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Performance assessment of *Nymphaea* accessions for landscape use under Coimbatore condition

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Abstract

An experiment was conducted to evaluate the growth performance of nine *Nymphaea* accessions for landscape use under the climatic conditions of Coimbatore. The experimental design was laid out in Completely Randomized Block Design (CRD) with three replications at Botanical Garden, Department of Floriculture and Landscape Architecture, Tamil Nadu Agricultural University, Coimbatore. All the accessions showed significant variations for vegetative and reproductive parameters such as number of leaves, leaf width, petiole length and number of flowers. The experimental results showed that the growth performance of different tropical *Nymphaea* accessions with various colors such as *N. colorata*, *N. 'Red Flare'*, *N. 'Peach Blow'* and *N. capensis* were comparatively better and can be exploited for landscape use under Coimbatore conditions. During the months of summer, the growth performance of hardy water lilies showed somber growth when compared to that of tropical water lilies.

Keywords: *Nymphaea*, water lilies, accessions, growth, landscape use

Introduction

Aquatic garden is one of the ancient arts of gardening in India. Aquatic gardens are the wonderful way to admire the beauty of aquatic plants. *Nelumbo* and *Nymphaea* are the important aquatic plants of the water gardens in India. The genus *Nymphaea* L. commonly called water lilies belongs to the family Nymphaeaceae. Water lilies are herbaceous aquatic plants, highly exploited as an ornamental plant in aquatic gardening (Sharma 2001) [17]. The floral extravaganzas of water lilies have attracted the Botanists, Horticulturists and plant enthusiasts across the world (Kabatova *et al.*, 2014) [11]. Among the various aquatic plants water lilies have a significant place in phytoremediation and landscaping (Li *et al.*, 2005; Shi 2009). They are also exploited for cosmetics, beverages, floral decorations and pharmaceuticals (McDonald *et al.*, 2012; Madhusudhanan *et al.*, 2011; Bello *et al.*, 2016) [15, 14, 3]. *Nymphaea* species are either day bloomers or night bloomers (Lima *et al.*, 2012) [7]. Water lilies are classified into two types *viz.*, Tropical and Hardy based on the cold tolerance level. The tropical water lilies are beautiful than the hardy water lilies (Ciwei Yu *et al.*, 2018) [22] and they spread across the globe with diversified flower colours (Zhu *et al.*, 2012) [21]. The continuous development of new cultivars and hybrids of water lilies resulting in an ever-expanding diversity of *Nymphaea*. There are numerous kinds of water lilies to suit different climates, size and depth of pond (Robinson 1996). Water lilies have the widest range of petal hues, ranging from black to white making them the most colourful aquatic flowering plants (Fei Chen *et al.*, 2017) [5]. Water lilies are known to exhibit phenotypic plasticity, where the size of leaves and flowers are influenced by the hydrological and edaphic conditions (Polina and Alexy 2007) [19]. The characters to be considered before selecting *Nymphaea* as an ornamental plant are flower size, flower colour, fragrance and periodicity of flowering (Dassanayake 2017) [6].

Materials and Methods

The experiment was conducted at the Botanical garden, Tamil Nadu Agricultural University, Coimbatore (Tamil Nadu) to evaluate the different accessions of *Nymphaea* for landscape use. Altogether nine accessions were collected including both hardy (T₁ and T₂) and tropical water lilies (T₃ to T₉). Table 1 lists the name of the treatments. Uniform sized rhizomes (40g) with single bud were planted in the pots of size 22x16x20 cm filled with clay. Planting was done in such a way that the crown should remain above the soil level. Planting the rhizomes too deep or too shallow will result in rotting or poor establishment of roots respectively. The top layer of pot was filled with an inch of fine gravel to prevent the fishes from disturbing the crown and discoloration

of water. The pots were then placed in the installed HDPE beds of size 3x2x0.6 m. The design was laid out in Completely Randomised Block Design (CRD) and replicated thrice. Initially, the water level was maintained at 10 cm depth. The water level was increased with the establishment of plants. Water lilies can tolerate the depth of water up to 2 m with annual average of 30 to 67 cm (Richard *et al.*, 2011) [16]. The final water depth maintained during flowering was 60 cm.

After the establishment of plants, the decayed leaves were removed periodically to maintain the plants healthy. Freshwater aquarium fishes such as Guppies (*Poecilia reticulata*) and Mollies (*P. sphenops*) were introduced into the water to keep the mosquito larvae at check. There was no incidence of disease observed. Giant African Snail (*Achatina fulica*) was the only pest detected which was controlled by manual picking.

Aquatic plants require pond water with neutral or slightly alkaline pH for their proper growth and development. The

decayed leaves and debris were removed at periodical interval to maintain the pH at optimum level. The pH of the water samples was checked periodically and the results were within the optimum range. Water from the beds were pumped out and refilled at weekly intervals. The observations recorded at monthly intervals were number of leaves produced, leaf width, petiole length and number of flowers produced.

Table 1: Treatment Details

Treatments	Accession names
1	<i>N.</i> 'Chromatella'
2	<i>N.</i> 'Colorado'
3	<i>N. colorata</i>
4	<i>N.</i> 'Peach Blow'
5	<i>N.</i> 'Trudy Slocum'
6	<i>N. capensis</i>
7	<i>N. omrana</i>
8	<i>N.</i> 'Red Flare'
9	<i>N.</i> 'Panama Pacific'



Fig 1: T₁- *N.* 'Chromatella', T₂- *N.* 'Colorado', T₃- *N. colorata*, T₄- *N.* 'Peach Blow', T₅- *N.* 'Trudy Slocum', T₆- *N. capensis*, T₇- *N. omrana*, T₈- *N.* 'Red Flare', T₉- *N.* 'Panama Pacific'

Results and Discussion

Data on number of leaves, petiole length, leaf width and number of flowers were recorded on monthly intervals and analysed statistically. The experiment revealed that all the accessions significantly differed from each other for both vegetative and reproductive parameters.

Table 2 indicates the average number of leaves produced by

different accessions. After a month of planting, production of leaves was initiated. The number of leaves varied significantly among different accessions of *Nymphaea*. At 9MAP, the maximum number of leaves (9.74) was recorded in T₃ (*N. colorata*) followed by T₆ (*N. capensis*) with the value of 8.89.

Table 2: Mean performance of different accessions for number of leaves

Treatments	1MAP	2MAP	3MAP	4MAP	5MAP	6MAP	7MAP	8MAP	9MAP
T ₁	1.72	1.77	0.93	0.75	0.69	1.32	2.43	4.59	7.23
T ₂	1.63	1.68	0.87	0.70	0.62	1.27	2.32	4.33	6.99
T ₃	2.03	2.53	2.92	3.07	3.22	3.57	5.32	7.12	9.74
T ₄	1.97	2.01	2.34	2.97	3.12	3.21	4.15	5.79	7.91
T ₅	1.83	2.07	2.20	2.34	2.97	3.09	3.39	5.32	5.53
T ₆	1.79	1.99	2.27	2.41	3.01	3.34	4.03	6.87	8.89
T ₇	1.89	2.01	2.37	2.76	2.98	3.10	3.49	4.27	5.74
T ₈	1.99	2.03	2.37	2.52	3.07	3.11	3.97	5.97	7.88
T ₉	1.82	2.05	2.20	2.32	2.95	3.01	3.37	5.23	7.60
SEd	0.083	0.104	0.110	0.124	0.142	0.150	0.196	0.296	0.405
CD (p=0.05)	0.174	0.218	0.233	0.261	0.299	0.316	0.412	0.623	0.852

MAP - Months After Planting

Table 3 represents the mean performance of different accessions for petiole length during the study period. The growth performance of tropical water lilies was moderately uniform throughout the study period, while meager growth was recorded in hardy water lilies during the summer months (March to May). At 9MAP, the leaves of T₇ (*N. omrana*)

recorded the longest petiole length (44.98 cm) followed by T₈ (*N. 'Red Flare'*) and T₃ (*N. colorata*) with the values of 38.89 cm and 33.79 cm respectively. The shortest petiole length was recorded in T₁ (*N. 'Chromatella'*) and T₂ (*N. 'Colorado'*) with the values of 27.89 cm and 25.45 cm respectively.

Table 3: Mean performance of different accessions for petiole length

Treatments	1MAP	2MAP	3MAP	4MAP	5MAP	6MAP	7MAP	8MAP	9MAP
T ₁	17.89	18.92	18.23	17.98	17.23	23.89	24.09	24.73	27.89
T ₂	17.83	18.9	18.14	17.73	17.16	21.99	22.13	22.48	25.45
T ₃	18.34	19.78	26.98	30.79	36.78	36.93	37.39	33.04	37.79
T ₄	17.99	18.83	21.28	24.63	26.03	26.82	28.82	28.98	32.98
T ₅	17.92	18.79	20.97	24.99	27.93	28.55	29.10	29.25	33.25
T ₆	17.90	18.64	19.97	22.34	27.26	27.95	28.61	28.79	32.79
T ₇	19.32	20.34	29.25	35.12	38.49	38.74	39.04	40.08	44.98
T ₈	18.29	19.92	25.86	30.28	33.06	33.59	34.22	34.56	39.89
T ₉	17.97	18.73	20.88	23.18	27.47	27.97	28.49	28.56	32.56
SEd	0.936	0.991	1.148	1.298	1.440	1.509	1.549	1.535	1.549
CD (p=0.05)	1.967	2.082	2.413	2.727	3.026	3.172	3.255	3.226	3.255

MAP - Months After Planting

The average width of the leaves produced by different accessions is revealed in the Table 4. The average leaf width of the plants at 1MAP and 2MAP were found to be non-significant. The leaves produced in the hardy water lilies during the months of March, April and May were found to

have reduced leaf width. At 9MAP, T₇ (*N. omrana*) produced the widest leaf (22.1 cm) followed by T₃ (*N. colorata*) and T₈ (*N. 'Red Flare'*) with the values of 19.78 cm and 19.05 cm respectively.

Table 4: Mean performance of different accessions for leaf width

Treatments	1MAP	2MAP	3MAP	4MAP	5MAP	6MAP	7MAP	8MAP	9MAP
T ₁	5.87	6.16	5.99	5.98	5.92	8.63	11.21	15.2	15.23
T ₂	5.59	6.19	6.13	6.01	5.99	8.89	11.67	15.78	15.93
T ₃	5.79	6.99	9.71	11.89	14.98	18.70	18.73	19.34	19.78
T ₄	5.26	6.78	7.93	8.32	9.13	10.49	10.55	17.29	17.57
T ₅	5.13	6.32	6.99	8.99	11.25	13.61	13.62	17.55	17.63
T ₆	5.32	6.37	7.68	8.78	11.28	12.97	12.98	17.09	17.29
T ₇	5.89	7.04	10.09	11.93	16.04	19.03	19.93	22.09	22.10
T ₈	5.57	6.83	8.45	9.19	11.15	13.08	13.32	19.03	19.05
T ₉	5.30	6.56	8.14	9.24	10.04	12.24	12.56	17.23	17.54
SEd	0.284	0.341	0.407	0.454	0.73	0.562	0.686	0.909	0.919
CD (p=0.05)	0.598	0.717	0.855	0.955	1.128	1.371	1.432	1.909	1.931

MAP - Months After Planting

Hardy water lilies did not sustain the hot temperature, whereas progress in plant performance was noticed, as the temperature reduced. While the tropical water lilies were in contrast. Tropical water lilies can resist the cold temperature up to some extent but cannot withstand the temperature below 0°C (Ji Qin, 2016). Al-Menaie *et al.*, (2010) [10, 21] reported that the growth and development of water lilies are dependent on

the seasonal changes. The water lilies grew at a positive rate during the summer, but the growth was reduced during the winter.

The average number of flowers produced by different accessions is presented in the table 5. Among the different accessions of *Nymphaea* grown, five accessions flowered at 2MAP. Highest number of flowers were recorded in T₃, T₄

and T₆ with the values of 1.32, 1.27 and 1.23 respectively. The flowers of *N. colorata* were wisteria blue coloured with glossy green leaves without mottling. The research findings of Liangsheng Zhang *et al.*, (2019) elaborated that the pigment responsible for the blue colour in *N. colorata* is delphinidin 3'-O-(2''-O-galloyl-6''-O-acetyl-β-galactopyranoside). *N. colorata* is prized for the rare aesthetic blue coloured petals. The flowers of *N. 'Peach Blow'* were purple coloured with light green leaves. *N. capensis* have blue coloured flowers with bright yellow centres; the leaves are dark green coloured. Alam *et al.*, (2016) [1] recorded profuse flowering in *N. capensis* from mid-spring to early autumn.

At 3MAP, T₃ (*N. colorata*) produced the maximum number of flowers (1.98) followed by T₈ (*N. 'Red Flare'*) with 1.35 flowers. *N. 'Red Flare'* produced deep pink coloured flowers with reddish-bronze leaves. Maximum number of flowers were recorded in T₆ (*N. capensis*) and T₃ (*N. colorata*) at 4MAP with the values of 2.37 and 2.27 respectively. *N. 'Chromatella'* and *N. 'Colorado'* were observed to have no flower production up to 5MAP. Sunian (2004) [18] reported

that the flowers of hardy water lilies are small and do not rise above the water surface. They do not flower profusely as the tropical water lilies do. T₃ (*N. colorata*) recorded the maximum number of flowers (6.87) and T₁ (*N. 'Chromatella'*) and T₂ (*N. 'Colorado'*) started flowering at 6MAP. The flowers of *N. 'Chromatella'* were yellow coloured with olive green leaves with bronze coloured mottling. *N. 'Colorado'* produced flowers with salmon colour and olive green foliage with burgundy speckles. At 7MAP, maximum number of flowers (12.38) were recorded in T₈ (*N. 'Red Flare'*). Highest number of flowers were recorded in T₃ (*N. colorata*) and T₈ (*N. 'Red Flare'*) at 8MAP with the values of 14.71 and 13.99 respectively.

At 9MAP, the flower production was highly significant among the different accessions. Maximum number of flowers were recorded in T₃ (*N. colorata*) and T₈ (*N. 'Red Flare'*) with the values of 16.35 and 15.89 respectively followed by T₄ (*N. 'Peach Blow'*) and T₆ (*N. capensis*) with the values of 13.34 and 12.76 respectively.

Table 5: Mean performance of different accessions for number of flowers

Treatments	1MAP	2MAP	3MAP	4MAP	5MAP	6MAP	7MAP	8MAP	9MAP
T1	0.00	0.00	0.00	0.00	0.00	2.32	4.49	6.85	7.93
T2	0.00	0.00	0.00	0.00	0.00	2.45	4.49	6.69	7.23
T3	0.00	1.32	1.98	2.27	3.49	6.87	10.97	14.71	16.35
T4	0.00	1.27	1.38	2.12	3.10	7.98	10.03	11.89	13.34
T5	0.00	1.17	1.29	1.37	2.35	4.78	8.59	8.87	10.66
T6	0.00	1.23	1.35	2.37	3.13	3.98	8.67	10.25	12.76
T7	0.00	0.00	1.01	1.32	2.37	2.58	6.87	8.69	10.35
T8	0.00	0.00	1.79	2.17	3.19	5.32	12.38	13.99	15.89
T9	0.00	1.01	1.24	1.98	2.10	4.78	8.97	7.79	10.23
SEd	0.00	0.049	0.070	0.096	0.136	0.284	0.481	0.566	0.651
CD (p=0.05)	0.00	0.103	0.147	0.202	0.287	0.598	1.012	1.189	1.367

MAP - Months After Planting

The size of leaves and flowers of water lilies are highly influenced by hydrological and edaphic conditions particularly temperature (Kupriyanova, 1976 [12]; Dubyana, 1982; Polina and Alexy, 2007 [19]; Bhunia *et al.*, 2012 [4]; Guruge *et al.*, 2016 [9]).

Conclusion

From the experiment conducted, tropical water lilies have been found best in terms of growth performance. The seasonal and temperature influence throughout the growth period of the *Nymphaea* accessions revealed that environment plays a key role in the sustainability of the plant growth. The accessions *N. colorata*, *N. 'Red Flare'*, *N. 'Peach Blow'* and *N. capensis* performed better in both vegetative and flowering parameters. These accessions have essential use in landscape under tropical conditions and are well suited for Coimbatore conditions.

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