation techniques are used to meet the market demands for some economically valuable ornamental geophyte species (Çiğ & Başdoğan, 2015). These techniques are based on the plantlet formation and bulblet regeneration, using various types of explants such as bulb scale segments and leaves, that are the most widely used (Yi et al., 2002; Lee et al., 2007; Salehzadeh et al., 2008; Sun et al., 2010; Gheisari & Miri, 2017; El-Naggar et al., 2023), flower buds (Wen-liang et al., 1999), peduncle (Ziv & Lilien-Kipnis, 2000), fruits containing immature zygotic embryos (Kizil et al., 2016), and somatic embryogenesis (Zarnadze et al., 2019). Bulblet multiplication is influenced by various factors, including light, temperature, humidity, the size and type of the explants used, plant growth regulators, carbohydrates,

and the type of culture medium (Bach & Swiderski, 2000; Chung et al., 2006; Li et al., 2023). Some hyacinth cultivars can also be propagated by leaf cuttings, and after introduction into the rooting medium, adventitious roots and new bulbils form at their basal part (Krause, 1980).

Hyacinths are cultivated as ornamental plants in parks and gardens, and can be used in monochromatic or mixed-colour combinations in flowerbeds, mixed borders, mass plantings for a maximum visual impact, near building entry areas, patios, along walkways, or in outdoor pots and planters, as well as cut flowers in bouquets and floral arrangements (Seyidoğlu et al., 2009). Bulbs can be forced to grow and bloom indoors earlier than in the garden. Prepared bulbs that have 12-14 weeks of pre-cooling at 9°C, are utilized for forcing either in soil in pots (Śmigielńska et al., 2014), or in water using special glass vases and in hydroponic system (Krzywińska, 2008; Çiğ & Koçak, 2019; Wu et al., 2021). A bulb storage temperature of 5 or 10°C is recommended before planting in pots to achieve rapid and quality flowering (Nalouisi et al., 2018). For the growth of hyacinth in pots, Addai (2011) recommended the application of $(\text{NH}_4)_2\text{SO}_4$ to enhance plant growth and bulb yield, and Na_2HPO_4 to improve flower quality, both nutrients at a rate of 60-90 mM. Controlling the height of potted plants is important to prevent stem elongation and curvature, especially when bearing a heavy inflorescence, and this is achieved through chemical methods involving growth regulators, primarily gibberellin inhibitors (Demir & Çelikel, 2013; 2019). After flowering, the bulbs are planted in the garden and bloom in the spring of the following year.

The flowers are also utilized in the perfumery industry for extraction of essential oils, which have numerous applications in cosmetics and aromatherapy (Boeriu, 2015). Brunke et al. (1994) isolated the volatiles of white hyacinths by dynamic headspace trapping and identified more than 70 constituents. Zarifikhosroshahi et al. (2022) identified 28 volatile compounds in the fresh flowers of wild hyacinths. Ethanolic extracts obtained from hyacinth flowers (Soare et al., 2012), and silver phytonanoparticles synthesized using aqueous petal extracts (Bunghez et al., 2012) have demonstrated

antioxidant and antimicrobial activities. Kury et al. (2021) and Shareef & Abdul-Jalil (2023) revealed that the biologically active compounds present in the plant extracts have anticancer and immunomodulatory effects.

The experiment was conducted to study the growth and flowering behaviour of nine hyacinth cultivars under open field conditions.

MATERIALS AND METHODS

The research was carried out to evaluate the vegetative growth and flowering characteristics of nine hyacinth cultivars as 'Blue Jacket' (deep blue), 'City of Haarlem' (light yellow), 'Delft Blue' (blue), 'Fondant' (pink), 'Jan Bos' (dark pink), 'Pink Pearl' (light pink with white edges), 'Purple Pride' (purple), 'White Pearl' (white), and 'Woodstock' (deep purple) grown in open field conditions, in the Floriculture Research Area of the Faculty of Horticulture, University of Craiova, from October 2021 to April 2022. The planting material imported from the Netherlands and purchased from the local market, consisted of bulbs with a circumference of 14-15 cm and a weight ranging from 37.62 to 49.85 g. These bulbs were planted in the experimental field in October 2021, at the distances of 20 cm between rows, 15 cm between bulbs on row and a planting depth of 10 cm, in a fertile, moist and loose soil. Prior to planting in soil, the bulbs were treated with a fungicidal solution to enhance protection against diseases. The monofactorial experiment was arranged in randomized complete block design with three replications. The observations and biometric measurements were conducted at the flowering stage on various growth parameters such as plant height (measured from the surface of the soil to the apex of the inflorescence), leaf length and width, number of leaves per plant, and on flowering characteristics (inflorescence length, number of florets in the inflorescence, number of days from planting to flowering, and duration of flowering). The collected data were statistically processed using descriptive statistics and one-way analysis of variance (ANOVA) for each evaluated parameter, followed by Duncan's Multiple Range Test at $p \leq 0.05$ significance level.

RESULTS AND DISCUSSIONS

Vegetative growth parameters

The results regarding to the evaluated vegetative parameters are presented in Table 1. Significant statistical differences were observed among the hyacinth cultivars for plant height. Analysing the average values for each cultivar, it was found that the highest value for this growth parameter was recorded in 'Woodstock' (31.25 cm), followed by 'Delft Blue' (29.87 cm), while the 'Fondant' cultivar exhibited the lowest plant height (20.46 cm), indicating less vigorous growth.

The average number of leaves per plant ranged from 5.73 to 8.00, with an average of all the cultivars of 6.78 leaves. The 'City of Haarlem' cultivar recorded the maximum value, which indicated a significant number of leaves compared to other cultivars, while the minimum number of leaves per plant was observed in 'White Pearl'. Regarding the average leaf length and width, the data analysis revealed significant differences among cultivars. The highest value of leaf length was recorded at 'Woodstock' (29.38 cm), followed by 'Delft Blue' (25.76 cm), while 'City of Haarlem' exhibited the lowest leaf length (15.52 cm), and also the smallest leaf width (2.41 cm). 'Delft Blue' recorded the highest value for the leaf width (3.93 cm).

Masoodi (2022) reported significant variations among some cultivars of hyacinths for various growth and propagation traits. Kaushik et al. (2021) also reported variations attributed to cultivars for several vegetative parameters. The size of bulbs used during planting is very important, as it influences the vegetative growth of plants, making them more vigorous and robust, as well as the flower quality and the commercial value. The size of underground storage organs has a positive correlation with flowering quality (Kapczyńska, 2014; Howard & Cellinese, 2020). The increase of growth and flowering parameters in proportion to bulb size may be attributed to the amount of nutrients stored in the bulb before planting (Addai & Scott, 2011).

Table 1. Evaluation of vegetative parameters of various hyacinth cultivars studied under open field conditions

Cultivar	Plant height (cm)	Number of leaves/plant	Leaf length (cm)	Leaf width (cm)
Blue Jacket	24.16 cd	7.22 a	23.41 c	3.00 ab
City of Haarlem	23.31 d	8.00 a	15.52 f	2.41 b
Delft Blue	29.87 ab	6.33 bc	25.76 b	3.93 a
Fondant	20.46 d	6.91 ab	21.35 cd	3.00 ab
Jan Bos	26.13 c	6.66 bc	20.81 de	2.56 b
Pink Pearl	27.20 bc	6.00 bc	20.23 de	3.33 ab
Purple Pride	21.38 d	7.00 ab	18.56 e	3.53 a
White Pearl	23.92 cd	5.73 c	22.63 cd	3.25 ab
Woodstock	31.25 a	7.13 a	29.38 a	3.76 a
Mean	25.30	6.78	21.96	3.20
CV%	14.43	10.18	18.35	15.94

Means with same letter(s) in a column are statistically non-significant at the 5% significance level according to Duncan's multiple range test

Flowering parameters

The aesthetic value of the plants, but also other aspects such as the period and duration of flowering and their adaptability to various environmental conditions, are important criteria for plant selection, association and placement in urban green areas. The hyacinths are important ornamental plants used in the spring decoration of parks, as well as public and private gardens, and constitute a visual element of great attractiveness through a diverse colour palette and the multiple possibilities for designing of floral compositions from green spaces, in combination with other spring-flowering species. In addition to plant height, important aesthetic qualities to consider to choosing cultivars include the inflorescence length, colour, and the number of florets in the inflorescence.

The analysis of variance showed significant differences among the nine hyacinth cultivars for the number of days to flowering, duration of flowering, inflorescence length, and the number of florets in the inflorescence. The data related to the evaluation of the main flowering characteristics of the studied cultivars are presented in Table 2.

The number of days from bulb planting to the start of flowering varied from one cultivar to another. The minimum days required for the

opening of basal florets (146.16 days) were recorded for 'Purple Pride', which exhibited the earliest flowering, followed by 'Pink Pearl' and 'White Pearl' with an average number of 148.28 and 148.76 days, respectively. The highest number of days to flowering was noticed in the 'Fondant' cultivar, that flowered the latest, after 162.35 days. For the inflorescence length, the range of variance was between 9.53 and 14.33 cm. It was observed that 'Woodstock' was significantly superior to the other cultivars, except 'Pink Pearl' which had a similar value. The lowest inflorescence length was recorded in the 'Fondant' cultivar, and a similar value was reported by Çiğ & Koçak (2019).

The number of florets per inflorescence was recorded when all florets were fully opened and depends on cultivar, but is also influenced by growing conditions and environmental factors especially temperature and light (Luria et al., 2002; Kadam et al., 2013). 'Blue Jacket' and 'City of Haarlem' were the most floriferous cultivars that produced over 40 florets in the inflorescence, while the lowest number of florets (20.16) was observed in 'White Pearl'. The results indicated that the duration of flowering in the field was different among the nine hyacinth cultivars. 'Fondant' had the longest flowering duration (15.12 days), while the shortest flowering time was recorded at 'Purple Pride' (10.14 days). For the other cultivars evaluated in this experiment, the average flowering duration ranged between 10.38 and 14.33 days.

From the data analysis, it was observed that the lowest coefficient of variation was recorded for the number of days to flowering (3.11%), while the highest coefficient of variation was noticed for the number of florets in the inflorescence (29.68%). The other growth and flowering parameters analyzed exhibited moderate variability. The hyacinth cultivars presented variable responses for the evaluated growth and flowering characteristics, that might be due to the genetic potential and the influence of the environmental conditions, which have an important role in the performance of a cultivar.

Table 2. Evaluation of flowering parameters of various hyacinth cultivars studied under open field conditions

Cultivar	Number of days to flowering	Inflorescence length (cm)	Number of florets per inflorescence	Duration of flowering (days)
Blue Jacket	154.21 b	10.47 bc	44.36 a	12.34 bc
City of Haarlem	150.83 bc	12.26 b	42.50 a	10.86 d
Delft Blue	149.52 cd	11.38 bc	28.65 bc	12.41 bc
Fondant	162.35 a	9.53 c	20.74 c	15.12 a
Jan Bos	152.63 bc	10.65 bc	35.91 ab	10.38 d
Pink Pearl	148.28 cd	14.16 a	32.48 ab	12.73 b
Purple Pride	146.16 d	9.92 c	23.52 c	10.14 d
White Pearl	148.76 cd	11.63 b	20.16 c	14.33 a
Woodstock	152.14 bc	14.33 a	25.23 c	11.25 cd
Mean	151.65	11.59	30.39	12.17
CV%	3.11	14.84	29.68	14.13

Means with same letter(s) in a column are statistically non-significant at the 5% significance level according to Duncan's multiple range test

CONCLUSIONS

The results of this study revealed significant variations among the nine hyacinth cultivars in terms of the growth and flowering parameters evaluated under similar growing conditions. 'Woodstock' was superior to the other cultivars regarding plant height, as well as the length of leaves and inflorescence. 'Blue Jacket' and 'City of Haarlem' exhibited the highest number of florets per inflorescence.

The minimum number of days to flowering was recorded at 'Purple Pride', while the 'Fondant' and 'White Pearl' cultivars showed the longest flowering duration.

It was concluded that all the studied hyacinth cultivars are suitable for cultivation as spring ornamental plants in green spaces, in containers, and window boxes to provide colour, beauty, and fragrance, but they can be used also as cut flowers and potted plants for the decorating indoor spaces.

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